

MATERIALS WITH IMPROVED PROPERTIES

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

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(NIH) and Grant W81XWH-13-1-0215 awarded by the Department of Defense (DOD).
The government has certain rights in the invention.

FIELD OF THE INVENTION

This invention is in the field of materials with improved properties, e.g.,
10 biocompatibility, particularly implantable devices with reduced foreign body response
and moieties that confer improved properties, e.g., biocompatibility.

BACKGROUND OF THE INVENTION

The foreign body response is an immune-mediated reaction that impacts the
fidelity of implanted biomedical devices (Anderson et al., *Semin. Immunol.* 20:86–100
15 (2008); Langer, *Adv. Mater.* 21:3235–3236 (2009); Ward, *J. Diabetes Sci. Technol.*
Online 2:768–777 (2008); Harding & Reynolds, *Trends Biotechnol.* 32:140–146 (2014)).
Macrophage recognition of biomaterial surfaces in these devices initiate a cascade of
inflammatory events that result in the fibrous and collagenous encapsulation of these
foreign materials (Anderson et al. (2008); Ward (2008); Harding & Reynolds (2014);
20 Grainger, *Nat. Biotechnol.* 31:507–509 (2013); Williams, *Biomaterials* 29:2941–2953
(2008)). This encapsulation, over time, often leads to device failure and can result in
discomfort for the recipient (Anderson et al. (2008); Harding & Reynolds (2014);
Williams (2008)). These adverse outcomes emphasize the critical need for biomaterials
that do not elicit foreign body responses to overcome this key challenge to long-term
25 biomedical device function.

The foreign body response to implanted biomaterials is the culmination of
inflammatory events and wound-healing processes resulting in implant encapsulation
(Anderson et al. (2008)). The final pathological product of this response is fibrosis,
which is characterized by the accumulation of excessive extracellular matrix at sites of
30 inflammation and is a key obstacle for implantable medical devices as the cellular and
collagenous deposition isolate the device from the host (Anderson et al. (2008); Wick et
al., *Annu. Rev. Immunol.* 31:107–135 (2013); Wynn & Ramalingam, *Nat. Med.* 18:1028–
1040 (2012)). This device isolation can interfere with sensing of the host environment,

lead to painful tissue distortion, cut off nourishment (for implants containing living, cellular components), and ultimately lead to device failure. Materials commonly used for medical device manufacture today elicit a foreign body response that results in fibrous encapsulation of the implanted material (Langer (2009); Ward (2008); Harding & Reynolds (2014); Williams (2008); Zhang et al., *Nat. Biotechnol.* 31:553–556 (2013)). Overcoming the foreign body response to implanted devices could pave the way for implementing new medical advances, making the development of materials with both anti-inflammatory and anti-fibrotic properties a critical medical need (Anderson et al. (2008); Langer (2009); Harding & Reynolds (2014)).

Macrophages are a key component of material recognition and actively adhere to the surface of foreign objects (Anderson et al. (2008); Ward (2008); Grainger, *Nat. Biotechnol.* 31:507–509 (2013); Sussman et al., *Ann. Biomed. Eng.* 1–9 (2013) (doi:10.1007/s10439-013-0933-0)). Objects too large for macrophage phagocytosis initiate processes that result in the fusion of macrophages into foreign-body giant cells. These multi-nucleated bodies amplify the immune response by secreting cytokines and chemokines that result in the recruitment of fibroblasts that actively deposit matrix to isolate the foreign material (Anderson et al. (2008); Ward (2008); Rodriguez et al., *J. Biomed. Mater. Res. A* 89:152–159 (2009); Hetrick et al., *Biomaterials* 28:4571–4580 (2007)). This response has been described for materials of both natural and synthetic origins that encompass a wide range of physicochemical properties, including alginate, chitosan, dextran, collagen, hyaluronan, poly(ethylene glycol) (PEG), poly(methyl methacrylate) (PMMA), poly(2-hydroxyethyl methacrylate) (PHEMA), polyurethane, polyethylene, silicone rubber, Teflon, gold, titanium, silica, and alumina (Ward (2008); Ratner, *J. Controlled Release* 78:211–218 (2002)).

The development of implantable devices that resist host foreign body responses for protracted periods of time is important for improving the performance and safety of such devices, and remains an unmet need. Accordingly, the search for materials of clinical relevance that address the foreign body response to implantable devices, i.e., ameliorate biocompatibility, remains an area of active research.

Therefore, it is an object of the invention to provide chemical compounds suitable for modifying the surface or a surface of a product to impart a beneficial effect to the product compared to a corresponding product that lacks the chemical modification.

It is also an object of the invention to provide chemical compounds suitable for modifying the surface or a surface of a product, where the chemically modified product

has optimized biocompatibility, e.g., greater long term biocompatibility, following implantation of the product compared to a corresponding product that lacks the chemical modification.

5 It is also an object of the invention to provide chemical compounds suitable for modifying the surface or a surface of a product, where the chemically modified product elicits a lower foreign body response following implantation of the product compared to a corresponding product that lacks the chemical modification.

10 It is also an object of the invention to provide a chemically modified product with improved biocompatibility and tailored physico-chemical properties, including porosity, roughness, lubricity, hydrophilicity, and hydrophobicity, compared to a corresponding product that lacks the chemical modification.

It is also an object of the invention to provide a chemically modified product that elicits a lower foreign body response, compared to a corresponding product that lacks the chemical modification.

15 It is also an object of the invention to provide methods for chemically modifying the surface or a surface of a product using compounds, where the chemically modified product has improved biocompatibility compared to a corresponding product that lacks the chemical modification.

20 It is also an object of the invention to provide methods for chemically modifying the surface or a surface of a product using compounds, where the chemically modified product elicits a lower foreign body response compared to a corresponding product that lacks the chemical modification.

25 It is also an object of the invention to provide methods for treating a disorder or disease in a subject by transplanting or implanting a product modified with a compound, where the modified product has improved biocompatibility compared to a corresponding product that lacks the chemical modification.

30 It is also an object of the invention to provide methods for treating a disorder or disease in a subject by transplanting or implanting a product modified with a compound, where the modified product elicits a lower foreign body response compared to a corresponding product that lacks the chemical modification.

SUMMARY OF THE INVENTION

Products, such as devices, prostheses, and materials, having surfaces comprising moieties or compounds that impart beneficial properties to these products are disclosed.

The surface-modified products have optimized properties, e.g., improved biocompatibility, compared to a corresponding product that lacks the moieties or compounds on its surface. Following implantation in a subject, the surface-modified products induce a lower foreign-body response, compared to a corresponding unmodified product.

In some embodiments, the surfaces of the products can be covalently modified using chemical compounds. In some embodiments, the chemical compounds contain hydrophobic groups. In preferred embodiments, the chemical compounds contain aryl/heteroaryl groups. In currently preferred embodiments for improving biocompatibility, the chemical compounds contain a triazole linked to a moiety or compound that can provide anti-fibrotic properties. In preferred embodiments, the moiety can be tetrahydropyran, thiomorpholine-1,1-dioxide, or aniline.

In one aspect, the products described herein can be implanted or administered to a subject comprising a human or an animal including, but not limited to, a mouse, dog, cat, horse, bovine or ovine and the like, that is in need thereof, e.g., in need of alleviation or amelioration from a disorder, e.g., a recognized medical condition.

Disclosed are products, such as devices, prostheses, and materials, where the surface or a surface of the product includes one or more of the moieties or compounds described herein. In some embodiments, the product can be formed from a starting material or intermediate which includes the the moiety or compound. In some embodiments, the product can be formed by covalently modifying a starting material or the surface of a starting material, intermediate, or an otherwise finished object. For example, the surface or a surface of the product can be chemically modified after formation of the product with one or more compounds. The compounds are preferably compounds that confer a beneficial effect, such as lower foreign body response and improved biocompatibility, on the product. In some emodiments, the modifying compounds can provide anti-fibrotic properties. Also disclosed are methods of chemically modifying products and methods of using the chemically modified products, such as by implantation into a subject.

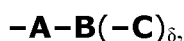
In some embodiments, the compound can have a structure $-X-R_1$, where X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

R_1 is hydrogen, or an organic grouping containing any number of carbon atoms, preferably 1-30 carbon atoms, more preferably 1-20 carbon atoms, more preferably 1-14

carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_1 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_2 + Q_3$); and

R_2 is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_2 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$).

In some embodiments, R_1 is, independently in one or more sites of chemical modification,



Formula XII

wherein

A is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$);

B, and **C** are, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$); and

δ is an integer from, as valency permits, 0 to 30.

In some embodiments, R_1 is, independently in one or more sites of chemical modification,



Formula II

wherein

R_3 is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, 5 branched, or cyclic structural formats, representative R_3 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$); and

R^b is absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally 10 including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R^b organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in 15 combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$).

Independently in some embodiments of **B**, **C**, and R^b , and independently in combination with any embodiments of any other relevant substituent classes, **B**, **C**, and 20 R^b can be, independently, absent, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_3$).

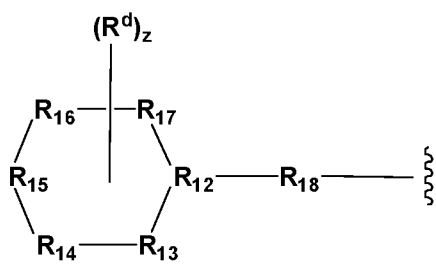
Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 25 can be, independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_1 .

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_2 .

Independently in some embodiments of **B**, **C**, and R^b , and independently in 30 combination with any embodiments of any other relevant substituent classes, **B**, **C**, and R^b can be, independently, absent, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_1 .

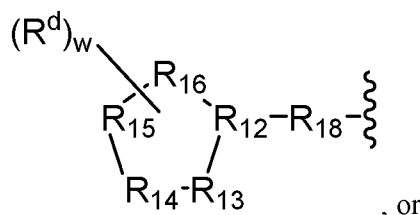
Independently in some embodiments of **B**, **C**, and R^b , and independently in combination with any embodiments of any other relevant substituent classes, **B**, **C**, and R^b can be, independently, absent, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_2 .

- 5 Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,

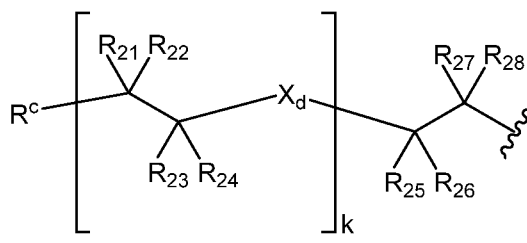


Formula VI

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Formula IX



Formula VIII

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wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

- wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_3$); or together with the carbon atom to which they are
- 20

attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

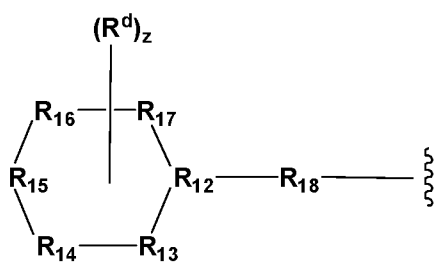
wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_3$);

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

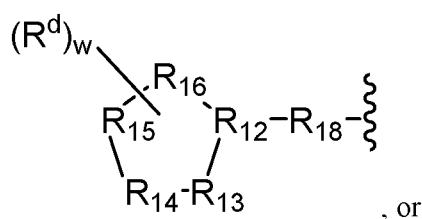
wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

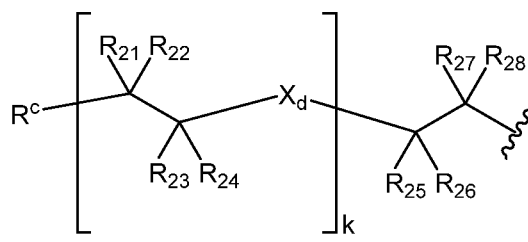
Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula VI



Formula IX



Formula VIII

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wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);

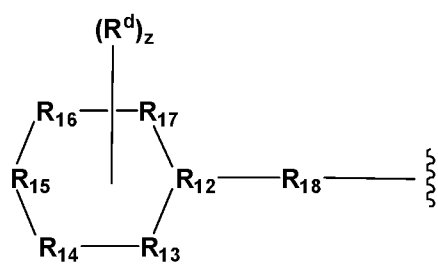
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, R^b , absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, U_1

+ Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃); and

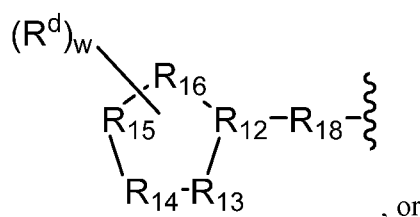
- wherein R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ are independently **C**, R^b, hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or
- 5 U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

Independently in some embodiments of R^b, and independently in combination with any embodiments of any other relevant substituent classes, R^b can be

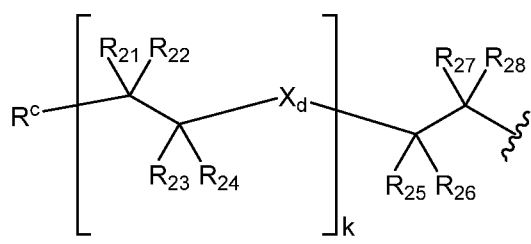


Formula VI

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Formula IX



Formula VIII

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wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

- wherein R^d are independently **C**, U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ +
- 20 Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

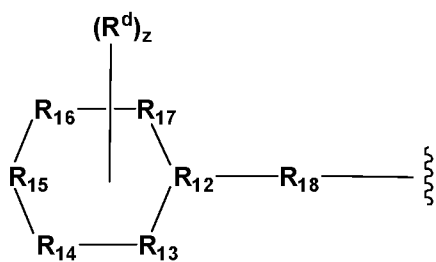
wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
5 embodiments, $U_3 + Q_1 + Q_3$);

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

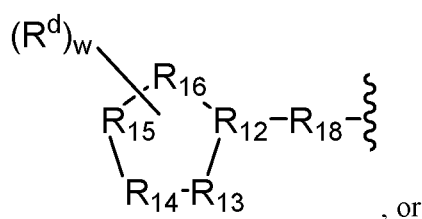
10 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
15 these embodiments, $U_1 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

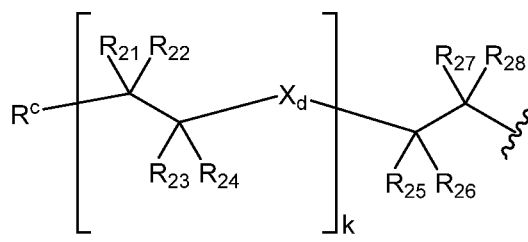
Independently in some embodiments of **C**, and independently in combination
20 with any embodiments of any other relevant substituent classes **C** can be



Formula VI



Formula IX



Formula VIII

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wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

10

wherein X_d are independently absent, O, or S;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);

15

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

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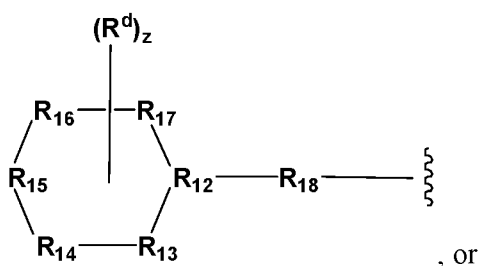
wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, U_1

25

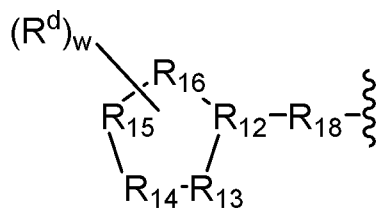
+ Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃); and

wherein R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ are independently hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

Independently in some embodiments of **A** and R₃, and independently in combination with any embodiments of any other relevant substituent classes, **A** and R₃ can be, independently,



Formula VI



Formula IX

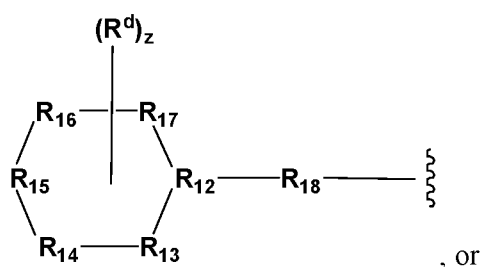
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently **B**, **C**, **-B(-C)**₆, R^b, U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

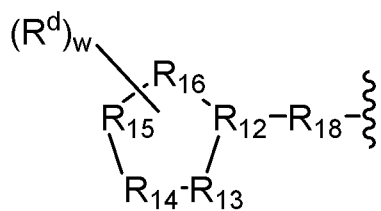
wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula VI



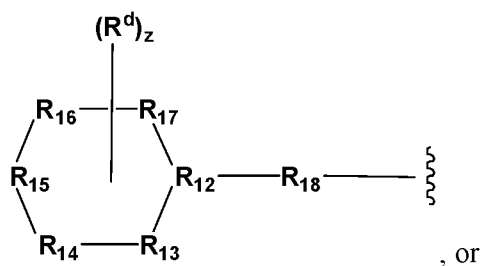
Formula IX

wherein z is an integer from 0-11; wherein w is an integer from 0-9;
 wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

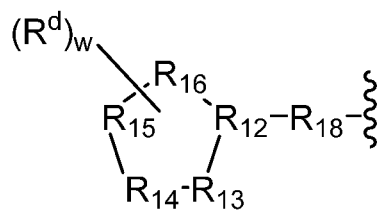
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, $S(O)$, or $S(O)_2$, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently C , R^b , absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula VI



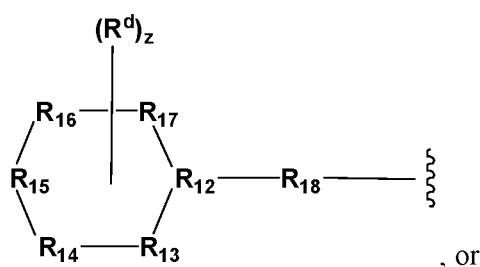
Formula IX

wherein z is an integer from 0-11; wherein w is an integer from 0-9;
 wherein R^d are independently C , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

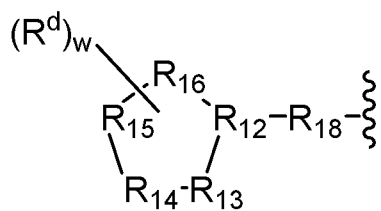
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C , O , N , S , $S(O)$, or $S(O)_2$, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula VI



Formula IX

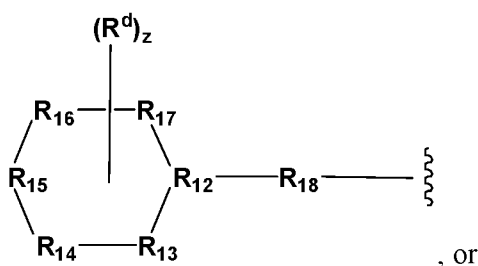
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently **C**, **O**, **N**, **S**, $S(O)$, or $S(O)_2$, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VI

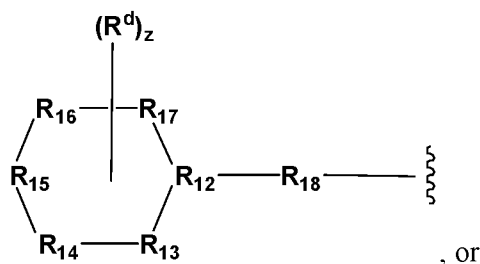
wherein z is an integer from 0-11;

wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, $S(O)$, or $S(O)_2$, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula VI

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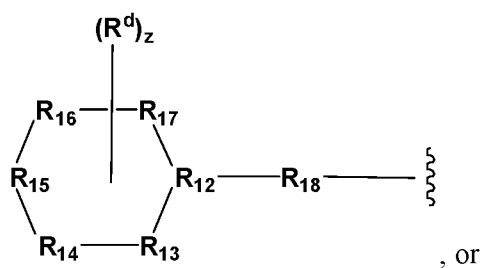
wherein z is an integer from 0-11;

wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
10 embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to
15 valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR_{20} , wherein each R_{19} is, as valency permits, independently **C**, R^b ,
20 absent, hydrogen, =O, =S, -OH, -SH, or NR_{20} , wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula VI

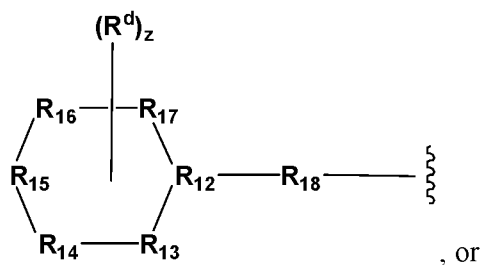
wherein z is an integer from 0-11;

5 wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

10 wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

20 Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula VI

25 wherein z is an integer from 0-11;

wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

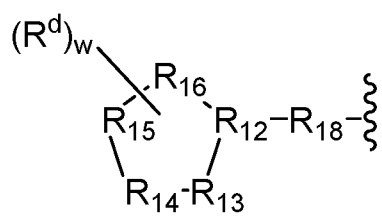
5 membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

10 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these

15 embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula IX

20

wherein w is an integer from 0-9;

wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

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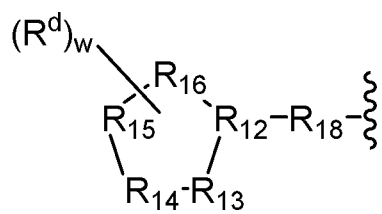
wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂,

30 wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency,

and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;
and

- wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

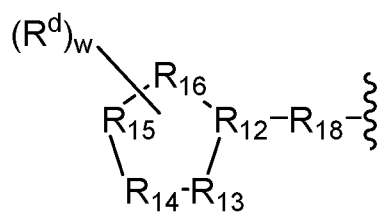
- Independently in some embodiments of **B**, and independently in combination
with any embodiments of any other relevant substituent classes, **B** can be



Formula IX

- wherein w is an integer from 0-9;
- wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;
- wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, $S(O)$, or $S(O)_2$, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;
and
- wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **C**, R^b , absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula IX

5

wherein w is an integer from 0-9;

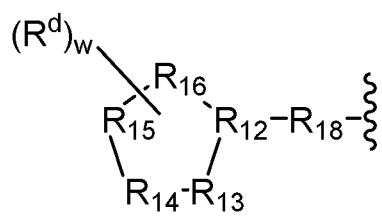
wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;

15 and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula IX

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wherein w is an integer from 0-9;

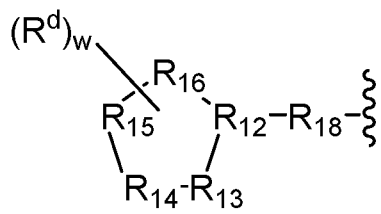
wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;

and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula IX

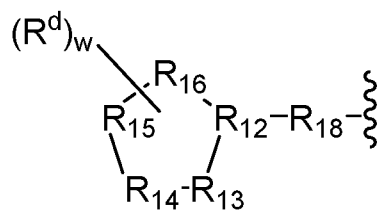
wherein w is an integer from 0-9;

wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

- 5 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
10 these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula IX

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wherein w is an integer from 0-9;

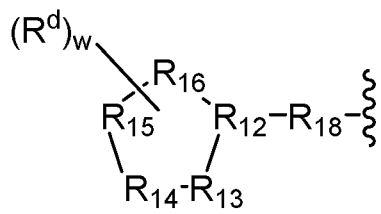
- wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
20 embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

- wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and
25

- wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, R^b ,
30 absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, U_1

+ Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃).

Independently in some embodiments of R^b, and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula IX

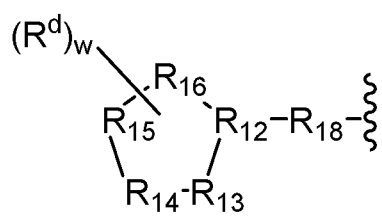
wherein w is an integer from 0-9;

wherein R^d are independently **C**, U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are independently C or N, wherein the bonds between adjacent R₁₂ to R₁₆ are double or single according to valency, wherein one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and the others are C, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency; and

wherein R₁₈ are independently absent, -(CR₁₉R₁₉)_p- or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R₁₉ is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R₂₀ is U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula IX

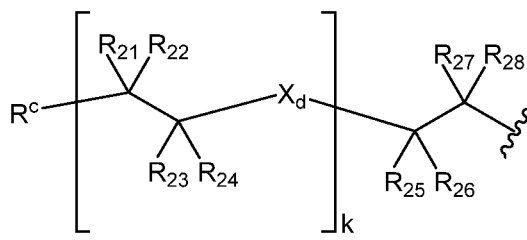
wherein w is an integer from 0-9;

5 wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

10 membered unsubstituted or substituted carbocyclic or heterocyclic ring;
wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

20 Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VIII

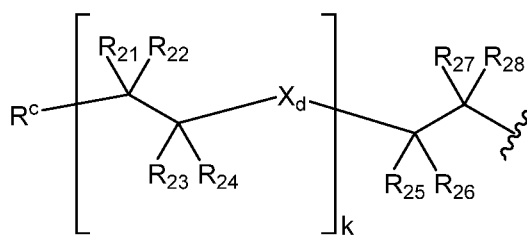
wherein k is an integer from 0 to 20;

wherein X_d are independently absent, O, or S;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
5 embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination
10 with any embodiments of any other relevant substituent classes, **B** can be



Formula VIII

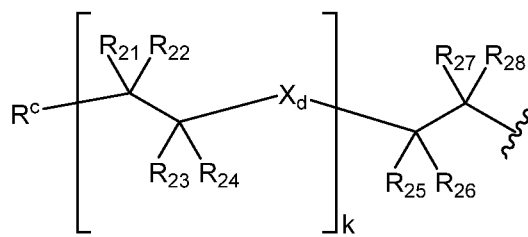
wherein k is an integer from 0 to 20;

15 wherein X_d are independently absent, O, or S;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
embodiments, $U_3 + Q_1 + Q_3$); and

20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination
with any embodiments of any other relevant substituent classes, R^b can be



Formula VIII

wherein k is an integer from 0 to 20;

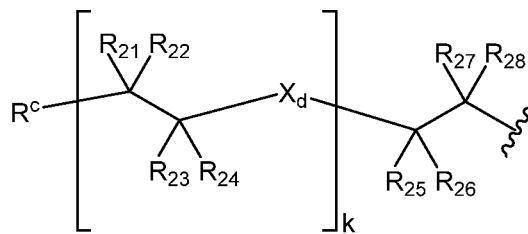
5 wherein X_d are independently absent, O, or S;

wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

10 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be

15



Formula VIII

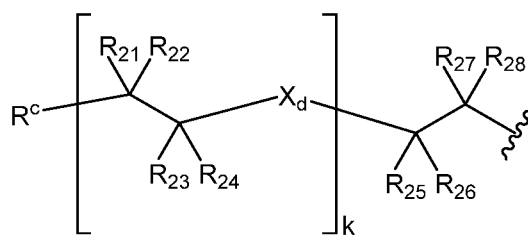
wherein k is an integer from 0 to 20;

wherein X_d are independently absent, O, or S;

20 wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in
 5 combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VIII

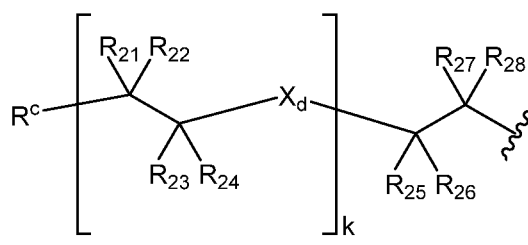
10 wherein k is an integer from 0 to 20;

wherein X_d are independently O or S;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in
 15 these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination
 20 with any embodiments of any other relevant substituent classes, **B** can be



Formula VIII

wherein k is an integer from 0 to 20;

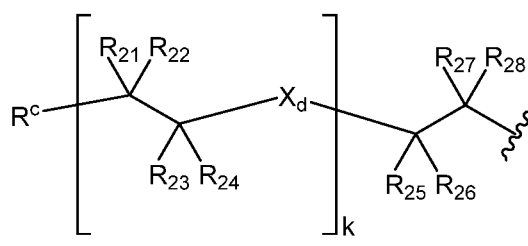
25 wherein X_d are independently O or S;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be

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Formula VIII

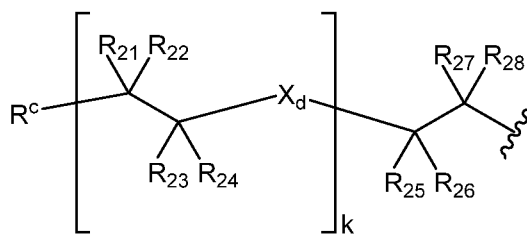
wherein k is an integer from 0 to 20;

wherein X_d are independently O or S;

- 15 wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula VIII

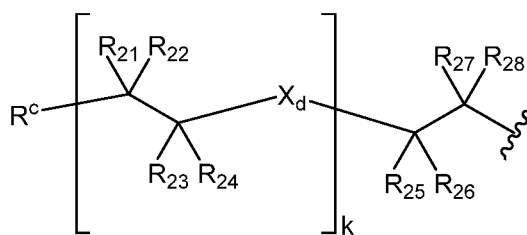
wherein k is an integer from 0 to 20;

5 wherein X_d are independently O or S;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

10 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3
 15 can be, independently,



Formula VIII

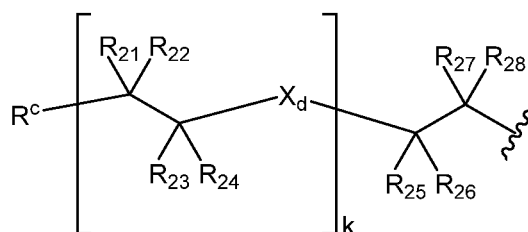
wherein k is an integer from 1 to 20;

20 wherein X_d are O;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination
 5 with any embodiments of any other relevant substituent classes, **B** can be



Formula VIII

wherein k is an integer from 1 to 20;

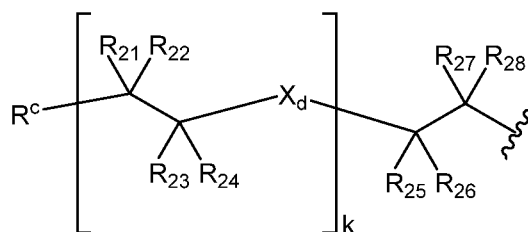
10 wherein X_d are O;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
 embodiments, $U_3 + Q_1 + Q_3$); and

15 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination
 with any embodiments of any other relevant substituent classes, R^b can be

20



Formula VIII

wherein k is an integer from 1 to 20;

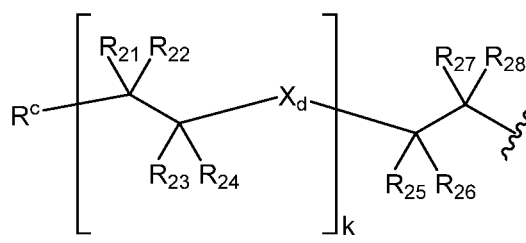
wherein X_d are O;

wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be

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Formula VIII

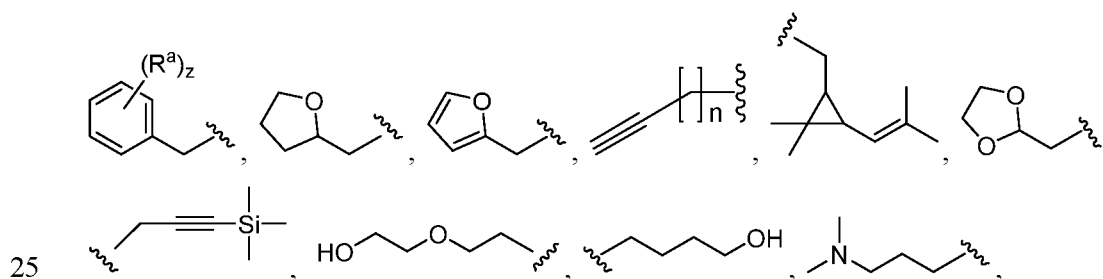
wherein k is an integer from 1 to 20;

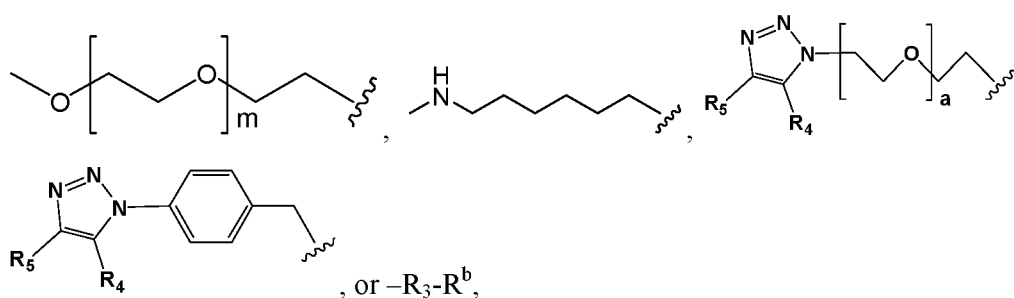
wherein X_d are O;

- 15 wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

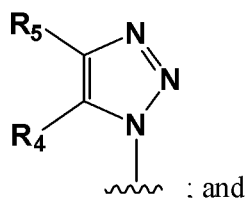
- 20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, R_1 is, independently in one or more sites of chemical modification,





where a is an integer from 1 to 30, z is an integer from 0-5, n is an integer from 1 to 12, m is an integer from 3 to 16, and R^a and R^b are independently selected from U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_2 + Q_3$), and R^b is



R_3 , R_4 , and R_5 are, independently, hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, the compound can have a structure $-X-R_1$, where

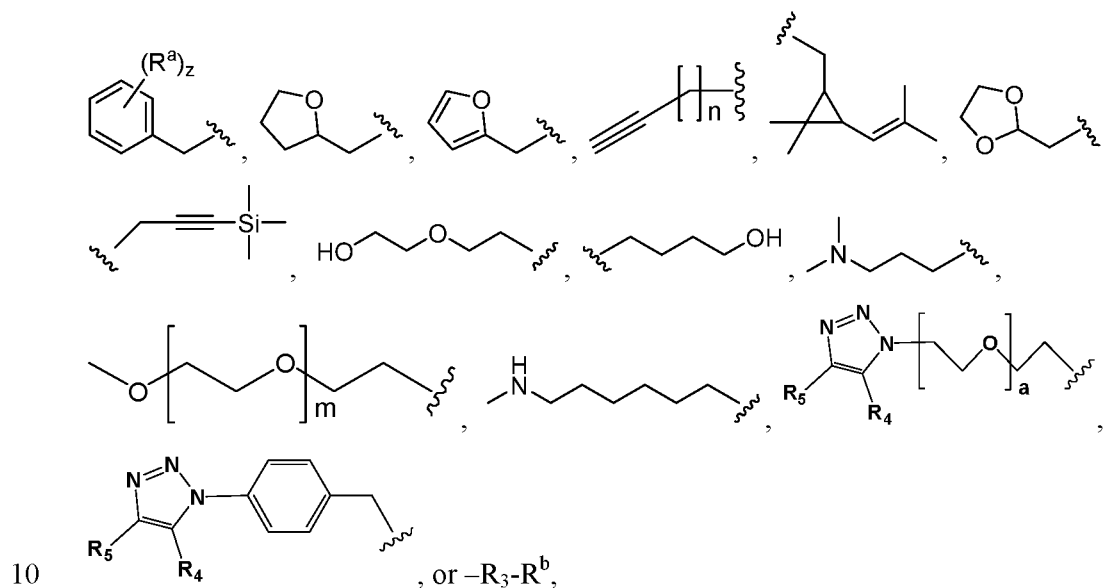
X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

R_1 is, independently in one or more sites of chemical modification, hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$);

R_2 is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including

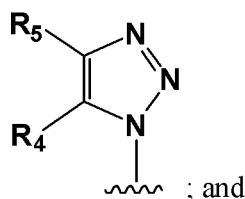
one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_2 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

- 5 In some embodiments, R_1 is, independently in one or more sites of chemical modification,



where a is an integer from 1 to 30, z is an integer from 0-5, n is an integer from 1 to 12, m is an integer from 3 to 16, R^a is independently selected from U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$

- 15 (preferably, in these embodiments, $U_3 + Q_1 + Q_2 + Q_3$), and R^b is



- R_3 , R_4 , and R_5 are, independently, hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_3 , R_4 , and R_5 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).
- 20

Independently in some embodiments of a, and independently in combination with any embodiments of any other relevant substituent classes, a can be an integer from 1 to 30, 2 to 30, 3 to 30, 4 to 30, 5 to 30, 6 to 30, 7 to 30, 8 to 30, 9 to 30, 10 to 30, 11 to 30, 12 to 30, 13 to 30, 14 to 30, 15 to 30, 16 to 30, 17 to 30, 18 to 30, 19 to 30, 20 to 30, 21 to 30, 22 to 30, 23 to 30, 24 to 30, 25 to 30, 26 to 30, 27 to 30, 28 to 30, 29 to 30, 1 to 29, 2 to 29, 3 to 29, 4 to 29, 5 to 29, 6 to 29, 7 to 29, 8 to 29, 9 to 29, 10 to 29, 11 to 29, 12 to 29, 13 to 29, 14 to 29, 15 to 29, 16 to 29, 17 to 29, 18 to 29, 19 to 29, 20 to 29, 21 to 29, 22 to 29, 23 to 29, 24 to 29, 25 to 29, 26 to 29, 27 to 29, 28 to 29, 1 to 28, 2 to 28, 3 to 28, 4 to 28, 5 to 28, 6 to 28, 7 to 28, 8 to 28, 9 to 28, 10 to 28, 11 to 28, 12 to 28, 13 to 28, 14 to 28, 15 to 28, 16 to 28, 17 to 28, 18 to 28, 19 to 28, 20 to 28, 21 to 28, 22 to 28, 23 to 28, 24 to 28, 25 to 28, 26 to 28, 27 to 28, 1 to 27, 2 to 27, 3 to 27, 4 to 27, 5 to 27, 6 to 27, 7 to 27, 8 to 27, 9 to 27, 10 to 27, 11 to 27, 12 to 27, 13 to 27, 14 to 27, 15 to 27, 16 to 27, 17 to 27, 18 to 27, 19 to 27, 20 to 27, 21 to 27, 22 to 27, 23 to 27, 24 to 27, 25 to 27, 26 to 27, 1 to 26, 2 to 26, 3 to 26, 4 to 26, 5 to 26, 6 to 26, 7 to 26, 8 to 26, 9 to 26, 10 to 26, 11 to 26, 12 to 26, 13 to 26, 14 to 26, 15 to 26, 16 to 26, 17 to 26, 18 to 26, 19 to 26, 20 to 26, 21 to 26, 22 to 26, 23 to 26, 24 to 26, 25 to 26, 1 to 25, 2 to 25, 3 to 25, 4 to 25, 5 to 25, 6 to 25, 7 to 25, 8 to 25, 9 to 25, 10 to 25, 11 to 25, 12 to 25, 13 to 25, 14 to 25, 15 to 25, 16 to 25, 17 to 25, 18 to 25, 19 to 25, 20 to 25, 21 to 25, 22 to 25, 23 to 25, 24 to 25, 1 to 24, 2 to 24, 3 to 24, 4 to 24, 5 to 24, 6 to 24, 7 to 24, 8 to 24, 9 to 24, 10 to 24, 11 to 24, 12 to 24, 13 to 24, 14 to 24, 15 to 24, 16 to 24, 17 to 24, 18 to 24, 19 to 24, 20 to 24, 21 to 24, 22 to 24, 23 to 24, 1 to 23, 2 to 23, 3 to 23, 4 to 23, 5 to 23, 6 to 23, 7 to 23, 8 to 23, 9 to 23, 10 to 23, 11 to 23, 12 to 23, 13 to 23, 14 to 23, 15 to 23, 16 to 23, 17 to 23, 18 to 23, 19 to 23, 20 to 23, 21 to 23, 22 to 23, 1 to 22, 2 to 22, 3 to 22, 4 to 22, 5 to 22, 6 to 22, 7 to 22, 8 to 22, 9 to 22, 10 to 22, 11 to 22, 12 to 22, 13 to 22, 14 to 22, 15 to 22, 16 to 22, 17 to 22, 18 to 22, 19 to 22, 20 to 22, 21 to 22, 1 to 21, 2 to 21, 3 to 21, 4 to 21, 5 to 21, 6 to 21, 7 to 21, 8 to 21, 9 to 21, 10 to 21, 11 to 21, 12 to 21, 13 to 21, 14 to 21, 15 to 21, 16 to 21, 17 to 21, 18 to 21, 19 to 21, 20 to 21, 1 to 20, 2 to 20, 3 to 20, 4 to 20, 5 to 20, 6 to 20, 7 to 20, 8 to 20, 9 to 20, 10 to 20, 11 to 20, 12 to 20, 13 to 20, 14 to 20, 15 to 20, 16 to 20, 17 to 20, 18 to 20, 19 to 20, 1 to 19, 2 to 19, 3 to 19, 4 to 19, 5 to 19, 6 to 19, 7 to 19, 8 to 19, 9 to 19, 10 to 19, 11 to 19, 12 to 19, 13 to 19, 14 to 19, 15 to 19, 16 to 19, 17 to 19, 18 to 19, 1 to 18, 2 to 18, 3 to 18, 4 to 18, 5 to 18, 6 to 18, 7 to 18, 8 to 18, 9 to 18, 10 to 18, 11 to 18, 12 to 18, 13 to 18, 14 to 18, 15 to 18, 16 to 18, 17 to 18, 1 to 17, 2 to 17, 3 to 17, 4 to 17, 5 to 17, 6 to 17, 7 to 17, 8 to 17, 9 to 17, 10 to 17, 11 to 17, 12 to 17, 13 to 17, 14 to 17, 15 to 17, 16 to 17, 1 to 16, 2 to 16, 3 to

16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 1 to 15, 2 to 15, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 1 to 14, 2 to 14, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 1 to 13, 2 to 13, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, a is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30.

Independently in some embodiments of a, and independently in combination with any embodiments of any other relevant substituent classes, a can be an integer from 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of a, and independently in combination with any embodiments of any other relevant substituent classes, a can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of a, and independently in combination with any embodiments of any other relevant substituent classes, a can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred embodiments, a is 1, 2, 3, 4, or 5.

Independently in some embodiments of m, and independently in combination with any embodiments of any other relevant substituent classes, m can be an integer from 3 to 16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 3 to 9, 4 to 9, 5 to

9, 6 to 9, 7 to 9, 8 to 9, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 3 to 6, 4 to 6, 5 to 6, 3 to 5, 4 to 5, and 3 to 4. In some embodiments, m is 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16.

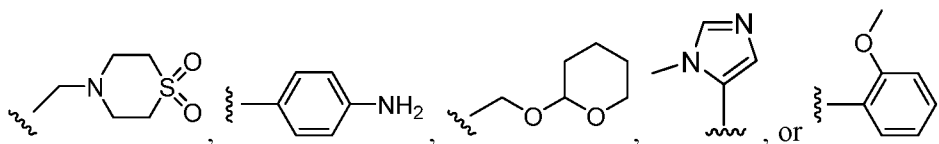
Independently in some embodiments of m, and independently in combination with any embodiments of any other relevant substituent classes, m can be an integer from 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 3 to 6, 4 to 6, 5 to 6, 3 to 5, 4 to 5, and 3 to 4. Independently in some embodiments of m, and independently in combination with any embodiments of any other relevant substituent classes, m can be 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of m, and independently in combination with any embodiments of any other relevant substituent classes, m can be an integer from 3 to 5, 4 to 5, or 3 to 4. In preferred embodiments, m is 3, 4, or 5.

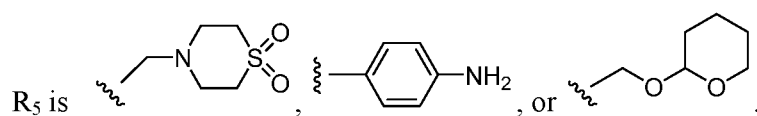
Independently in some embodiments of n, and independently in combination with any embodiments of any other relevant substituent classes, n can be an integer from 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, n is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20.

Independently in some embodiments of n, and independently in combination with any embodiments of any other relevant substituent classes, n can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred embodiments, n is 1, 2, 3, 4, or 5.

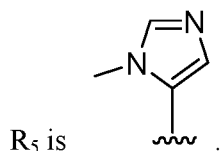
In some embodiments, R_3 is $-\text{CH}_2\text{-Ar-}$ or $-\text{CH}_2\text{-CH}_2\text{-(O-CH}_2\text{-CH}_2\text{)}_3\text{-}$; R_2 is hydrogen; R_4 is hydrogen, methyl, $-\text{COOH}$, $-\text{CH}_2\text{-O-CH}_2\text{-CH}_2\text{-OH}$, or $-\text{CH}_2\text{-OH}$; and R_5 is methyl, $-\text{COCH}_3$, $-\text{CH}_2\text{-N(CH}_2\text{-CH}_3\text{)}_2$, $-\text{N(CH}_2\text{-CH}_3\text{)}_2$, $-\text{CH}_2\text{-O-CH}_3$, $-(\text{CH}_2)_6\text{-CH}_3$, $-\text{CH}_2\text{-O-CH}_2\text{-CH}_2\text{-OH}$, $-\text{CH}_2\text{-CH(COOH)-(CH}_2\text{)}_5\text{-CH}_3$,



In some embodiments, R_4 is hydrogen; and

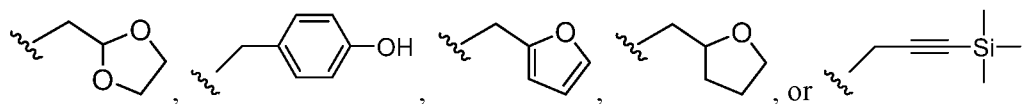


In some embodiments, R₄ is hydrogen; and

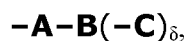


5 In some embodiments, R₅ is methyl, -COCH₃, or -CH₂-N(CH₂-CH₃)₂.

In some embodiments, X is oxygen or NR₂, wherein R₂ is hydrogen, methyl, or -CH₂-CH₃; and R₁ is -CH₂-CH₂-CH₂-CH₂-OH, -CH₂-CH₂-(O-CH₂-CH₂)_n-O-CH₃, where n is an integer from 3 to 16, -CH₂-CH₂-O-CH₂-CH₂-OH, -(CH₂-CH₂)₃-NH-CH₃,

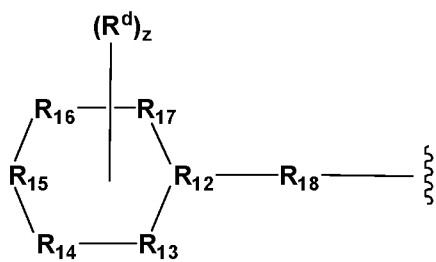


10 Independently in some embodiments of Formula I, X is oxygen, sulfur, or NR₂, wherein R₂ is hydrogen, alkyl, or substituted alkyl, wherein R₁ is



Formula XII

15 wherein **A** is



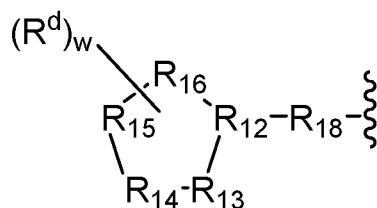
Formula VI

R¹⁸ in **A** is -(CR₁₉R₁₉)_p-, p is an integer from 0 to 5; each R₁₉ is hydrogen; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C or N, wherein the bonds between adjacent R₁₂

20

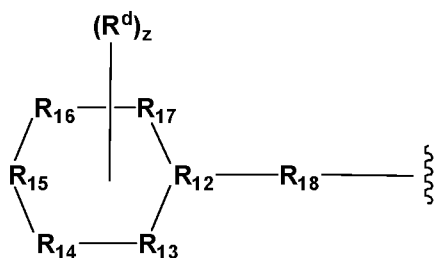
to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency;

wherein **B** is



Formula IX

- R¹⁸ in **B** is -(CR₁₉R₁₉)_p-; p is an integer from 0 to 5; each R₁₉ is hydrogen; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆, are independently C or N, wherein the bonds between adjacent R₁₂ to R₁₆ are double or single according to valency, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency;
- wherein **C** is

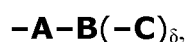


Formula VI

- R¹⁸ in **C** is -(CR₁₉R₁₉)_p- or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein p and q are independently integers from 0 to 5; X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀; each R₁₉ is hydrogen; R₂₀ is alkyl or substituted alkyl; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; each R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are

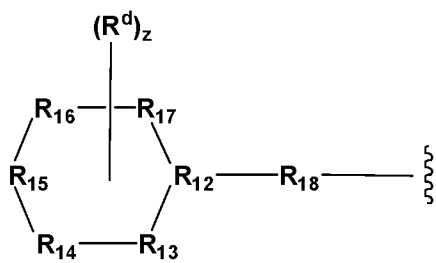
independently C, O, N, or S, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and wherein δ is 1.

- 5 Independently in some embodiments of Formula I, X is oxygen, sulfur, or NR₂, wherein R₂ is hydrogen, alkyl, or substituted alkyl, wherein R₁ is



Formula XII

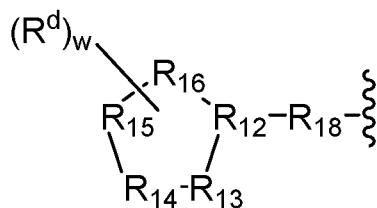
- 10 wherein **A** is



Formula VI

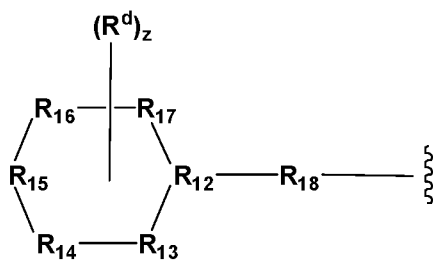
- R¹⁸ in **A** is -(CH₂)_p-; p is an integer from 0 to 5; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C or N, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and R¹⁵ is bound to **B**;
- 15
- 20

wherein **B** is



Formula IX

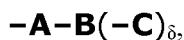
- R^{18} in **B** is $-(CH_2)_p-$; p is an integer from 0 to 5; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C_3 - C_{20} cyclic, substituted C_3 - C_{20} cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} , are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency, and R^{14} is bound to **C**;
- wherein **C** is



Formula VI

- R^{18} in **C** is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 1 and q is 0; X_b is $-O-$; each R_{19} is hydrogen; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C_3 - C_{20} cyclic, substituted C_3 - C_{20} cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; each R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, or S, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and
- wherein δ is 1.

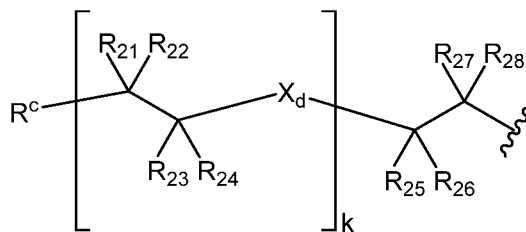
Independently in some embodiments of Formula I, X is oxygen, sulfur, or NR₂,
 wherein R₂ is hydrogen, alkyl, or substituted alkyl,
 wherein R₁ is



Formula XII

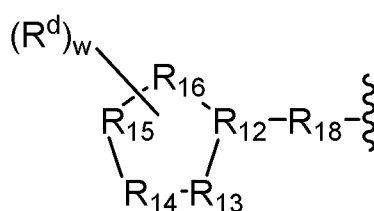
5

wherein **A** is



Formula VI

R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ in **A** are independently hydrogen, alkyl,
 10 substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl,
 substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, arylalkyl,
 substituted arylalkyl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, carbonyl,
 substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido,
 substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted
 15 heterocyclic, poly(ethylene glycol), or poly(lactic-co-glycolic acid); k is an integer from
 0 to 20; each X_d is independently absent, O, or S; and R^c is **B**;
 wherein **B** is

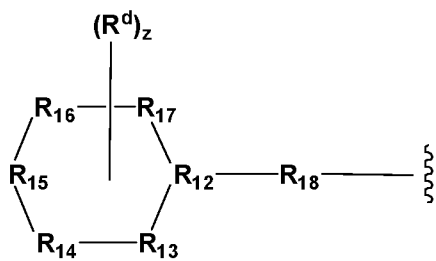


Formula IX

20 R¹⁸ in **B** is -(CR₁₉R₁₉)_p-; p is an integer from 0 to 5; each R₁₉ is hydrogen; each
 R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl,
 substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl,
 heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl,
 amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀
 25 cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R₁₂,
 R₁₃, R₁₄, R₁₅, and R₁₆, are independently C or N, wherein the bonds between adjacent R₁₂

to R₁₆ are double or single according to valency, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency;

wherein **C** is



Formula VI

- 5 **R¹⁸** in **C** is $-(\text{CR}_{19}\text{R}_{19})_p-$ or $-(\text{CR}_{19}\text{R}_{19})_p\text{-X}_b\text{-(CR}_{19}\text{R}_{19})_q-$, wherein p and q are independently integers from 0 to 5; X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀; each R₁₉ is hydrogen; R₂₀ is alkyl or substituted alkyl; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and wherein δ is 1.

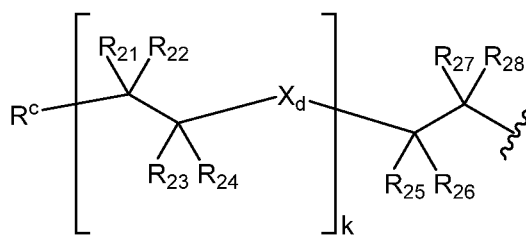
Independently in some embodiments of Formula I, X is oxygen, sulfur, or NR₂, wherein R₂ is hydrogen, alkyl, or substituted alkyl,

- 20 wherein R₁ is



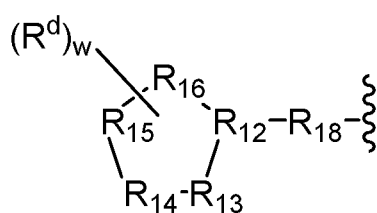
Formula XII

wherein **A** is



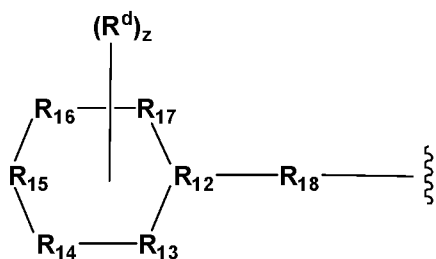
Formula VI

R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} in **A** are independently hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, poly(ethylene glycol), or poly(lactic-co-glycolic acid); k is an integer from 0 to 20; each X_d is independently absent, O, or S; and R^c is **B**; wherein **B** is



Formula IX

R^{18} in **B** is $-(CR_{19}R_{19})_p$; p is an integer from 0 to 5; each R₁₉ is hydrogen; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆, are independently C or N, wherein the bonds between adjacent R₁₂ to R₁₆ are double or single according to valency, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency, and R¹⁴ is bound to **C**; wherein **C** is

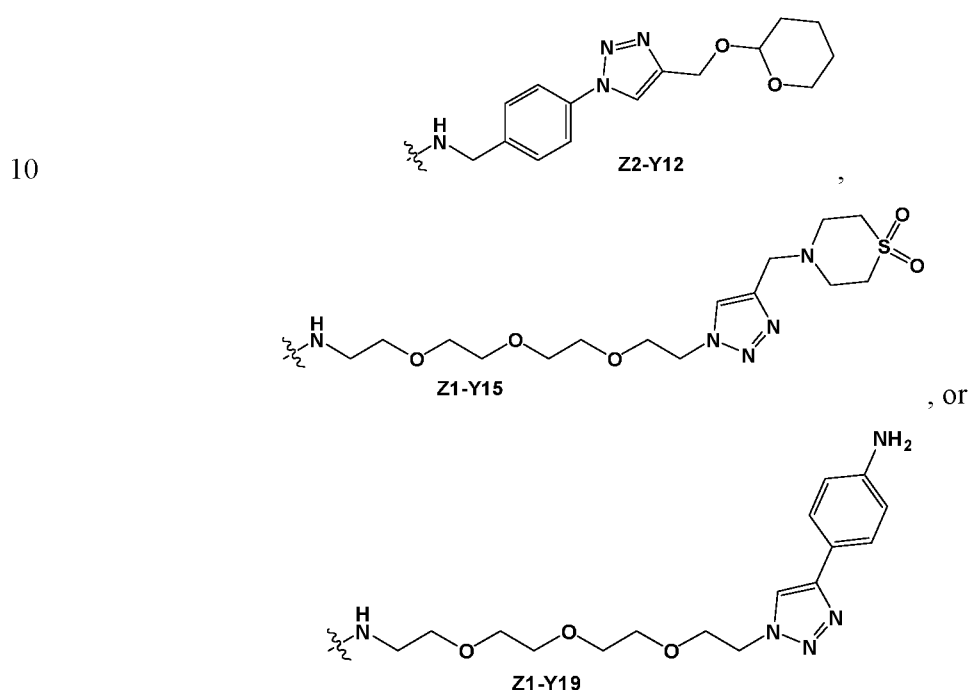


Formula VI

R^{18} in **C** is $-(CR_{19}R_{19})_p$; p is an integer from 0 to 5; each R₁₉ is hydrogen; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted

alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, N, or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and wherein δ is 1.

In some embodiments, the compound is



In some embodiments, the product includes a cargo or payload, such as a biological material. For example, the biological material can be cells or tissue. In some embodiments, the cargo is disposed within an outer member (e.g. a coating or encapsulating layer) that includes compounds as described herein on its surface.

In some embodiments, the product can be a cardiac pacemaker, a catheter, a needle injection catheter, a blood clot filter, a vascular transplant, a balloon, a stent transplant, a biliary stent, an intestinal stent, a bronchial stent, an esophageal stent, a ureteral stent, an aneurysm-filling coil or other coil device, a surgical repair mesh, a transmyocardial revascularization device, a percutaneous myocardial revascularization device, a prosthesis, an organ, a vessel, an aorta, a heart valve, a tube, an organ replacement part, an implant, a fiber, a hollow fiber, a membrane, a textile, banked

blood, a blood container, a titer plate, an adsorber media, a dialyzer, a connecting piece, a sensor, a valve, an endoscope, a filter, a pump chamber, or another medical device intended to have hemocompatible properties.

5 In some embodiments, the product includes cells or tissues encapsulated or coated with a polymer, where the the surface or a surface of the polymeric product includes compounds as described herein. In some embodiments of such products:

(a) the polymer comprises polydimethylsiloxane (PDMS);

(b) the compound comprises the formula $-A-B(-C)_\delta$ (Formula XIII), where **A** is Formula VIII or Formula VI, **B** is Formula IX, δ is 1, **C** is Formula VI;

10 (c) the product is spherical or spheroidal in shape;

(d)) the product has an average diameter of 1.5 mm;

(e) the cell is a cell producing a recombinant product; and, optionally,

(f) the product has a pore size of 0.1 to 1 μ m.

15 In some embodiments, the product is provided as a preparation of products and the products in the preparation have one or more of the following characteristics:

(1) at least 50% of the products in the preparation have a surface with a concentration of 1 to 5% surface modifications as measured by X-ray photoelectron spectroscopy (XPS);

(2) at least 50% of the products in the preparation have the shape specified in (c);

20 (3) at least 50% of the products in the preparation have a the diameter specified in (d); and

(4) at least 50% of the products in the preparation have the pore size of (f).

In some embodiments, the product has properties (1) and (2).

In some embodiments, the product has properties (1) and (3).

25 In some embodiments, the product has properties (1) and (4).

In some embodiments, the product has properties (2) and (3).

In some embodiments, the product has properties (2) and (4).

In some embodiments, the product has properties (3) and (4).

In some embodiments, the product has properties (1), (2), and (3).

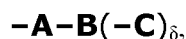
30 In some embodiments, the product has properties (1), (2), (3). and (4).

In some embodiments, when implanted into the subject, at least 5% of the cells are alive after 30 days.

In some embodiments, when implanted into the subject, the cells respond to an increase in blood glucose by secreting insulin.

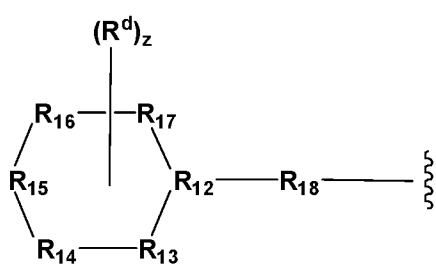
In some embodiments, the product is singularly modified with the compound of (b).

In some embodiments, the product is encapsulated or coated with a polymer, wherein the polymer comprises a compound with a structure $-X-R_1$, wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface; R_2 is hydrogen, alkyl, or substituted alkyl; and R_1 is



Formula XII

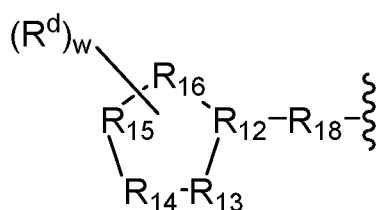
wherein **A** is



Formula VI

R^{18} in **A** is $-(CH_2)_p$; p is an integer from 0 to 5; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C_3 - C_{20} cyclic, substituted C_3 - C_{20} cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C or N, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and R^{15} is bound to **B**;

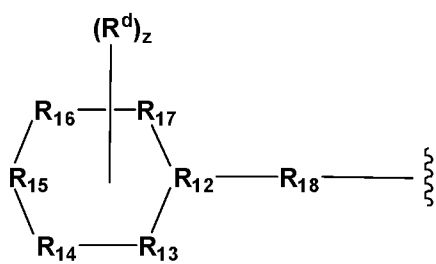
wherein **B** is



Formula IX

R^{18} in **B** is $-(CH_2)_p$; p is an integer from 0 to 5; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy,

alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆, are
 5 independently C or N, wherein the bonds between adjacent R₁₂ to R₁₆ are double or single according to valency, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency, and R¹⁴ is bound to **C**.
 wherein **C** is



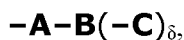
Formula VI

R¹⁸ in **C** is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, p is 1 and q is 0; X_b is -O-; each R₁₉ is hydrogen; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted
 15 carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; each R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, O, N, or S, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency;
 20 wherein δ is 1; and
 wherein the product has one or more characteristics selected from:

- (a) a spherical or spheroidal shape;
- (b) a mean diameter between 1 mm and 4 mm;
- (c) a mean pore size ranging from 0.1 μm to 10 μm;
- 25 (d) a density of chemical derivatizations between 100 and 1000 per μm² on the surface or a surface of the products, in the interior of the products, or both; and
- (e) a concentration of between 10 and 100 percent surface modifications.

In some embodiments, the product is encapsulated or coated with a polymer, wherein the polymer comprises a compound with a structure-X-R₁, wherein X is

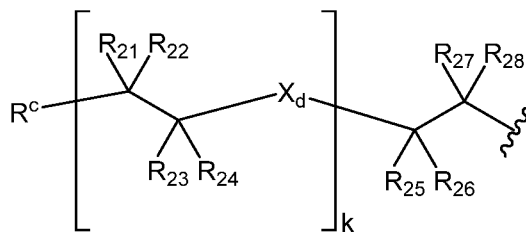
oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface; R₂ is hydrogen, alkyl, or substituted alkyl; and R₁ is



Formula XII

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wherein **A** is

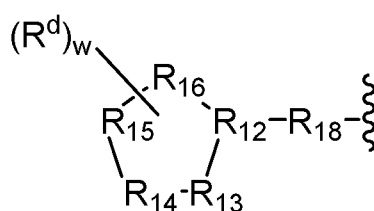


Formula VI

R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ in **A** are independently hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, poly(ethylene glycol), or poly(lactic-co-glycolic acid); k is an integer from 0 to 20; each X_d is independently absent, O, or S; and R^c is **B**;

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15
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wherein **B** is

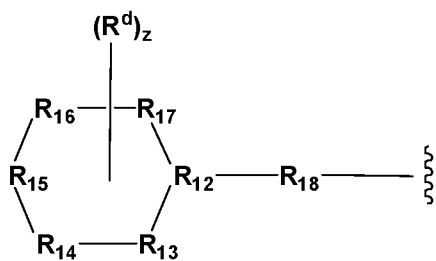


Formula IX

R¹⁸ in **B** is -(CR₁₉R₁₉)_p-; p is an integer from 0 to 5; each R₁₉ is hydrogen; each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; w is an integer from 0 to 4; each R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆, are independently C or N, wherein the bonds between adjacent R₁₂

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to R₁₆ are double or single according to valency, and wherein R₁₂ to R₁₆ are bound to none, one, or two hydrogens according to valency, and R¹⁴ is bound to **C**;
wherein **C** is



Formula VI

R¹⁸ in **C** is -(CR₁₉R₁₉)_p-; p is an integer from 0 to 5; each R₁₉ is hydrogen; R^d are independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, or substituted heterocyclic; z is an integer from 0 to 11; wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, N, or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency;
wherein δ is 1; and
wherein the product has one or more characteristics selected from:

- (a) a spherical or spheroidal shape;
- (b) a mean diameter between 1 mm and 4 mm;
- (c) a mean pore size ranging from 0.1 μm to 10 μm;
- (d) a density of chemical derivatizations between 100 and 1000 per μm² on the surface or a surface of the products, in the interior of the products, or both; and
- (e) a concentration of between 10 and 100 percent surface modifications.

In some embodiments, the product is multiply modified with the compound of (b) and another compound of different structure (for example, another compound as disclosed herein).

In some embodiments, the product is purified after chemical modification to remove any unreacted or partially reacted contaminants present with the chemically modified product, wherein the purified chemically modified product induces a lower foreign body response than a similar product that has not been chemically modified.

DETAILED DESCRIPTION OF THE INVENTION

It has been discovered that certain classes of chemical compounds confer beneficial effects, such as lower foreign body response, when used to chemically modify products for implantation into the body of a subject. In tests of a range of product materials, the disclosed chemical modifications improve the *in vivo* performance of implantable biomedical devices through chemical surface modification of commonly and widely used materials for device manufacture.

I. Definitions

“Biocompatible,” as used herein, refers to a substance or object that performs its desired function when introduced into an organism without inducing significant inflammatory response, immunogenicity, or cytotoxicity to native cells, tissues, or organs. For example, a biocompatible product is a product that performs its desired function when introduced into an organism without inducing significant inflammatory response, immunogenicity, or cytotoxicity to native cells, tissues, or organs. Biocompatibility, as used herein, can be quantified using the *in vivo* biocompatibility assay described below.

In this assay, a material or product as disclosed can be considered biocompatible if it produces, in a test of biocompatibility related to immune system reaction less than 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, 10%, 8%, 6%, 5%, 4%, 3%, 2%, or 1% of the reaction, in the same test of biocompatibility, produced by a material or product the same as the test material or product except for a lack of the surface modification on the test material or product. Examples of useful biocompatibility tests include measuring and assessing cytotoxicity in cell culture, inflammatory response after implantation (such as by fluorescence detection of cathepsin activity), and immune system cells recruited to implant (for example, macrophages and neutrophils).

“Foreign body response” as used herein, refers to the immunological response of biological tissue to the presence of any foreign material in the tissue which can include protein adsorption, macrophages, multinucleated foreign body giant cells, fibroblasts, and angiogenesis.

“Contacting” as used herein in the context of coating refers to any way for coating a product, using one or more of the compounds disclosed herein, on a substrate such as a product. Contacting can include, but is not limited to, intraoperative dip-coating, spraying, wetting, immersing, dipping, painting, bonding or adhering, stepwise surface derivatization, or otherwise providing a substrate or surface with a compound. The

compound can be covalently attached, non-covalently attached, or both, to the substrate or surface.

"Coating" as used herein, refers to any temporary, semi-permanent or permanent layer, covering or surface. A coating can be applied as a gas, vapor, liquid, paste, semi-solid, or solid. In addition a coating can be applied as a liquid and solidified into a hard coating. Elasticity can be engineered into coatings to accommodate pliability, e.g. swelling or shrinkage, of the substrate or surface to be coated.

"Chemical modification" and related terms, as used herein in the context of the disclosed products, refers to chemical modification of the product. Generally, such chemical modification is by direct attachment, coupling, or adherence of a compound to the surface material of the product. Preferably, the chemical modification involves modification with one or more of the disclosed compounds. Chemical modification, as defined herein in the context of the disclosed products, can be accomplished at any time and in any manner, including, for example, synthesis or production of the modified form of the product or material when the product or material is formed, addition of the chemical modification after the final product or material is formed, or at any time in between. The terms "replaced," "replace," "modified," "singularly modified," "singular modification," "multiply modified," "multiple modifications," "chemically modified," "surface modified," "modification," "chemical modification," "surface modification," "substituted," "substitution," "derived from," "based on," or "derivatized," and similar terms, as used herein to describe a structure, do not limit the structure to one made from a specific starting material or by a particular synthetic route. Except where specifically and expressly provided to the contrary, the terms refer to a structural property, regardless of how the structure was formed, and the structure is not limited to a structure made by any specific method.

In some embodiments, where explicitly indicated, addition or application of a material, compound, or composition to a starting material or intermediate before it is made into or incorporated into the final product can be specifically excluded. Thus, for example, chemical modification of alginate or another polymer prior to the polymer being incorporated into a capsule or other structure can be, in some embodiments, specifically excluded as the manner of producing a chemical modification of the capsule or structure. As another example, coating a device, prosthesis, or other product with a material that was chemically modified prior to being applied as a coating can be, in some embodiments, specifically excluded as the manner of producing a chemical modification

of the device, prosthesis, or product. However, for such embodiments where such specific exclusions are used, so long as the product was itself chemically modified, coating of or addition to the product of another material that has chemical modifications does not alter the fact that the product was chemically modified according to the
5 meaning of the term used herein.

“Surface modification” and related terms, as used herein in the context of a product, e.g., the disclosed products, refers to chemical modification of the surface or a surface of the product. Generally, such surface modification is by direct attachment, coupling, or adherence of a compound to the surface material of the product. Preferably,
10 the surface modification involves modification with one or more of the disclosed compounds. Surface modification, as defined herein in the context of the disclosed products, can be accomplished at any time and in any manner, including, for example, synthesis or production of the modified form of the product or material when the product or material is formed, addition of the chemical modification after the final product or
15 material is formed, or at any time in between. Except where specifically and expressly provided to the contrary, the term “surface modification” refers to a structural property, regardless of how the structure was formed, and the structure is not limited to a structure made by any specific method.

In some embodiments, where explicitly indicated, addition or application of a
20 material, compound, or composition to a starting material or intermediate before it is made into or incorporated into the final product can be specifically excluded. Thus, for example, chemical or surface modification of alginate or another polymer prior to the polymer being incorporated into a capsule or other structure can be, in some embodiments, specifically excluded as the manner of producing a surface modification
25 of the capsule or structure. As another example, coating a device, prosthesis, or other product with a material that was chemically modified prior to being applied as a coating can be, in some embodiments, specifically excluded as the manner of producing a surface modification of the device, prosthesis, or product. However, for such embodiments where such specific exclusions are used, so long as the product was itself
30 surface modified, coating of or addition to the product of another material that has chemical modifications does not alter the fact that the product was surface modified according to the meaning of the term used herein.

In some embodiments, the moieties or compounds modifying the product can be present on the surface or a surface of the product, and are not present, or are not present

in a significant amount, elsewhere in the product, e.g., on internal or interior surfaces. In some embodiments, at least 50, 60, 70, 80, 90, 95, or 99% of the moieties or compounds are present on the surface or a surface of the product. In some embodiments, the moieties or compounds are present on the exterior face of the surface or a surface of the product, and are not present, or not present in a significant amount, elsewhere in the product, e.g., on internal or interior surfaces. In some embodiments, at least 50, 60, 70, 80, 90, 95, or 99% of the moieties or compounds are present on the external face of the surface or a surface of the product.

In some embodiments, the moieties or compounds modifying the product can be present on a portion or component of the product, and are not present, or are not present in a significant amount, elsewhere in the product. Such differences can be referred to as asymmetry of the modification or coating. In some embodiments, at least 50, 60, 70, 80, 90, 95, or 99% of the moieties or compounds are present on the portion or component of the product. In some embodiments, the moieties or compounds are present on the exterior face of the portion or component of the product, and are not present, or not present in a significant amount, elsewhere in the product. In some embodiments, at least 50, 60, 70, 80, 90, 95, or 99% of the moieties or compounds are present on the external face of the portion or component of the product.

“Surface,” as used herein in the context of the disclosed products, refers to the exterior or outer boundary of a product. Generally, the surface or a surface of a product corresponds to the idealized surface of a three dimensional solid that is topological homeomorphic with the product. The surface or a surface of the product can be an exterior surface or an interior surface of the product. An exterior surface forms the outermost layer of a product or device. An interior surface surrounds an inner cavity of a product or device, such as the inner cavity of a tube. As an example, both the outside surface of a tube and the inside surface of a tube are part of the surface or a surface of the tube. However, internal surfaces of the product that are not in topological communication with the exterior surface, such as a tube with closed ends, can be excluded as the surface or a surface of a product. Preferred surfaces to be chemically modified are the outside surface and surfaces that can contact immune system components. Where the product is porous or has holes in its mean (idealized or surface, the internal faces of passages and holes would not be considered part of the surface or a surface of the product if its opening on the mean surface of the product is less than 5 nm.

“Corresponding product” and “similar product,” as used herein, refers a product that has, as far as is practical or possible, the same composition, structure, and construction as a reference product. The terms “corresponding” and “similar” can be used for the same meaning with any particular or subgroup of products or other materials described herein. For example, a “similar surface modification” refers a surface modification that has, as far as is practical or possible, the same composition, structure, and construction as a reference surface modification.

“Control corresponding product” and “control similar product,” as used herein, refers a product that has, as far as is practical or possible, the same composition, structure, and construction as a reference product except for one or more specified parameters. For example, a control corresponding product that lacks the chemical modification in reference to a chemically modified product refers to a product that has, as far as is practical or possible, the same composition, structure, and construction as a reference product except for the chemical modification. Generally, a product prior to chemical modification constitutes a control corresponding product to the chemically modified form of the product. The terms “control corresponding” and “control similar” can be used for the same meaning with any particular or subgroup of products or other materials described herein. For example, a “control similar surface modification” refers a surface modification that has, as far as is practical or possible, the same composition, structure, and construction as a reference surface modification except for one or more specified parameters. Components that are “control corresponding” or “control similar” relative to a reference component are useful as controls in assays assessing the effect of independent variables.

“Preparation,” as used herein in reference to products, compounds, and other objects and components themselves (as opposed to their production or preparation), refers to a plurality of the product, compound, or other object or component, each such product, compound, or other object or component having a set of common properties and structure but also having some differences in properties or structure. For example, a preparation of capsules with capsules having the same composition, structure, and functional properties, can include, for example, capsules having a variance in shape, size, pore size, generally around a desired mean. It is not necessary that such variance be intended or purposely designed, although that is contemplated. Rather, such variance generally is a consequence of the variability in production or preparation of the products,

compounds, and other objects and components (as is exemplified by production of capsules).

“Implanting,” as used herein, refers to the insertion or grafting into the body of a subject a product or material.

5 “Administering,” as used herein, refers to contacting a substance or product to the body of a subject. For example, administering a substance or a product includes contacting the skin of a subject and injecting or implanting a substance or product into the subject.

10 “Chemical compound,” as used herein, refers to an organic compound. The disclosed compounds for chemically modifying products are examples of chemical compounds.

“High,” “higher,” “increases,” “elevates,” and “elevation,” as used herein, refer to increases above a reference level, e.g., a basal level, e.g., as compared to a control. “Low,” “lower,” “reduces,” and “reduction,” as used herein, refer to decreases below a
15 reference level, e.g., a basal level, e.g., as compared to a control. “Improved,” as used herein, refers to a change that is desirable, which may be a higher or lower value of some measure.

“Long term,” as used herein, refers to a state or situation that extends for longer than days or weeks. Preferred long term effects last several months or years.

20 “Monitoring” as used herein refers to any method in the art by which an activity can be measured.

“Providing,” as used herein, refers to any method, device, or means of adding a compound or molecule to something, e.g., a method or device known in the art. Examples of providing can include the use of pipettes, pipetmen, syringes, needles,
25 tubing, guns, etc. This can be manual or automated. It can include transfection by any mean or any other means of providing nucleic acids to dishes, cells, tissue, cell-free systems and can be *in vitro* or *in vivo*.

“Preventing,” as used herein, refers to administering or applying a treatment or therapy prior to the onset of clinical symptoms of a disease or conditions so as to prevent
30 a physical manifestation of aberrations associated with the disease or condition.

“In need of treatment,” as used herein, refers to a subject that would benefit from the treatment. In some embodiments, it comprises a judgment made by a caregiver (e.g. physician, nurse, nurse practitioner, or individual in the case of humans; veterinarian in the case of animals, including non-human mammals) that a subject requires or will

benefit from treatment. This judgment can be made based on a variety of factors that are in the realm of a care giver's expertise, but that includes the knowledge that the subject is ill, or will be ill, as the result of a condition that is treatable by the compounds of the invention.

5 “Subject,” as used herein, includes, but is not limited to, animals, plants, bacteria, viruses, parasites and any other organism or entity. The subject can be a vertebrate, more specifically a mammal (e.g., a human, horse, pig, rabbit, dog, sheep, goat, non-human primate, cow, cat, guinea pig or rodent), a fish, a bird or a reptile or an amphibian. The subject can be an invertebrate, more specifically an arthropod (e.g., insects and
10 crustaceans). The term does not denote a particular age or sex. Thus, adult and newborn subjects, as well as fetuses, whether male or female, are intended to be covered. A patient refers to a subject afflicted with a disease or disorder. The term “patient” includes human and veterinary subjects.

 “Treatment” and “treating,” as used herein, refer to the medical management of a
15 subject with the intent to cure, ameliorate, stabilize, or prevent a disease, pathological condition, or disorder. This term includes active treatment, that is, treatment directed specifically toward the improvement of a disease, pathological condition, or disorder, and also includes causal treatment, that is, treatment directed toward removal of the cause of the associated disease, pathological condition, or disorder. In addition, this term
20 includes palliative treatment, that is, treatment designed for the relief of symptoms rather than the curing of the disease, pathological condition, or disorder; preventative treatment, that is, treatment directed to minimizing or partially or completely inhibiting the development of the associated disease, pathological condition, or disorder; and supportive treatment, that is, treatment employed to supplement another specific therapy
25 directed toward the improvement of the associated disease, pathological condition, or disorder. It is understood that treatment, while intended to cure, ameliorate, stabilize, or prevent a disease, pathological condition, or disorder, need not actually result in the cure, ameliorization, stabilization or prevention. The effects of treatment can be measured or assessed as described herein and as known in the art as is suitable for the disease,
30 pathological condition, or disorder involved. Such measurements and assessments can be made in qualitative and/or quantitative terms. Thus, for example, characteristics or features of a disease, pathological condition, or disorder and/or symptoms of a disease, pathological condition, or disorder can be reduced to any effect or to any amount.

A cell can be *in vitro*. Alternatively, a cell can be *in vivo* and can be found in a subject. A “cell” can be a cell from any organism including, but not limited to, a bacterium.

5 “Beneficial effect,” as used herein, refers to any effect that is desired. In the context of the disclosed chemically modified products, beneficial effects include lower foreign body response, improved biocompatibility, and reduced immune response or reaction.

10 “Independently” as used herein in the context of chemical formulae (and unless the context clearly indicates otherwise), means that each instance of the group referred to is chosen independently of the other instances of that group. For example, each instance of the group could be different from every other instance, some other instances, or no other instances of the group. Where multiple groups are referred to, “independently” means that each instance of each given group is chosen independently of the other instances of the respective group and that each of the groups are chosen independently of
15 the other groups. For example, each instance of a first group could be different from every instance, some other instances, or no other instances of a second group (or third, or fourth, etc., group).

20 “Component” as used herein in the context of a product, e.g., medical products, such as medical devices, is a part of a product that is structurally integrated with that product. A component may be applied to a substrate or to the surface or a surface of a product, contained within the substance of the product, retained in the interior of the product, or any other arrangement whereby that part is an integral element of the structure of the product. As an example, the silicone covering surrounding the mechanical part of a pacemaker is a component of the pacemaker. A component may be
25 the lumen of a product where the lumen performs some function essential to the overall function of the product. The lumen of a tissue expander port is a component of the tissue expander. A component can refer to a reservoir or a discrete area within the product specifically adapted for the delivery of a fluid to a surface of the product. A reservoir within an implantable drug delivery device is a component of that device.

30 The phrase “effective amount,” as used herein in the context of a coating, generally refers to the amount of the coating applied to the implant in order to provide one or more clinically measurable endpoints, such as reduced foreign body response compared to an uncoated implant, an implant coated with an unmodified coating, or another suitable control. The phrase “effective amount,” as used herein in the context of

a cell, capsule, product, device, material, composition, or compound, refers to a nontoxic but sufficient amount of the cell, capsule, product, device, material, composition, or compound to provide the desired result. The exact amount required may vary from subject to subject, depending on the species, age, and general condition of the subject;
5 the severity of the disease that is being treated; the particular cell, capsule, product, device, material, composition, or compound used; its mode of administration; and other routine variables. An appropriate effective amount can be determined by one of ordinary skill in the art using only routine experimentation.

“Singularly modified,” as used herein, refers to a modified product that contains
10 one or more covalently attached compounds, non-covalently attached compounds, or both, wherein substantially all of the covalently attached compounds, non-covalently attached compounds, or both are the same compound. A singularly modified device includes, for example, a modified device wherein all the modifications are carried out using Z1-Y15 (see below).

15 “Multiply modified,” as used herein, refers to a modified product that contains one or more covalently attached compounds, non-covalently attached compounds, or both, wherein substantially all of the covalently attached compounds, non-covalently attached compounds, or both are not formed using the same compound. A multiply modified device includes, for example, a modified device wherein the modifications are
20 carried out using Z2-Y12, Z1-Y15 and Z1-Y19 (see below).

“Capsule,” as used herein, refers to a particle having a mean diameter of about 150 μm to about 5 cm, formed of a cross-linked hydrogel, having a cross-linked hydrogel core that is surrounded by one or more polymeric shells, having one or more cross-linked hydrogel layers, having a cross-linked hydrogel coating, or a combination thereof. The
25 capsule may have any shape suitable for, for example, cell encapsulation. The capsule may contain one or more cells dispersed in the cross-linked hydrogel, thereby “encapsulating” the cells. Reference to “capsules” herein refers to and includes microcapsules unless the context clearly indicates otherwise. Preferred capsules have a mean diameter of about 150 μm to about 8 mm.

30 “Microcapsule” and “microgel,” as used herein, are used interchangeably to refer to a particle or capsule having a mean diameter of about 150 μm to about 1000 μm .

“Biological material” and “biomaterial,” as used herein, refers to any biological substance, including, but not limited to, tissue, cells, biological micromolecules, such as a nucleotides, amino acids, cofactors, and hormones, biological macromolecules, such as

nucleic acids, polypeptides, proteins (for example enzymes, receptors, secretory proteins, structural and signaling proteins, hormones, ligands, etc.), polysaccharides, and/or any combination thereof.

5 “Cell,” as used herein, refers to individual cells, cell lines, primary cultures, or cultures derived from such cells unless specifically indicated. “Culture,” as used herein, refers to a composition including cells, such as isolated cells, which can be of the same or a different type. “Cell line,” as used herein, refers to a permanently established cell culture that will proliferate indefinitely given appropriate fresh medium and space, thus making the cell line “immortal.” “Cell strain,” as used herein, refers to a cell culture
10 having a plurality of cells adapted to culture, but with finite division potential. “Cell culture,” as used herein, is a population of cells grown on a medium such as agar.

Cells can be, for example, xenogeneic, autologous, or allogeneic. Cells can also be primary cells. Cells can also be cells derived from the culture and expansion of a cell obtained from a subject. For example, cells can also be stem cells or derived from stem
15 cells. Cells can also be immortalized cells. Cells can also be genetically engineered to express or produce a protein, nucleic acid, or other product.

“Mammalian cell,” as used herein, refers to any cell derived from a mammalian subject.

20 “Autologous,” as used herein, refers to a transplanted biological material, such as cells, taken from the same individual.

“Allogeneic,” as used herein, refers to a transplanted biological material, such as cells, taken from a different individual of the same species.

“Xenogeneic,” as used herein, refers to a transplanted biological material, such as cells, taken from a different species.

25 “Endocrine cell,” as used herein, refers to a cell of the endocrine system.

“Secreting endocrine cell,” as used herein, refers to an endocrine cell that secretes one or more hormones.

“Islet cell,” as used herein, refers to an endocrine cell derived from a mammalian pancreas. Islet cells include alpha cells that secrete glucagon, beta cells that secrete
30 insulin and amylin, delta cells that secrete somatostatin, PP cells that secrete pancreatic polypeptide, or epsilon cells that secrete ghrelin. The term includes homogenous and heterogeneous populations of these cells. In preferred embodiments, a population of islet cells contains at least beta cells. In certain embodiments, an islet cell is a human islet cell.

“Hormone-producing cell,” as used herein, refers to a cell that produces one or more hormones. Preferred hormone-producing cells produce hormone in response to physiological stimulus, such as the physiological stimulus that cause secretion of the hormone from an endocrine cell that naturally secretes the hormone. Secreting endocrine cells, hormone-producing cells derived from stem cells, and cells genetically engineered to produce hormone are examples of hormone-producing cells.

“Insulin-producing cell,” as used herein, refers to a cell that produces insulin. Preferred insulin-producing cells produce insulin in response to glucose levels. Islet beta cells, insulin-producing cells derived from stem cells, and cells genetically engineered to produce insulin are examples of insulin-producing cells.

“Transplant,” as used herein, refers to the transfer of a cell, tissue, or organ to a subject from another source. The term is not limited to a particular mode of transfer. Encapsulated cells may be transplanted by any suitable method, such as by injection or surgical implantation.

“Primary cells,” “primary cell lines,” and “primary cultures,” as used herein, are used interchangeably to refer to cells and cells cultures that have been derived from a subject and allowed to grow *in vitro* for a limited number of passages, that is, splittings, of the culture.

“Mesenchymal stem cell” or “MSC,” as used herein, refer to multipotent stem cells present in or derived from mesenchymal tissue that can differentiate into a variety of cell types, including: osteoblasts, chondrocytes, and adipocytes.

“Derived from,” as used herein, with respect to cells, refer to cells obtained from tissue, cell lines, or cells, which optionally are then cultured, passaged, differentiated, induced, etc., to produce the derived cells. For example, induced pluripotent stem cells are derived from somatic cells.

“Pluripotency,” as used herein, refers to the ability of cells to differentiate into multiple types of cells in an organism. By “pluripotent stem cells,” it is meant cells that can self-renew and differentiate to produce all types of cells in an organism. By “multipotency” it is meant the ability of cells to differentiate into some types of cells in an organism but not all, typically into cells of a particular tissue or cell lineage.

“Multi-potent cells” and “adult stem cells,” as used herein, refer to any type of stem cell that is not derived from an embryo or fetus and generally has a limited capacity to generate new cell types (referred to as “multipotency”) and being committed to a particular lineage.

“Induced pluripotent stem cell,” as used herein, encompasses pluripotent stem cells, that, like embryonic stem (ES) cells, can be cultured over a long period of time while maintaining the ability to differentiate into all types of cells in an organism, but that, unlike ES cells (which are derived from the inner cell mass of blastocysts), are
5 derived from somatic cells.

“Analog” and “Derivative,” in the context of chemical compounds, are used herein interchangeably, and refer to a compound having a structure similar to that of a parent compound, but varying from the parent compound by a difference in one or more certain components. (Designation as a parent compound does not mean that the parent
10 compound is used as a starting material or intermediate but is rather a structural relationship.) Analogs or derivatives differ from the parent compound in one or more atoms, functional groups, or substructures, which are replaced with other atoms, groups, or substructures. An analog or derivative can be imagined to be formed, at least theoretically, from the parent compound via some chemical or physical process. The
15 terms analog and derivative encompass compounds which retain the same basic ring structure as the parent compound, but possess one or more different substituents on the ring(s). For example, an analog or derivative of Z2-Y12 refers to a compound that retains the core of Z2-Y12, e.g., but differs in or more substituents on any of the rings. In some embodiments, an analog or derivative retains at least, 20, 30, 40, 50, 60, 70, 80, 90, or
20 100% of a selected activity of a reference compound, e.g., a parent compound.

“Substantially,” as used herein, specifies an amount of 95% or more, 96% or more, 97% or more, 98% or more, or 99% or more.

“Click chemistry,” as used herein, refers to chemical reactions used to couple two compounds together which are high yielding, wide in scope, create only byproducts that
25 can be removed without chromatography, are stereospecific, simple to perform, and can be conducted in easily removable or benign solvents. Examples of reactions which fulfill these criteria include the nucleophilic ring opening of epoxides and aziridines, non-aldol type carbonyl reactions, including the formation of hydrazones and heterocycles, additions to carbon-carbon multiple bonds, including Michael Additions, and
30 cycloaddition reactions, such as a 1,3-dipolar cycloaddition reaction (i.e., a Huisgen cycloaddition reaction). See, for example, Moses, and Moorhouse, *Chem Soc. Rev.* 36:1249-1262 (2007); Kolb and Sharpless, *Drug Discovery Today*. 8(24):1128-1137 (2003); and Kolb et al., *Angew. Chem. Int. Ed.* 40:2004-2021 (2001).

“Substituted,” as used herein, refers to all permissible substituents of the compounds or functional groups described herein. In the broadest sense, the permissible substituents include acyclic and cyclic, branched and unbranched, carbocyclic and heterocyclic, aromatic and nonaromatic substituents of organic compounds. Illustrative substituents include, but are not limited to, halogens, hydroxyl groups, or any other organic groupings containing any number of carbon atoms, preferably 1-14 carbon atoms, and optionally include one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats. Representative substituents include alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, halo, hydroxyl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, phenoxy, substituted phenoxy, aroxy, substituted aroxy, alkylthio, substituted alkylthio, phenylthio, substituted phenylthio, arylthio, substituted arylthio, cyano, isocyano, substituted isocyano, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, sulfonyl, substituted sulfonyl, sulfonic acid, phosphoryl, substituted phosphoryl, phosphonyl, substituted phosphonyl, polyaryl, substituted polyaryl, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, amino acid, poly(lactic-co-glycolic acid), peptide, and polypeptide groups. Such alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, halo, hydroxyl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, phenoxy, substituted phenoxy, aroxy, substituted aroxy, alkylthio, substituted alkylthio, phenylthio, substituted phenylthio, arylthio, substituted arylthio, cyano, isocyano, substituted isocyano, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, sulfonyl, substituted sulfonyl, sulfonic acid, phosphoryl, substituted phosphoryl, phosphonyl, substituted phosphonyl, polyaryl, substituted polyaryl, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, amino acid, poly(lactic-co-glycolic acid), peptide, and polypeptide groups can be further substituted.

Heteroatoms such as nitrogen may have hydrogen substituents and/or any permissible substituents of organic compounds described herein which satisfy the valences of the heteroatoms. It is understood that “substitution” or “substituted” includes the implicit proviso that such substitution is in accordance with permitted valence of the substituted atom and the substituent, and that the substitution results in a stable

compound, i.e. a compound that does not spontaneously undergo transformation such as by rearrangement, cyclization, elimination, etc.

Except where specifically and expressly provided to the contrary, the term “substituted” refers to a structure, e.g., a chemical compound or a moiety on a larger
5 chemical compound, regardless of how the structure was formed. The structure is not limited to a structure made by any specific method.

“Aryl,” as used herein, refers to C₅-C₂₆-membered aromatic, fused aromatic, fused heterocyclic, or biaromatic ring systems. Broadly defined, “aryl,” as used herein, includes 5-, 6-, 7-, 8-, 9-, 10-, 14-, 18-, and 24-membered single-ring aromatic groups,
10 for example, benzene, naphthalene, anthracene, phenanthrene, chrysene, pyrene, corannulene, coronene, etc.

“Aryl” further encompasses polycyclic ring systems having two or more cyclic rings in which two or more carbons are common to two adjoining rings (i.e., “fused rings”) wherein at least one of the rings is aromatic, e.g., the other cyclic ring or rings
15 can be cycloalkyls, cycloalkenyls, cycloalkynyls, aryls and/or heterocycles.

The term “substituted aryl” refers to an aryl group, wherein one or more hydrogen atoms on one or more aromatic rings are substituted with one or more substituents including, but not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, alkoxy, carbonyl (such as a ketone, aldehyde, carboxyl, alkoxy carbonyl,
20 formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, imino, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl (such as CF₃, -CH₂-CF₃, -CCl₃), -CN, aryl, heteroaryl, and
25 combinations thereof.

“Heterocycle,” “heterocyclic” and “heterocyclyl” are used interchangeably, and refer to a cyclic radical attached via a ring carbon or nitrogen atom of a monocyclic or bicyclic ring containing 3-10 ring atoms, and preferably from 5-6 ring atoms, consisting of carbon and one to four heteroatoms each selected from the group consisting of non-
30 peroxide oxygen, sulfur, and N(Y) wherein Y is absent or is H, O, C₁-C₁₀ alkyl, phenyl or benzyl, and optionally containing 1-3 double bonds and optionally substituted with one or more substituents. Heterocyclyl are distinguished from heteroaryl by definition. Examples of heterocycles include, but are not limited to piperazinyl, piperidinyl,

piperidonyl, 4-piperidonyl, dihydrofuro[2,3-*b*]tetrahydrofuran, morpholinyl, piperazinyl, piperidinyl, piperidonyl, 4-piperidonyl, piperonyl, pyranyl, 2H-pyrrolyl, 4*H*-quinoliziny, quinuclidinyl, tetrahydrofuranyl, 6*H*-1,2,5-thiadiazinyl. Heterocyclic groups can optionally be substituted with one or more substituents as defined above for alkyl and aryl.

The term “heteroaryl” refers to C₅-C₂₆-membered aromatic, fused aromatic, biaromatic ring systems, or combinations thereof, in which one or more carbon atoms on one or more aromatic ring structures have been substituted with an heteroatom. Suitable heteroatoms include, but are not limited to, oxygen, sulfur, and nitrogen. Broadly defined, “heteroaryl,” as used herein, includes 5-, 6-, 7-, 8-, 9-, 10-, 14-, 18-, and 24-membered single-ring aromatic groups that may include from one to four heteroatoms, for example, pyrrole, furan, thiophene, imidazole, oxazole, thiazole, triazole, tetrazole, pyrazole, pyridine, pyrazine, pyridazine and pyrimidine, and the like. The heteroaryl group may also be referred to as “aryl heterocycles” or “heteroaromatics”. “Heteroaryl” further encompasses polycyclic ring systems having two or more rings in which two or more carbons are common to two adjoining rings (*i.e.*, “fused rings”) wherein at least one of the rings is heteroaromatic, e.g., the other cyclic ring or rings can be cycloalkyls, cycloalkenyls, cycloalkynyls, aryls, heterocycles, or combinations thereof. Examples of heteroaryl rings include, but are not limited to, benzimidazolyl, benzofuranyl, benzothiofuranyl, benzothiophenyl, benzoxazolyl, benzoxazoliny, benzthiazolyl, benztriazolyl, benztetrazolyl, benzisoxazolyl, benzisothiazolyl, benzimidazoliny, carbazolyl, 4*aH*-carbazolyl, carboliny, chromanyl, chromenyl, cinnoliny, decahydroquinoliny, 2*H*,6*H*-1,5,2-dithiazinyl, furanyl, furazanyl, imidazolidinyl, imidazoliny, imidazolyl, 1*H*-indazolyl, indolenyl, indoliny, indoliziny, indolyl, 3*H*-indolyl, isatinoyl, isobenzofuranyl, isochromanyl, isoindazolyl, isoindoliny, isoindolyl, isoquinoliny, isothiazolyl, isoxazolyl, methylenedioxyphenyl, naphthyridiny, octahydroisoquinoliny, 1,2,3-oxadiazolyl, 1,2,4-oxadiazolyl, 1,2,5-oxadiazolyl, 1,3,4-oxadiazolyl, oxazolidinyl, oxazolyl, oxindolyl, pyrimidinyl, phenanthridiny, phenanthroliny, phenazinyl, phenothiazinyl, phenoxathiny, phenoxazinyl, phthalazinyl, pteridinyl, puriny, pyraziny, pyrazolidiny, pyrazoliny, pyrazolyl, pyridazinyl, pyridooxazole, pyridoimidazole, pyridothiazole, pyridiny, pyridyl, pyrimidinyl, pyrrolidinyl, pyrroliny, pyrrolyl, quinazoliny, quinoliny, quinoxaliny, tetrahydroisoquinoliny, tetrahydroquinoliny, tetrazolyl, 1,2,3-thiadiazolyl, 1,2,4-thiadiazolyl, 1,2,5-thiadiazolyl, 1,3,4-thiadiazolyl, thianthrenyl, thiazolyl, thienyl,

thienothiazolyl, thienooxazolyl, thienoimidazolyl, thiophenyl and xanthenyl. One or more of the rings can be substituted as defined below for "substituted heteroaryl".

The term "substituted heteroaryl" refers to a heteroaryl group in which one or more hydrogen atoms on one or more heteroaromatic rings are substituted with one or more substituents including, but not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, alkoxy, carbonyl (such as a ketone, aldehyde, carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxyl, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, imino, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl (such as CF₃, -CH₂-CF₃, -CCl₃), -CN, aryl, heteroaryl, and combinations thereof.

"Alkyl," as used herein, refers to the radical of saturated aliphatic groups, including straight-chain alkyl, alkenyl, or alkynyl groups, branched-chain alkyl, cycloalkyl (alicyclic), alkyl substituted cycloalkyl groups, and cycloalkyl substituted alkyl. In preferred embodiments, a straight chain or branched chain alkyl has 30 or fewer carbon atoms in its backbone (e.g., C₁-C₃₀ for straight chains, C₃-C₃₀ for branched chains), preferably 20 or fewer, more preferably 15 or fewer, most preferably 10 or fewer. Likewise, preferred cycloalkyls have from 3-10 carbon atoms in their ring structure, and more preferably have 5, 6 or 7 carbons in the ring structure. The term "alkyl" (or "lower alkyl") as used throughout the specification, examples, and claims is intended to include both "unsubstituted alkyls" and "substituted alkyls," the latter of which refers to alkyl moieties having one or more substituents replacing a hydrogen on one or more carbons of the hydrocarbon backbone. Such substituents include, but are not limited to, halogen, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxyl, phosphoryl, phosphate, phosphonate, phosphinate, amino, amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, aralkyl, or an aromatic or heteroaromatic moiety.

Unless the number of carbons is otherwise specified, "lower alkyl" as used herein means an alkyl group, as defined above, but having from one to ten carbons, more preferably from one to six carbon atoms in its backbone structure. Likewise, "lower alkenyl" and "lower alkynyl" have similar chain lengths. Throughout the application,

preferred alkyl groups are lower alkyls. In preferred embodiments, a substituent designated herein as alkyl is a lower alkyl.

“Alkyl” includes one or more substitutions at one or more carbon atoms of the hydrocarbon radical as well as heteroalkyls. Suitable substituents include, but are not limited to, halogens, such as fluorine, chlorine, bromine, or iodine; hydroxyl; -NRR', wherein R and R' are independently hydrogen, alkyl, or aryl, and wherein the nitrogen atom is optionally quaternized; -SR, wherein R is hydrogen, alkyl, or aryl; -CN; -NO₂; -COOH; carboxylate; -COR, -COOR, or -CON(R)₂, wherein R is hydrogen, alkyl, or aryl; azide, aralkyl, alkoxyl, imino, phosphonate, phosphinate, silyl, ether, sulfonyl, sulfonamido, heterocyclyl, aromatic or heteroaromatic moieties, haloalkyl (such as -CF₃, -CH₂-CF₃, -CCl₃); -CN; -NCOCOCH₂CH₂; -NCOCOCHCH; -NCS; and combinations thereof.

It will be understood by those skilled in the art that the moieties substituted on the hydrocarbon chain can themselves be substituted, if appropriate. For instance, the substituents of a substituted alkyl may include halogen, hydroxy, nitro, thiols, amino, azido, imino, amido, phosphoryl (including phosphonate and phosphinate), sulfonyl (including sulfate, sulfonamido, sulfamoyl, sulfoxide, and sulfonate), and silyl groups, as well as ethers, alkylthios, carbonyls (including ketones, aldehydes, carboxylates, and esters), haloalkyls, -CN and the like. Cycloalkyls can be substituted in the same manner.

The terms “alkenyl” and “alkynyl” refer to unsaturated aliphatic groups analogous in length and possible substitution to the alkyls described above, but that contain at least one double or triple bond, respectively.

The term “substituted alkenyl” refers to alkenyl moieties having one or more substituents replacing one or more hydrogen atoms on one or more carbons of the hydrocarbon backbone. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxyl, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

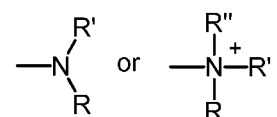
The term “substituted alkynyl” refers to alkynyl moieties having one or more substituents replacing one or more hydrogen atoms on one or more carbons of the

hydrocarbon backbone. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxyl, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term “phenyl” is art recognized, and refers to the aromatic moiety -C₆H₅, *i.e.*, a benzene ring without one hydrogen atom.

The term “substituted phenyl” refers to a phenyl group, as defined above, having one or more substituents replacing one or more hydrogen atoms on one or more carbons of the phenyl ring. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxyl, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

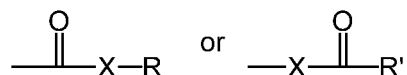
“Amino” and “Amine,” as used herein, are art-recognized and refer to both substituted and unsubstituted amines, e.g., a moiety that can be represented by the general formula:



wherein, R, R', and R'' each independently represent a hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted carbonyl, -(CH₂)_m-R''', or R and R' taken together with the N atom to which they are attached complete a heterocycle having from 3 to 14 atoms in the ring structure; R''' represents a hydroxy group, substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8. In preferred embodiments, only one of R and R' can be a carbonyl, e.g., R and R' together with the nitrogen do not form an imide. In preferred embodiments, R and R' (and optionally R'') each independently represent a hydrogen atom, substituted or unsubstituted alkyl, a

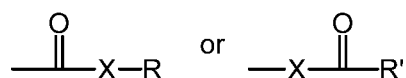
substituted or unsubstituted alkenyl, or $-(CH_2)_m-R''$. Thus, the term 'alkylamine' as used herein refers to an amine group, as defined above, having a substituted or unsubstituted alkyl attached thereto (i.e. at least one of R, R', or R'' is an alkyl group).

5 "Carbonyl," as used herein, is art-recognized and includes such moieties as can be represented by the general formula:



wherein X is a bond, or represents an oxygen or a sulfur, and R represents a hydrogen, a substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl, $-(CH_2)_m-R''$, or a pharmaceutical acceptable salt, R' represents a hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl or $-(CH_2)_m-R''$; R'' represents a hydroxy group, substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8. Where X is oxygen and R is defines as above, the moiety is also referred to as a carboxyl group. When X is oxygen and R is hydrogen, the formula represents a 'carboxylic acid'. Where X is oxygen and R' is hydrogen, the formula represents a 'formate'. Where X is oxygen and R or R' is not hydrogen, the formula represents an "ester". In general, where the oxygen atom of the above formula is replaced by a sulfur atom, the formula represents a 'thiocarbonyl' group. Where X is sulfur and R or R' is not hydrogen, the formula represents a 'thioester.' Where X is sulfur and R is hydrogen, the formula represents a 'thiocarboxylic acid.' Where X is sulfur and R' is hydrogen, the formula represents a 'thioformate.' Where X is a bond and R is not hydrogen, the above formula represents a 'ketone.' Where X is a bond and R is hydrogen, the above formula represents an 'aldehyde.'

30 The term "substituted carbonyl" refers to a carbonyl, as defined above, wherein one or more hydrogen atoms in R, R' or a group to which the moiety



is attached, are independently substituted. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term "carboxyl" is as defined above for the formula



and is defined more specifically by the formula $\text{---R}^{\text{iv}}\text{COOH}$, wherein R^{iv} is an alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, alkylaryl, arylalkyl, aryl, or heteroaryl. In preferred embodiments, a straight chain or branched chain alkyl, alkenyl, and alkynyl have 30 or fewer carbon atoms in its backbone (e.g., $\text{C}_1\text{---C}_{30}$ for straight chain alkyl, $\text{C}_3\text{---C}_{30}$ for branched chain alkyl, $\text{C}_2\text{---C}_{30}$ for straight chain alkenyl and alkynyl, $\text{C}_3\text{---C}_{30}$ for branched chain alkenyl and alkynyl), preferably 20 or fewer, more preferably 15 or fewer, most preferably 10 or fewer. Likewise, preferred cycloalkyls, heterocyclyls, aryls and heteroaryls have from 3-10 carbon atoms in their ring structure, and more preferably have 5, 6 or 7 carbons in the ring structure.

20 The term "substituted carboxyl" refers to a carboxyl, as defined above, wherein one or more hydrogen atoms in R^{iv} are substituted. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

30 "Heteroalkyl," as used herein, refers to straight or branched chain, or cyclic carbon-containing radicals, or combinations thereof, containing at least one heteroatom. Suitable heteroatoms include, but are not limited to, O, N, Si, P and S, wherein the nitrogen, phosphorous and sulfur atoms are optionally oxidized, and the nitrogen heteroatom is optionally quaternized.

Examples of saturated hydrocarbon radicals include, but are not limited to, methyl, ethyl, n-propyl, isopropyl, n-butyl, t-butyl, isobutyl, sec-butyl, cyclohexyl, (cyclohexyl)methyl, cyclopropylmethyl, and homologs and isomers of, for example, n-pentyl, n-hexyl, n-heptyl, n-octyl. Examples of unsaturated alkyl groups include, but are not limited to, vinyl, 2-propenyl, crotyl, 2-isopentenyl, 2-(butadienyl), 2,4-pentadienyl, 3-(1,4-pentadienyl), ethynyl, 1- and 3-propynyl, and 3-butynyl.

The terms "alkoxyl" or "alkoxy," "aroxy" or "aryloxy," generally describe compounds represented by the formula $-OR^V$, wherein R^V includes, but is not limited to, substituted or unsubstituted alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, cycloalkenyl, heterocycloalkenyl, aryl, heteroaryl, arylalkyl, heteroalkyls, alkylaryl, alkylheteroaryl.

The terms "alkoxyl" or "alkoxy" as used herein refer to an alkyl group, as defined above, having an oxygen radical attached thereto. Representative alkoxyl groups include methoxy, ethoxy, propyloxy, tert-butoxy and the like. An "ether" is two hydrocarbons covalently linked by an oxygen. Accordingly, the substituent of an alkyl that renders that alkyl an ether is or resembles an alkoxyl, such as can be represented by one of -O-alkyl, -O-alkenyl, and -O-alkynyl. The term alkoxy also includes cycloalkyl, heterocyclyl, cycloalkenyl, heterocycloalkenyl, and arylalkyl having an oxygen radical attached to at least one of the carbon atoms, as valency permits.

The term "substituted alkoxy" refers to an alkoxy group having one or more substituents replacing one or more hydrogen atoms on one or more carbons of the alkoxy backbone. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term "phenoxy" is art recognized, and refers to a compound of the formula $-OR^V$ wherein R^V is (*i.e.*, $-O-C_6H_5$). One of skill in the art recognizes that a phenoxy is a species of the aroxy genus.

The term "substituted phenoxy" refers to a phenoxy group, as defined above, having one or more substituents replacing one or more hydrogen atoms on one or more carbons of the phenyl ring. Such substituents include, but are not limited to, halogen,

azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, 5 sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The terms "aroxy" and "aryloxy," as used interchangeably herein, are represented by -O-aryl or -O-heteroaryl, wherein aryl and heteroaryl are as defined herein.

The terms "substituted aroxy" and "substituted aryloxy," as used interchangeably 10 herein, represent -O-aryl or -O-heteroaryl, having one or more substituents replacing one or more hydrogen atoms on one or more ring atoms of the aryl and heteroaryl, as defined herein. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a 15 thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term "alkylthio" refers to an alkyl group, as defined above, having a sulfur 20 radical attached thereto. The "alkylthio" moiety is represented by -S-alkyl.

Representative alkylthio groups include methylthio, ethylthio, and the like. The term "alkylthio" also encompasses cycloalkyl groups having a sulfur radical attached thereto.

The term "substituted alkylthio" refers to an alkylthio group having one or more substituents replacing one or more hydrogen atoms on one or more carbon atoms of the 25 alkylthio backbone. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, 30 sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term "phenylthio" is art recognized, and refers to -S-C₆H₅, *i.e.*, a phenyl group attached to a sulfur atom.

The term “substituted phenylthio” refers to a phenylthio group, as defined above, having one or more substituents replacing a hydrogen on one or more carbons of the phenyl ring. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

10 “Arylthio” refers to -S-aryl or -S-heteroaryl groups, wherein aryl and heteroaryl as as defined herein.

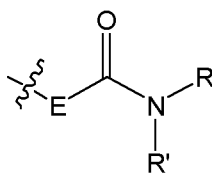
The term “substituted arylthio” represents -S-aryl or -S-heteroaryl, having one or more substituents replacing a hydrogen atom on one or more ring atoms of the aryl and heteroaryl rings as defined herein. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

20 “Arylalkyl,” as used herein, refers to an alkyl group that is substituted with a substituted or unsubstituted aryl or heteroaryl group.

“Alkylaryl,” as used herein, refers to an aryl group (e.g., an aromatic or hetero aromatic group), substituted with a substituted or unsubstituted alkyl group.

25

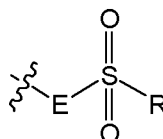
The terms “amide” or “amido” are used interchangeably, refer to both “unsubstituted amido” and “substituted amido” and are represented by the general formula:



30 wherein, E is absent, or E is substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted

aralkyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted aryl,
 substituted or unsubstituted heteroaryl, substituted or unsubstituted heterocyclyl, wherein
 independently of E, R and R' each independently represent a hydrogen, substituted or
 unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted
 5 alkynyl, substituted or unsubstituted carbonyl, substituted or unsubstituted cycloalkyl,
 substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl,
 substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or
 unsubstituted heteroaryl, $-(CH_2)_m-R'''$, or R and R' taken together with the N atom to
 which they are attached complete a heterocycle having from 3 to 14 atoms in the ring
 10 structure; R''' represents a hydroxy group, substituted or unsubstituted carbonyl group,
 an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is
 zero or an integer ranging from 1 to 8. In preferred embodiments, only one of R and R'
 can be a carbonyl, e.g., R and R' together with the nitrogen do not form an imide. In
 preferred embodiments, R and R' each independently represent a hydrogen atom,
 15 substituted or unsubstituted alkyl, a substituted or unsubstituted alkenyl, or $-(CH_2)_m-R'''$.
 When E is oxygen, a carbamate is formed. The carbamate cannot be attached to another
 chemical species, such as to form an oxygen-oxygen bond, or other unstable bonds, as
 understood by one of ordinary skill in the art.

The term "sulfonyl" is represented by the formula



20

wherein E is absent, or E is alkyl, alkenyl, alkynyl, aralkyl, alkylaryl, cycloalkyl,
 aryl, heteroaryl, heterocyclyl, wherein independently of E, R represents a hydrogen,
 substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or
 unsubstituted alkynyl, substituted or unsubstituted amine, substituted or unsubstituted
 25 cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted
 alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or
 substituted or unsubstituted heteroaryl, $-(CH_2)_m-R'''$, or E and R taken together with the
 S atom to which they are attached complete a heterocycle having from 3 to 14 atoms in
 the ring structure; R''' represents a hydroxy group, substituted or unsubstituted carbonyl
 30 group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and
 m is zero or an integer ranging from 1 to 8. In preferred embodiments, only one of E and

R can be substituted or unsubstituted amine, to form a “sulfonamide” or “sulfonamido.” The substituted or unsubstituted amine is as defined above.

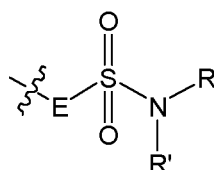
The term “substituted sulfonyl” represents a sulfonyl in which E, R, or both, are independently substituted. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxy carbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term “sulfonic acid” refers to a sulfonyl, as defined above, wherein R is hydroxyl, and E is absent, or E is substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl.

The term “sulfate” refers to a sulfonyl, as defined above, wherein E is absent, oxygen, alkoxy, aroxy, substituted alkoxy or substituted aroxy, as defined above, and R is independently hydroxyl, alkoxy, aroxy, substituted alkoxy or substituted aroxy, as defined above. When E is oxygen, the sulfate cannot be attached to another chemical species, such as to form an oxygen-oxygen bond, or other unstable bonds, as understood by one of ordinary skill in the art.

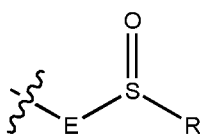
The term “sulfonate” refers to a sulfonyl, as defined above, wherein E is oxygen, alkoxy, aroxy, substituted alkoxy or substituted aroxy, as defined above, and R is independently hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted amine, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl, $-(CH_2)_m-R''$, R'' represents a hydroxy group, substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8. When E is oxygen, sulfonate cannot be attached to another chemical species, such as to form an oxygen-oxygen bond, or other unstable bonds, as understood by one of ordinary skill in the art.

The term “sulfamoyl” refers to a sulfonamide or sulfonamide represented by the formula



wherein E is absent, or E is substituted or unsubstituted alkyl, substituted or
 5 unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted
 aralkyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted cycloalkyl,
 substituted or unsubstituted aryl, substituted or unsubstituted heteroaryl, substituted or
 unsubstituted heterocyclyl, wherein independently of E, R and R' each independently
 10 represent a hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted
 alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted carbonyl,
 substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl,
 substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted
 or unsubstituted aryl, or substituted or unsubstituted heteroaryl, $-(CH_2)_m-R'''$, or R and
 15 R' taken together with the N atom to which they are attached complete a heterocycle
 having from 3 to 14 atoms in the ring structure; R''' represents a hydroxy group,
 substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl
 ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8. In
 preferred embodiments, only one of R and R' can be a carbonyl, e.g., R and R' together
 with the nitrogen do not form an imide.

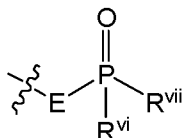
20 The term “sulfoxide” is represented by the formula



wherein E is absent, or E is alkyl, alkenyl, alkynyl, aralkyl, alkylaryl, cycloalkyl,
 aryl, heteroaryl, heterocyclyl, wherein independently of E, R represents a hydrogen,
 25 substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or
 unsubstituted alkynyl, substituted or unsubstituted amine, substituted or unsubstituted
 cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted
 alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or
 substituted or unsubstituted heteroaryl, $-(CH_2)_m-R'''$, or E and R taken together with the

S atom to which they are attached complete a heterocycle having from 3 to 14 atoms in the ring structure; R''' represents a hydroxy group, substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8.

5 The term “phosphonyl” is represented by the formula



wherein E is absent, or E is substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted aralkyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted aryl, substituted or unsubstituted heteroaryl, substituted or unsubstituted heterocyclyl, wherein, independently of E, R^{vi} and R^{vii} are independently hydrogen, substituted or unsubstituted alkyl, substituted or unsubstituted alkenyl, substituted or unsubstituted alkynyl, substituted or unsubstituted carbonyl, substituted or unsubstituted cycloalkyl, substituted or unsubstituted heterocyclyl, substituted or unsubstituted alkylaryl, substituted or unsubstituted arylalkyl, substituted or unsubstituted aryl, or substituted or unsubstituted heteroaryl, -(CH₂)_m-R''', or R and R' taken together with the P atom to which they are attached complete a heterocycle having from 3 to 14 atoms in the ring structure; R''' represents a hydroxy group, substituted or unsubstituted carbonyl group, an aryl, a cycloalkyl ring, a cycloalkenyl ring, a heterocycle, or a polycycle; and m is zero or an integer ranging from 1 to 8.

The term “substituted phosphonyl” represents a phosphonyl in which E, R^{vi} and R^{vii} are independently substituted. Such substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

The term “phosphoryl” defines a phosphonyl in which E is absent, oxygen, alkoxy, aroxy, substituted alkoxy or substituted aroxy, as defined above, and independently of E, R^{vi} and R^{vii} are independently hydroxyl, alkoxy, aroxy, substituted alkoxy or substituted aroxy, as defined above. When E is oxygen, the phosphoryl cannot be attached to another

chemical species, such as to form an oxygen-oxygen bond, or other unstable bonds, as understood by one of ordinary skill in the art. When E, R^{vi} and R^{vii} are substituted, the substituents include, but are not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

10 The term “polyaryl” refers to a chemical moiety that includes two or more aryls, heteroaryls, and combinations thereof. The aryls, heteroaryls, and combinations thereof, are fused, or linked via a single bond, ether, ester, carbonyl, amide, sulfonyl, sulfonamide, alkyl, azo, and combinations thereof.

15 The term “substituted polyaryl” refers to a polyaryl in which one or more of the aryls, heteroaryls are substituted, with one or more substituents including, but not limited to, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, carbonyl (such as a carboxyl, alkoxycarbonyl, formyl, or an acyl), silyl, ether, ester, thiocarbonyl (such as a thioester, a thioacetate, or a thioformate), alkoxy, phosphoryl, phosphate, phosphonate, phosphinate, amino (or quarternized amino), amido, amidine, imine, cyano, nitro, azido, sulfhydryl, alkylthio, sulfate, sulfonate, sulfamoyl, sulfoxide, sulfonamido, sulfonyl, heterocyclyl, alkylaryl, haloalkyl, -CN, aryl, heteroaryl, and combinations thereof.

20 The term “C₃-C₂₀ cyclic” refers to a substituted or unsubstituted cycloalkyl, substituted or unsubstituted cycloalkenyl, substituted or unsubstituted cycloalkynyl, substituted or unsubstituted heterocyclyl that have from three to 20 carbon atoms, as geometric constraints permit. The cyclic structures are formed from single or fused ring systems. The substituted cycloalkyls, cycloalkenyls, cycloalkynyls and heterocyclyls are substituted as defined above for the alkyls, alkenyls, alkynyls and heterocyclyls, respectively.

30 The terms “hydroxyl” and “hydroxy” are used interchangeably and are represented by -OH.

 The terms “thiol” and “sulfhydryl” are used interchangeably and are represented by -SH.

 The term “oxo” refers to =O bonded to a carbon atom.

The terms “cyano” and “nitrile” are used interchangeably to refer to -CN.

The term “nitro” refers to -NO₂.

The term “phosphate” refers to -O-PO₃.

The term “azide” or “azido” are used interchangeably to refer to -N₃.

- 5 The term “substituted C₁-C_x alkyl” refers to alkyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x alkyl” refers to alkyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

- 10 The term “substituted C₁-C_x alkylene” refers to alkylene groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x alkylene” refers to alkylene groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten. The term “alkylene” as used herein, refers to a moiety with the formula -(CH₂)_a-, wherein “a” is an integer from one to ten.

- 15 The term “substituted C₂-C_x alkenyl” refers to alkenyl groups having from two to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from two to ten. The term “unsubstituted C₂-C_x alkenyl” refers to alkenyl groups having from two to x carbon atoms that are not substituted, wherein “x” is an integer from two to ten.

- 20 The term “substituted C₂-C_x alkynyl” refers to alkynyl groups having from two to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from two to ten. The term “unsubstituted C₂-C_x alkynyl” refers to alkynyl groups having from two to x carbon atoms that are not substituted, wherein “x” is an integer from two to ten.

- 25 The term “substituted C₁-C_x alkoxy” refers to alkoxy groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x alkoxy” refers to alkoxy groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

- 30 The term “substituted C₁-C_x alkylamino” refers to alkylamino groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x alkylamino” refers to alkyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten. The terms “alkylamine” and “alkylamino” are used

interchangeably. In any alkylamino, where the nitrogen atom is substituted with one, two, or three substituents, the nitrogen atom can be referred to as a secondary, tertiary, or quaternary nitrogen atom, respectively.

5 The term “substituted C₁-C_x alkylthio” refers to alkylthio groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x alkylthio” refers to alkylthio groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

10 The term “substituted C₁-C_x carbonyl” refers to carbonyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x carbonyl” refers to carbonyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

15 The term “substituted C₁-C_x carboxyl” refers to carboxyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x carboxyl” refers to carboxyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

20 The term “substituted C₁-C_x amido” refers to amido groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x amido” refers to amido groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

25 The term “substituted C₁-C_x sulfonyl” refers to sulfonyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x sulfonyl” refers to sulfonyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

30 The term “substituted C₁-C_x sulfonic acid” refers to sulfonic acid groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x sulfonic acid” refers to sulfonic acid groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The term “substituted C₁-C_x sulfamoyl” refers to sulfamoyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x sulfamoyl” refers to sulfamoyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The term “substituted C₁-C_x sulfoxide” refers to sulfoxide groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x sulfoxide” refers to sulfoxide groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The term “substituted C₁-C_x phosphoryl” refers to phosphoryl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x phosphoryl” refers to phosphoryl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The term “substituted C₁-C_x phosphonyl” refers to phosphonyl groups having from one to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The term “unsubstituted C₁-C_x phosphonyl” refers to phosphonyl groups having from one to x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The term “substituted C₀-C_x sulfonyl” refers to sulfonyl groups having from zero to x carbon atoms, wherein, if present, at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x sulfonyl” refers to sulfonyl groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The term “substituted C₀-C_x sulfonic acid” refers to sulfonic acid groups having from zero to x carbon atoms, wherein, if present, at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x sulfonic acid” refers to sulfonic acid groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The term “substituted C₀-C_x sulfamoyl” refers to sulfamoyl groups having from zero to x carbon atoms, wherein, if present, at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x sulfamoyl”

refers to sulfamoyl groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The term “substituted C₀-C_x sulfoxide” refers to sulfoxide groups having from zero to x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x sulfoxide” refers to sulfoxide groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The term “substituted C₀-C_x phosphoryl” refers to phosphoryl groups having from zero to x carbon atoms, wherein, if present, at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x phosphoryl” refers to phosphoryl groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The term “substituted C₀-C_x phosphonyl” refers to phosphonyl groups having from zero to x carbon atoms, wherein, if present, at least one carbon atom is substituted, wherein “x” is an integer from zero to ten. The term “unsubstituted C₀-C_x phosphonyl” refers to phosphonyl groups having from zero to x carbon atoms that are not substituted, wherein “x” is an integer from zero to ten.

The terms substituted “C_x alkyl,” “C_x alkylene,” “C_x alkenyl,” “C_x alkynyl,” “C_x alkoxy,” “C_x alkylamino,” “C_x alkylthio,” “C_x carbonyl,” “C_x carboxyl,” “C_x amido,” “C_x sulfonyl,” “C_x sulfonic acid,” “C_x sulfamoyl,” “C_x phosphoryl,” and “C_x phosphonyl” refer to alkyl, alkylene, alkenyl, alkynyl, alkoxy, alkylamino, alkylthio, carbonyl, carboxyl, amido, sulfonyl, sulfonic acid, sulfamoyl, sulfoxide, phosphoryl, and phosphonyl groups, respectively, having x carbon atoms, wherein at least one carbon atom is substituted, wherein “x” is an integer from one to ten. The terms unsubstituted “C_x alkyl,” “C_x alkylene,” “C_x alkenyl,” “C_x alkynyl,” “C_x alkoxy,” “C_x alkylamino,” “C_x alkylthio,” “C_x carbonyl,” “C_x carboxyl,” “C_x amido,” “C_x sulfonyl,” “C_x sulfonic acid,” “C_x sulfamoyl,” “C_x phosphoryl,” and “C_x phosphonyl” refer to alkyl, alkylene, alkenyl, alkynyl, alkoxy, alkylamino, alkylthio, carbonyl, carboxyl, amido, sulfonyl, sulfonic acid, sulfamoyl, sulfoxide, phosphoryl, and phosphonyl groups, respectively, having x carbon atoms that are not substituted, wherein “x” is an integer from one to ten.

The terms unsubstituted “C₀ sulfonyl,” “C₀ sulfonic acid,” “C₀ sulfamoyl,” “C₀ phosphoryl,” and “C₀ phosphonyl” refer to alkyl, alkylene, alkenyl, alkynyl, alkoxy, alkylamino, alkylthio, carbonyl, carboxyl, amido, sulfonyl, sulfonic acid, sulfamoyl,

sulfoxide, phosphoryl, and phosphonyl groups, respectively, having zero carbon atoms that are not substituted.

“Halogen,” as used herein, refers to fluorine, chlorine, bromine, or iodine.

As used herein, U₁ represents the organic groups alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, substituted alkoxy, phenoxy, substituted phenoxy, aroxy, substituted aroxy, alkylthio, substituted alkylthio, phenylthio, substituted phenylthio, arylthio, substituted arylthio, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, polyaryl, substituted polyaryl, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, amino acid, poly(ethylene glycol), peptide, and polypeptide group.

As used herein, U₂ represents the organic groups alkylamino, dialkylamino, hydroxy, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, substituted alkoxy, phenoxy, substituted phenoxy, aroxy, substituted aroxy, alkylthio, substituted alkylthio, phenylthio, substituted phenylthio, arylthio, substituted arylthio, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, polyaryl, substituted polyaryl, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, amino acid, poly(ethylene glycol), peptide, and polypeptide group.

As used herein, U₃ represents the organic groups alkylamino, dialkylamino, hydroxy, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, phenyl, substituted phenyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, substituted alkoxy, phenoxy, substituted phenoxy, aroxy, substituted aroxy, alkylthio, substituted alkylthio, phenylthio, substituted phenylthio, arylthio, substituted arylthio, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, polyaryl, substituted polyaryl, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, substituted heterocyclic, amino acid, poly(ethylene glycol), peptide, and polypeptide group.

As used herein, U₄ represents the organic groups alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, alkoxy, substituted alkoxy, carboxyl, substituted carboxyl, amino,

substituted amino, amido, substituted amido, C₃-C₂₀ cyclic, substituted C₃-C₂₀ cyclic, heterocyclic, and substituted heterocyclic.

As used herein, Q₁ represents the organic groups arylalkyl and substituted arylalkyl.

5 As used herein, Q₂ represents the organic groups sulfonyl, substituted sulfonyl, sulfonic acid, phosphoryl, substituted phosphoryl, phosphonyl, and substituted phosphonyl.

As used herein, Q₃ represents the organic group poly(lactic-co-glycolic acid).

As used herein, Q₄ represents the organic groups phenyl and substituted phenyl.

10 As used herein, Q₅ represents the organic groups alkylamino, dialkylamino, and hydroxy.

As used herein, Q₆ represents the organic groups aroxy, substituted aroxy, carbonyl, substituted carbonyl, and poly(ethylene glycol).

As used herein, Q₇ represents the organic groups alkylthio, substituted alkylthio, arylthio, substituted arylthio, phenoxy, substituted phenoxy, phenylthio, substituted phenylthio, polyaryl, and substituted polyaryl.

As used herein, Q₈ represents the organic groups amino acid, peptide, and polypeptide group.

In some embodiments, groups Q₁, Q₂, Q₃, or any combination thereof, can be
20 used along with any one of U₁, U₂, and U₃. For example, U₁ can be combined with Q₁, with Q₂, with Q₃, with Q₁ and Q₂, with Q₁ and Q₃, with Q₂ and Q₃, and with Q₁, Q₂, and Q₃. Such combinations can be referred to as U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, and U₁ + Q₁ + Q₂ + Q₃, respectively. Similarly, U₂ can be combined with Q₁, with Q₂, with Q₃, with Q₁ and Q₂, with Q₁ and Q₃, with Q₂ and Q₃,
25 and with Q₁, Q₂, and Q₃. Such combinations can be referred to as U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, and U₂ + Q₁ + Q₂ + Q₃, respectively. Similarly, U₃ can be combined with Q₁, with Q₂, with Q₃, with Q₁ and Q₂, with Q₁ and Q₃, with Q₂ and Q₃, and with Q₁, Q₂, and Q₃. Such combinations can be referred to as U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, and U₃ + Q₁ + Q₂ +
30 Q₃, respectively.

In some embodiments, groups Q₁, Q₂, Q₃, Q₅, or any combination thereof, can be used along with U₁. For example, U₁ can be combined with Q₁, with Q₂, with Q₃, with Q₅, with Q₁ and Q₂, with Q₁ and Q₃, with Q₁ and Q₅, with Q₂ and Q₃, with Q₂ and Q₅, with Q₃ and Q₅, with Q₁, Q₂, and Q₃, with Q₁, Q₂, and Q₅, with Q₁, Q₃, and Q₅, with Q₂,

Q₃, and Q₅, and with Q₁, Q₂, Q₃, and Q₅. Such combinations can be referred to as U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₅, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₁ + Q₅, U₁ + Q₂ + Q₃, U₁ + Q₂ + Q₅, U₁ + Q₃ + Q₅, U₁ + Q₁ + Q₂ + Q₃, U₁ + Q₁ + Q₂ + Q₅, U₁ + Q₁ + Q₃ + Q₅, U₁ + Q₂ + Q₃ + Q₅, respectively.

- 5 In some embodiments, groups Q₁, Q₂, Q₃, Q₄, Q₅, Q₆, Q₇, Q₈ or any combination thereof, can be used along with U₄. For example, U₄ can be combined with Q₁, with Q₂, with Q₃, with Q₄, with Q₅, with Q₆, with Q₇, with Q₈, with Q₁ + Q₂, with Q₁ + Q₃, with Q₁ + Q₄, with Q₁ + Q₅, with Q₁ + Q₆, with Q₁ + Q₇, with Q₁ + Q₈, with Q₂ + Q₃, with Q₂ + Q₄, with Q₂ + Q₅, with Q₂ + Q₆, with Q₂ + Q₇, with Q₂ + Q₈, with Q₃ + Q₄, with Q₃ + Q₅, with Q₃ + Q₆, with Q₃ + Q₇, with Q₃ + Q₈, with Q₄ + Q₅, with Q₄ + Q₆, with Q₄ + Q₇, with Q₄ + Q₈, with Q₅ + Q₆, with Q₅ + Q₇, with Q₅ + Q₈, with Q₆ + Q₇, with Q₆ + Q₈, with Q₇ + Q₈, with Q₁ + Q₂ + Q₃, with Q₁ + Q₂ + Q₄, with Q₁ + Q₂ + Q₅, with Q₁ + Q₂ + Q₆, with Q₁ + Q₂ + Q₇, with Q₁ + Q₂ + Q₈, with Q₁ + Q₃ + Q₄, with Q₁ + Q₃ + Q₅, with Q₁ + Q₃ + Q₆, with Q₁ + Q₃ + Q₇, with Q₁ + Q₃ + Q₈, with Q₁ + Q₄ + Q₅, with Q₁ + Q₄ + Q₆, with Q₁ + Q₄ + Q₇, with Q₁ + Q₄ + Q₈, with Q₁ + Q₅ + Q₆, with Q₁ + Q₅ + Q₇, with Q₁ + Q₅ + Q₈, with Q₁ + Q₆ + Q₇, with Q₁ + Q₆ + Q₈, with Q₁ + Q₇ + Q₈, with Q₂ + Q₃ + Q₄, with Q₂ + Q₃ + Q₅, with Q₂ + Q₃ + Q₆, with Q₂ + Q₃ + Q₇, with Q₂ + Q₃ + Q₈, with Q₂ + Q₄ + Q₅, with Q₂ + Q₄ + Q₆, with Q₂ + Q₄ + Q₇, with Q₂ + Q₄ + Q₈, with Q₂ + Q₅ + Q₆, with Q₂ + Q₅ + Q₇, with Q₂ + Q₅ + Q₈, with Q₂ + Q₆ + Q₇, with Q₂ + Q₆ + Q₈, with Q₂ + Q₇ + Q₈, with Q₃ + Q₄ + Q₅, with Q₃ + Q₄ + Q₆, with Q₃ + Q₄ + Q₇, with Q₃ + Q₄ + Q₈, with Q₃ + Q₅ + Q₆, with Q₃ + Q₅ + Q₇, with Q₃ + Q₅ + Q₈, with Q₃ + Q₆ + Q₇, with Q₃ + Q₆ + Q₈, with Q₃ + Q₇ + Q₈, with Q₄ + Q₅ + Q₆, with Q₄ + Q₅ + Q₇, with Q₄ + Q₅ + Q₈, with Q₄ + Q₆ + Q₇, with Q₄ + Q₆ + Q₈, with Q₄ + Q₇ + Q₈, with Q₅ + Q₆ + Q₇, with Q₅ + Q₆ + Q₈, with Q₅ + Q₇ + Q₈, with Q₆ + Q₇ + Q₈, with Q₁ + Q₂ + Q₃ + Q₄, with Q₁ + Q₂ + Q₃ + Q₅, with Q₁ + Q₂ + Q₃ + Q₆, with Q₁ + Q₂ + Q₃ + Q₇, with Q₁ + Q₂ + Q₃ + Q₈, with Q₁ + Q₃ + Q₄ + Q₅, with Q₁ + Q₃ + Q₄ + Q₆, with Q₁ + Q₃ + Q₄ + Q₇, with Q₁ + Q₃ + Q₄ + Q₈, with Q₁ + Q₄ + Q₅ + Q₆, with Q₁ + Q₄ + Q₅ + Q₇, with Q₁ + Q₄ + Q₅ + Q₈, with Q₁ + Q₅ + Q₆ + Q₇, with Q₁ + Q₅ + Q₆ + Q₈, with Q₁ + Q₆ + Q₇ + Q₈, with Q₂ + Q₃ + Q₄ + Q₅, with Q₂ + Q₃ + Q₄ + Q₆, with Q₂ + Q₃ + Q₄ + Q₇, with Q₂ + Q₃ + Q₄ + Q₈, with Q₂ + Q₄ + Q₅ + Q₆, with Q₂ + Q₄ + Q₅ + Q₇, with Q₂ + Q₄ + Q₅ + Q₈, with Q₂ + Q₅ + Q₆ + Q₇, with Q₂ + Q₅ + Q₆ + Q₈, with Q₂ + Q₆ + Q₇ + Q₈, with Q₃ + Q₄ + Q₅ + Q₆, with Q₃ + Q₄ + Q₅ + Q₇, with Q₃ + Q₄ + Q₅ + Q₈, with Q₃ + Q₅ + Q₆ + Q₇, with Q₃ + Q₅ + Q₆ + Q₈, with Q₃ + Q₆ + Q₇ + Q₈, with Q₄ + Q₅ + Q₆ + Q₇, with Q₄ + Q₅ + Q₆ + Q₈, with Q₄ + Q₆ + Q₇ + Q₈, with Q₅ + Q₆ + Q₇ + Q₈, with Q₁ + Q₂ + Q₃ + Q₄ + Q₅, with Q₁

$+ Q_2 + Q_3 + Q_4 + Q_6$, with $Q_1 + Q_2 + Q_3 + Q_4 + Q_7$, with $Q_1 + Q_2 + Q_3 + Q_4 + Q_8$, with
 $Q_1 + Q_3 + Q_4 + Q_5 + Q_6$, with $Q_1 + Q_3 + Q_4 + Q_5 + Q_7$, with $Q_1 + Q_3 + Q_4 + Q_5 + Q_8$,
with $Q_1 + Q_4 + Q_5 + Q_6 + Q_7$, with $Q_1 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_1 + Q_5 + Q_6 + Q_7 + Q_8$,
with $Q_2 + Q_3 + Q_4 + Q_5 + Q_6$, with $Q_2 + Q_3 + Q_4 + Q_5 + Q_7$, with $Q_2 + Q_3 + Q_4 + Q_5 +$
5 Q_8 , with $Q_2 + Q_4 + Q_5 + Q_6 + Q_7$, with $Q_2 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_2 + Q_5 + Q_6 + Q_7$
 $+ Q_8$, with $Q_3 + Q_4 + Q_5 + Q_6 + Q_7$, with $Q_3 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_3 + Q_5 + Q_6 +$
 $Q_7 + Q_8$, with $Q_4 + Q_5 + Q_6 + Q_7 + Q_8$, with $Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6$, with $Q_1 + Q_2$
 $+ Q_3 + Q_4 + Q_5 + Q_7$, with $Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_8$, with $Q_1 + Q_3 + Q_4 + Q_5 + Q_6 +$
 Q_7 , with $Q_1 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_1 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8$, with $Q_2 + Q_3$
10 $+ Q_4 + Q_5 + Q_6 + Q_7$, with $Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_2 + Q_4 + Q_5 + Q_6 + Q_7 +$
 Q_8 , with $Q_3 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8$, with $Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7$, with Q_1
 $+ Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8$, with $Q_1 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8$, with $Q_2 + Q_3 +$
 $Q_4 + Q_5 + Q_6 + Q_7 + Q_8$, or with $Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8$. Such
combinations can be referred to as $U_4 + Q_1$, $U_4 + Q_2$, $U_4 + Q_3$, $U_4 + Q_4$, $U_4 + Q_5$, $U_4 + Q_6$,
15 $U_4 + Q_7$, $U_4 + Q_8$, $U_4 + Q_1 + Q_2$, $U_4 + Q_1 + Q_3$, $U_4 + Q_1 + Q_4$, $U_4 + Q_1 + Q_5$, $U_4 + Q_1 +$
 Q_6 , $U_4 + Q_1 + Q_7$, $U_4 + Q_1 + Q_8$, $U_4 + Q_2 + Q_3$, $U_4 + Q_2 + Q_4$, $U_4 + Q_2 + Q_5$, $U_4 + Q_2 +$
 Q_6 , $U_4 + Q_2 + Q_7$, $U_4 + Q_2 + Q_8$, $U_4 + Q_3 + Q_4$, $U_4 + Q_3 + Q_5$, $U_4 + Q_3 + Q_6$, $U_4 + Q_3 +$
 Q_7 , $U_4 + Q_3 + Q_8$, $U_4 + Q_4 + Q_5$, $U_4 + Q_4 + Q_6$, $U_4 + Q_4 + Q_7$, $U_4 + Q_4 + Q_8$, $U_4 + Q_5 +$
 Q_6 , $U_4 + Q_5 + Q_7$, $U_4 + Q_5 + Q_8$, $U_4 + Q_6 + Q_7$, $U_4 + Q_6 + Q_8$, $U_4 + Q_7 + Q_8$, $U_4 + Q_1 +$
20 $Q_2 + Q_3$, $U_4 + Q_1 + Q_2 + Q_4$, $U_4 + Q_1 + Q_2 + Q_5$, $U_4 + Q_1 + Q_2 + Q_6$, $U_4 + Q_1 + Q_2 + Q_7$,
 $U_4 + Q_1 + Q_2 + Q_8$, $U_4 + Q_1 + Q_3 + Q_4$, $U_4 + Q_1 + Q_3 + Q_5$, $U_4 + Q_1 + Q_3 + Q_6$, $U_4 + Q_1 +$
 $Q_3 + Q_7$, $U_4 + Q_1 + Q_3 + Q_8$, $U_4 + Q_1 + Q_4 + Q_5$, $U_4 + Q_1 + Q_4 + Q_6$, $U_4 + Q_1 + Q_4 + Q_7$,
 $U_4 + Q_1 + Q_4 + Q_8$, $U_4 + Q_1 + Q_5 + Q_6$, $U_4 + Q_1 + Q_5 + Q_7$, $U_4 + Q_1 + Q_5 + Q_8$, $U_4 + Q_1 +$
 $Q_6 + Q_7$, $U_4 + Q_1 + Q_6 + Q_8$, $U_4 + Q_1 + Q_7 + Q_8$, $U_4 + Q_2 + Q_3 + Q_4$, $U_4 + Q_2 + Q_3 + Q_5$,
25 $U_4 + Q_2 + Q_3 + Q_6$, $U_4 + Q_2 + Q_3 + Q_7$, $U_4 + Q_2 + Q_3 + Q_8$, $U_4 + Q_2 + Q_4 + Q_5$, $U_4 + Q_2 +$
 $Q_4 + Q_6$, $U_4 + Q_2 + Q_4 + Q_7$, $U_4 + Q_2 + Q_4 + Q_8$, $U_4 + Q_2 + Q_5 + Q_6$, $U_4 + Q_2 + Q_5 + Q_7$,
 $U_4 + Q_2 + Q_5 + Q_8$, $U_4 + Q_2 + Q_6 + Q_7$, $U_4 + Q_2 + Q_6 + Q_8$, $U_4 + Q_2 + Q_7 + Q_8$, $U_4 + Q_3 +$
 $Q_4 + Q_5$, $U_4 + Q_3 + Q_4 + Q_6$, $U_4 + Q_3 + Q_4 + Q_7$, $U_4 + Q_3 + Q_4 + Q_8$, $U_4 + Q_3 + Q_5 + Q_6$,
 $U_4 + Q_3 + Q_5 + Q_7$, $U_4 + Q_3 + Q_5 + Q_8$, $U_4 + Q_3 + Q_6 + Q_7$, $U_4 + Q_3 + Q_6 + Q_8$, $U_4 + Q_3 +$
30 $Q_7 + Q_8$, $U_4 + Q_4 + Q_5 + Q_6$, $U_4 + Q_4 + Q_5 + Q_7$, $U_4 + Q_4 + Q_5 + Q_8$, $U_4 + Q_4 + Q_6 + Q_7$,
 $U_4 + Q_4 + Q_6 + Q_8$, $U_4 + Q_4 + Q_7 + Q_8$, $U_4 + Q_5 + Q_6 + Q_7$, $U_4 + Q_5 + Q_6 + Q_8$, $U_4 + Q_5 +$
 $Q_7 + Q_8$, $U_4 + Q_6 + Q_7 + Q_8$, $U_4 + Q_1 + Q_2 + Q_3 + Q_4$, $U_4 + Q_1 + Q_2 + Q_3 + Q_5$, $U_4 + Q_1 +$
 $Q_2 + Q_3 + Q_6$, $U_4 + Q_1 + Q_2 + Q_3 + Q_7$, $U_4 + Q_1 + Q_2 + Q_3 + Q_8$, $U_4 + Q_1 + Q_3 + Q_4 + Q_5$,
 $U_4 + Q_1 + Q_3 + Q_4 + Q_6$, $U_4 + Q_1 + Q_3 + Q_4 + Q_7$, $U_4 + Q_1 + Q_3 + Q_4 + Q_8$, $U_4 + Q_1 + Q_4$

+ Q₅ + Q₆, U₄ + Q₁ + Q₄ + Q₅ + Q₇, U₄ + Q₁ + Q₄ + Q₅ + Q₈, U₄ + Q₁ + Q₅ + Q₆ + Q₇, U₄
 + Q₁ + Q₅ + Q₆ + Q₈, U₄ + Q₁ + Q₆ + Q₇ + Q₈, U₄ + Q₂ + Q₃ + Q₄ + Q₅, U₄ + Q₂ + Q₃ +
 Q₄ + Q₆, U₄ + Q₂ + Q₃ + Q₄ + Q₇, U₄ + Q₂ + Q₃ + Q₄ + Q₈, U₄ + Q₂ + Q₄ + Q₅ + Q₆, U₄ +
 Q₂ + Q₄ + Q₅ + Q₇, U₄ + Q₂ + Q₄ + Q₅ + Q₈, U₄ + Q₂ + Q₅ + Q₆ + Q₇, U₄ + Q₂ + Q₅ + Q₆
 5 + Q₈, U₄ + Q₂ + Q₆ + Q₇ + Q₈, U₄ + Q₃ + Q₄ + Q₅ + Q₆, U₄ + Q₃ + Q₄ + Q₅ + Q₇, U₄ + Q₃
 + Q₄ + Q₅ + Q₈, U₄ + Q₃ + Q₅ + Q₆ + Q₇, U₄ + Q₃ + Q₅ + Q₆ + Q₈, U₄ + Q₃ + Q₆ + Q₇ +
 Q₈, U₄ + Q₄ + Q₅ + Q₆ + Q₇, U₄ + Q₄ + Q₅ + Q₆ + Q₈, U₄ + Q₄ + Q₆ + Q₇ + Q₈, U₄ + Q₅ +
 Q₆ + Q₇ + Q₈, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₅, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₆, U₄ + Q₁ + Q₂
 + Q₃ + Q₄ + Q₇, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₈, U₄ + Q₁ + Q₃ + Q₄ + Q₅ + Q₆, U₄ + Q₁ +
 10 Q₃ + Q₄ + Q₅ + Q₇, U₄ + Q₁ + Q₃ + Q₄ + Q₅ + Q₈, U₄ + Q₁ + Q₄ + Q₅ + Q₆ + Q₇, U₄ + Q₁
 + Q₄ + Q₅ + Q₆ + Q₈, U₄ + Q₁ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆, U₄ +
 Q₂ + Q₃ + Q₄ + Q₅ + Q₇, U₄ + Q₂ + Q₃ + Q₄ + Q₅ + Q₈, U₄ + Q₂ + Q₄ + Q₅ + Q₆ + Q₇, U₄
 + Q₂ + Q₄ + Q₅ + Q₆ + Q₈, U₄ + Q₂ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇,
 U₄ + Q₃ + Q₄ + Q₅ + Q₆ + Q₈, U₄ + Q₃ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₄ + Q₅ + Q₆ + Q₇ +
 15 Q₈, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₅ + Q₇, U₄ + Q₁ + Q₂
 + Q₃ + Q₄ + Q₅ + Q₈, U₄ + Q₁ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇, U₄ + Q₁ + Q₃ + Q₄ + Q₅ + Q₆ +
 Q₈, U₄ + Q₁ + Q₄ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇, U₄ + Q₂ + Q₃
 + Q₄ + Q₅ + Q₆ + Q₈, U₄ + Q₂ + Q₄ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇ +
 Q₈, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇, U₄ + Q₁ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆ + Q₈, U₄
 20 + Q₁ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇ + Q₈, U₄ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇ + Q₈, and U₄ +
 Q₁ + Q₂ + Q₃ + Q₄ + Q₅ + Q₆ + Q₇ + Q₈, respectively.

As used herein, J₁ represents the organic groups substituted or unsubstituted C₁-
 C₁₀ alkyl, C₁-C₁₀ alkylene, C₂-C₁₀ alkenyl, C₂-C₁₀ alkynyl, C₁-C₁₀ alkoxy, C₁-C₁₀
 alkylamino, C₁-C₁₀ alkylthio, C₁-C₁₀ carbonyl, C₁-C₁₀ carboxyl, C₁-C₁₀ amido, C₁-C₁₀
 25 sulfonyl, C₁-C₁₀ sulfonic acid, C₁-C₁₀ sulfamoyl, C₁-C₁₀ sulfoxide, C₁-C₁₀ phosphoryl,
 C₁-C₁₀ phosphonyl, C₁-C₉ alkyl, C₁-C₉ alkylene, C₂-C₉ alkenyl, C₂-C₉ alkynyl, C₁-C₉
 alkoxy, C₁-C₉ alkylamino, C₁-C₉ alkylthio, C₁-C₉ carbonyl, C₁-C₉ carboxyl, C₁-C₉
 amido, C₁-C₉ sulfonyl, C₁-C₉ sulfonic acid, C₁-C₉ sulfamoyl, C₁-C₉ sulfoxide, C₁-C₉
 phosphoryl, C₁-C₉ phosphonyl, C₁-C₈ alkyl, C₁-C₈ alkylene, C₂-C₈ alkenyl, C₂-C₈
 30 alkynyl, C₁-C₈ alkoxy, C₁-C₈ alkylamino, C₁-C₈ alkylthio, C₁-C₈ carbonyl, C₁-C₈
 carboxyl, C₁-C₈ amido, C₁-C₈ sulfonyl, C₁-C₈ sulfonic acid, C₁-C₈ sulfamoyl, C₁-C₈
 sulfoxide, C₁-C₈ phosphoryl, C₁-C₈ phosphonyl, C₁-C₇ alkyl, C₁-C₇ alkylene, C₂-C₇
 alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, C₁-C₇ alkylamino, C₁-C₇ alkylthio, C₁-C₇
 carbonyl, C₁-C₇ carboxyl, C₁-C₇ amino, C₁-C₇ amido, C₁-C₇ sulfonyl, C₁-C₇ sulfonic

acid, C₁-C₇ sulfamoyl, C₁-C₇ sulfoxide, C₁-C₇ phosphoryl, C₁-C₇ phosphonyl, C₁-C₆ alkyl, C₁-C₆ alkylene, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, C₁-C₆ alkylthio, C₁-C₆ carbonyl, C₁-C₆ carboxyl, C₁-C₆ amido, C₁-C₆ sulfonyl, C₁-C₆ sulfonic acid, C₁-C₆ sulfamoyl, C₁-C₆ sulfoxide, C₂-C₆ phosphoryl, C₂-C₆ phosphonyl,

5 C₁-C₅ alkyl, C₁-C₅ alkylene, C₂-C₅ alkenyl, C₂-C₅ alkynyl, C₁-C₅ alkoxy, C₁-C₅ alkylamino, C₁-C₅ alkylthio, C₁-C₅ carbonyl, C₁-C₅ carboxyl, C₁-C₅ amido, C₁-C₅ sulfonyl, C₁-C₅ sulfonic acid, C₁-C₅ sulfamoyl, C₁-C₅ sulfoxide, C₁-C₅ phosphoryl, C₁-C₅ phosphonyl, C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₄ carbonyl, C₁-C₄ carboxyl, C₁-C₄ amino, C₁-C₄

10 amido, C₁-C₄ sulfonyl, C₁-C₄ sulfonic acid, C₁-C₄ sulfamoyl, C₁-C₄ sulfoxide, C₁-C₄ phosphoryl, C₁-C₄ phosphonyl, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₃ carbonyl, C₁-C₃ carboxyl, C₁-C₃ amino, C₁-C₃ amido, C₁-C₃ sulfonyl, C₁-C₃ sulfonic acid, C₁-C₃ sulfamoyl, C₁-C₃ sulfoxide, C₁-C₃ phosphoryl, C₁-C₃ phosphonyl, C₁-C₂ alkyl, C₁-C₂

15 alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₁-C₂ sulfamoyl, C₁-C₂ sulfoxide, C₁-C₂ phosphoryl, C₁-C₂ phosphonyl, C₀-C₁₀ sulfonyl, C₀-C₁₀ sulfonic acid, C₀-C₁₀ sulfamoyl, C₀-C₁₀ sulfoxide, C₀-C₁₀ phosphoryl, C₀-C₁₀ phosphonyl, C₀-C₉ sulfonyl, C₀-C₉ sulfonic acid, C₀-C₉ sulfamoyl, C₀-C₉ sulfoxide, C₀-C₉ phosphoryl, C₀-C₉

20 phosphonyl, C₀-C₈ sulfonyl, C₀-C₈ sulfonic acid, C₀-C₈ sulfamoyl, C₀-C₈ sulfoxide, C₀-C₈ phosphoryl, C₀-C₈ phosphonyl, C₀-C₇ sulfonyl, C₀-C₇ sulfonic acid, C₀-C₇ sulfamoyl, C₀-C₇ sulfoxide, C₀-C₇ phosphoryl, C₀-C₇ phosphonyl, C₀-C₆ sulfonyl, C₀-C₆ sulfonic acid, C₀-C₆ sulfamoyl, C₀-C₆ sulfoxide, C₀-C₆ phosphoryl, C₀-C₆ phosphonyl, C₀-C₅ sulfonyl, C₀-C₅ sulfonic acid, C₀-C₅ sulfamoyl, C₀-C₅ sulfoxide, C₀-C₅ phosphoryl, C₀-C₅

25 phosphonyl, C₀-C₄ sulfonyl, C₀-C₄ sulfonic acid, C₀-C₄ sulfamoyl, C₀-C₄ sulfoxide, C₀-C₄ phosphoryl, C₀-C₄ phosphonyl, C₀-C₃ sulfonyl, C₀-C₃ sulfonic acid, C₀-C₃ sulfamoyl, C₀-C₃ sulfoxide, C₀-C₃ phosphoryl, C₀-C₃ phosphonyl, C₀-C₂ sulfonyl, C₀-C₂ sulfonic acid, C₀-C₂ sulfamoyl, C₀-C₂ sulfoxide, C₀-C₂ phosphoryl, C₀-C₂ phosphonyl, C₀-C₁ sulfonyl, C₀-C₁ sulfonic acid, C₀-C₁ sulfamoyl, C₀-C₁ sulfoxide, C₀-C₁ phosphoryl, C₀-C₁

30 phosphonyl, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino, C₁₀ alkylthio, C₁₀ carbonyl, C₁₀ carboxyl, C₁₀ amido, C₁₀ sulfonyl, C₁₀ sulfonic acid, C₁₀ sulfamoyl, C₁₀ sulfoxide, C₁₀ phosphoryl, C₁₀ phosphonyl, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₉ carbonyl, C₉ carboxyl, C₉ amido, C₉ sulfonyl, C₉ sulfonic acid, C₉ sulfamoyl, C₉ sulfoxide, C₉

phosphoryl, C₉ phosphonyl, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₈ carbonyl, C₈ carboxyl, C₈ amido, C₈ sulfonyl, C₈ sulfonic acid, C₈ sulfamoyl, C₈ sulfoxide, C₈ phosphoryl, C₈ phosphonyl, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₇ carbonyl, C₇ carboxyl, C₇ amido, C₇ sulfonyl, C₇ sulfonic acid, C₇ sulfamoyl, C₇ sulfoxide, C₇ phosphoryl, C₇ phosphonyl, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₆ carbonyl, C₆ carboxyl, C₆ amido, C₆ sulfonyl, C₆ sulfonic acid, C₆ sulfamoyl, C₆ sulfoxide, C₆ phosphoryl, C₆ phosphonyl, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₅ carbonyl, C₅ carboxyl, C₅ amido, C₅ sulfonyl, C₅ sulfonic acid, C₅ sulfamoyl, C₅ sulfoxide, C₅ phosphoryl, C₅ phosphonyl, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₄ carbonyl, C₄ carboxyl, C₄ amido, C₄ sulfonyl, C₄ sulfonic acid, C₄ sulfamoyl, C₄ sulfoxide, C₄ phosphoryl, C₄ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂ carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, and C₀ phosphonyl.

As used herein, J₁ represents the organic groups substituted or unsubstituted C₁-C₁₀ alkyl, C₁-C₁₀ alkylene, C₂-C₁₀ alkenyl, C₂-C₁₀ alkynyl, C₁-C₁₀ alkoxy, C₁-C₁₀ alkylamino, C₁-C₁₀ alkylthio, C₁-C₉ alkyl, C₁-C₉ alkylene, C₂-C₉ alkenyl, C₂-C₉ alkynyl, C₁-C₉ alkoxy, C₁-C₉ alkylamino, C₁-C₉ alkylthio, C₁-C₈ alkyl, C₁-C₈ alkylene, C₂-C₈ alkenyl, C₂-C₈ alkynyl, C₁-C₈ alkoxy, C₁-C₈ alkylamino, C₁-C₈ alkylthio, C₁-C₇ alkyl, C₁-C₇ alkylene, C₂-C₇ alkenyl, C₂-C₇ alkynyl, C₁-C₇ alkoxy, C₁-C₇ alkylamino, C₁-C₇ alkylthio, C₁-C₆ alkyl, C₁-C₆ alkylene, C₂-C₆ alkenyl, C₂-C₆ alkynyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, C₁-C₆ alkylthio, C₁-C₅ alkyl, C₁-C₅ alkylene, C₂-C₅ alkenyl, C₂-C₅ alkynyl, C₁-C₅ alkoxy, C₁-C₅ alkylamino, C₁-C₅ alkylthio, C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino,

C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, and C₁ alkylthio.

10 II. Compounds

Described herein, are compounds, such as chemical compounds, for use to modify a product, such as the surface of a product, a surface of a product, the surface of the product, a surface of the product, the face of a surface of a product, a face of a surface of a product, the face of the surface of a product, a face of the surface of a product, the face of a surface of the product, a face of a surface of the product, the face of the surface of the product, and a face of the surface of the product. Generally, the surface(s) and face(s) of the product to be modified can be those that, when the device is administered to (e.g., implanted in) a subject, would be in contact with fluid, cells, or other components of the subjects body. The compounds are represented by the general formula:



Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

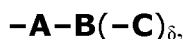
25 R₁ is hydrogen, or an organic grouping containing any number of carbon atoms, preferably 1-30 carbon atoms, more preferably 1-20 carbon atoms, more preferably 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R₁ organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂,
30 U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃); and

R₂ is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear,

branched, or cyclic structural formats, representative R₂ organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃).

X is preferably oxygen, sulfur, or NR₂.

- 5 In some embodiments, R₁ is, independently in one or more sites of chemical modification,



Formula XII

wherein

- 10 **A** is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃);

- 15 **B**, and **C** are, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃); and

δ is an integer from, as valency permits, 0 to 30.

X is preferably oxygen, sulfur, or NR₂.

- 25 In some embodiments, R₁ is, independently in one or more sites of chemical modification,



Formula II

wherein

- 30 **R**₃ is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R₃ organic groupings being those

present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

R^b is absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally
5 including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R^b organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments of R_1 , R_2 , R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C**, and independently
10 in combination with any embodiments of any other relevant substituent classes, R_1 , R_2 , R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C** can be, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats,
15 representative R_1 , R_2 , R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C** organic groupings being those present in $U_1 + Q_1 + Q_2 + Q_3$, $U_1 + Q_5$, $U_1 + Q_1 + Q_5$, $U_1 + Q_2 + Q_5$, $U_1 + Q_3 + Q_5$, $U_1 + Q_1 + Q_2 + Q_5$, $U_1 + Q_1 + Q_3 + Q_5$, $U_1 + Q_2 + Q_3 + Q_5$, or $U_1 + Q_1 + Q_2 + Q_3 + Q_5$.

In some embodiments of R_1 , R_2 , R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C**, and independently
in combination with any embodiments of any other relevant substituent classes, R_1 , R_2 ,
20 R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C** can be, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats,
representative R_1 , R_2 , R_3 , R_4 , R_5 , R^b , **A**, **B**, and **C** organic groupings being those present
25 in U_4 , $U_4 + Q_1$, $U_4 + Q_2$, $U_4 + Q_3$, $U_4 + Q_4$, $U_4 + Q_5$, $U_4 + Q_6$, $U_4 + Q_7$, $U_4 + Q_8$, $U_4 + Q_1 + Q_2$, $U_4 + Q_1 + Q_3$, $U_4 + Q_1 + Q_4$, $U_4 + Q_1 + Q_5$, $U_4 + Q_1 + Q_6$, $U_4 + Q_1 + Q_7$, $U_4 + Q_1 + Q_8$, $U_4 + Q_2 + Q_3$, $U_4 + Q_2 + Q_4$, $U_4 + Q_2 + Q_5$, $U_4 + Q_2 + Q_6$, $U_4 + Q_2 + Q_7$, $U_4 + Q_2 + Q_8$, $U_4 + Q_3 + Q_4$, $U_4 + Q_3 + Q_5$, $U_4 + Q_3 + Q_6$, $U_4 + Q_3 + Q_7$, $U_4 + Q_3 + Q_8$, $U_4 + Q_4 + Q_5$, $U_4 + Q_4 + Q_6$, $U_4 + Q_4 + Q_7$, $U_4 + Q_4 + Q_8$, $U_4 + Q_5 + Q_6$, $U_4 + Q_5 + Q_7$, $U_4 + Q_5 + Q_8$, $U_4 + Q_6 + Q_7$, $U_4 + Q_6 + Q_8$, $U_4 + Q_7 + Q_8$, $U_4 + Q_1 + Q_2 + Q_3$, $U_4 + Q_1 + Q_2 + Q_4$,
30 $U_4 + Q_1 + Q_2 + Q_5$, $U_4 + Q_1 + Q_2 + Q_6$, $U_4 + Q_1 + Q_2 + Q_7$, $U_4 + Q_1 + Q_2 + Q_8$, $U_4 + Q_1 + Q_3 + Q_4$, $U_4 + Q_1 + Q_3 + Q_5$, $U_4 + Q_1 + Q_3 + Q_6$, $U_4 + Q_1 + Q_3 + Q_7$, $U_4 + Q_1 + Q_3 + Q_8$, $U_4 + Q_1 + Q_4 + Q_5$, $U_4 + Q_1 + Q_4 + Q_6$, $U_4 + Q_1 + Q_4 + Q_7$, $U_4 + Q_1 + Q_4 + Q_8$, $U_4 + Q_1 +$

$Q_5 + Q_6, U_4 + Q_1 + Q_5 + Q_7, U_4 + Q_1 + Q_5 + Q_8, U_4 + Q_1 + Q_6 + Q_7, U_4 + Q_1 + Q_6 + Q_8,$
 $U_4 + Q_1 + Q_7 + Q_8, U_4 + Q_2 + Q_3 + Q_4, U_4 + Q_2 + Q_3 + Q_5, U_4 + Q_2 + Q_3 + Q_6, U_4 + Q_2 +$
 $Q_3 + Q_7, U_4 + Q_2 + Q_3 + Q_8, U_4 + Q_2 + Q_4 + Q_5, U_4 + Q_2 + Q_4 + Q_6, U_4 + Q_2 + Q_4 + Q_7,$
 $U_4 + Q_2 + Q_4 + Q_8, U_4 + Q_2 + Q_5 + Q_6, U_4 + Q_2 + Q_5 + Q_7, U_4 + Q_2 + Q_5 + Q_8, U_4 + Q_2 +$
5 $Q_6 + Q_7, U_4 + Q_2 + Q_6 + Q_8, U_4 + Q_2 + Q_7 + Q_8, U_4 + Q_3 + Q_4 + Q_5, U_4 + Q_3 + Q_4 + Q_6,$
 $U_4 + Q_3 + Q_4 + Q_7, U_4 + Q_3 + Q_4 + Q_8, U_4 + Q_3 + Q_5 + Q_6, U_4 + Q_3 + Q_5 + Q_7, U_4 + Q_3 +$
 $Q_5 + Q_8, U_4 + Q_3 + Q_6 + Q_7, U_4 + Q_3 + Q_6 + Q_8, U_4 + Q_3 + Q_7 + Q_8, U_4 + Q_4 + Q_5 + Q_6,$
 $U_4 + Q_4 + Q_5 + Q_7, U_4 + Q_4 + Q_5 + Q_8, U_4 + Q_4 + Q_6 + Q_7, U_4 + Q_4 + Q_6 + Q_8, U_4 + Q_4 +$
 $Q_7 + Q_8, U_4 + Q_5 + Q_6 + Q_7, U_4 + Q_5 + Q_6 + Q_8, U_4 + Q_5 + Q_7 + Q_8, U_4 + Q_6 + Q_7 + Q_8,$
10 $U_4 + Q_1 + Q_2 + Q_3 + Q_4, U_4 + Q_1 + Q_2 + Q_3 + Q_5, U_4 + Q_1 + Q_2 + Q_3 + Q_6, U_4 + Q_1 + Q_2$
 $+ Q_3 + Q_7, U_4 + Q_1 + Q_2 + Q_3 + Q_8, U_4 + Q_1 + Q_3 + Q_4 + Q_5, U_4 + Q_1 + Q_3 + Q_4 + Q_6, U_4$
 $+ Q_1 + Q_3 + Q_4 + Q_7, U_4 + Q_1 + Q_3 + Q_4 + Q_8, U_4 + Q_1 + Q_4 + Q_5 + Q_6, U_4 + Q_1 + Q_4 +$
 $Q_5 + Q_7, U_4 + Q_1 + Q_4 + Q_5 + Q_8, U_4 + Q_1 + Q_5 + Q_6 + Q_7, U_4 + Q_1 + Q_5 + Q_6 + Q_8, U_4 +$
 $Q_1 + Q_6 + Q_7 + Q_8, U_4 + Q_2 + Q_3 + Q_4 + Q_5, U_4 + Q_2 + Q_3 + Q_4 + Q_6, U_4 + Q_2 + Q_3 + Q_4$
15 $+ Q_7, U_4 + Q_2 + Q_3 + Q_4 + Q_8, U_4 + Q_2 + Q_4 + Q_5 + Q_6, U_4 + Q_2 + Q_4 + Q_5 + Q_7, U_4 + Q_2$
 $+ Q_4 + Q_5 + Q_8, U_4 + Q_2 + Q_5 + Q_6 + Q_7, U_4 + Q_2 + Q_5 + Q_6 + Q_8, U_4 + Q_2 + Q_6 + Q_7 +$
 $Q_8, U_4 + Q_3 + Q_4 + Q_5 + Q_6, U_4 + Q_3 + Q_4 + Q_5 + Q_7, U_4 + Q_3 + Q_4 + Q_5 + Q_8, U_4 + Q_3 +$
 $Q_5 + Q_6 + Q_7, U_4 + Q_3 + Q_5 + Q_6 + Q_8, U_4 + Q_3 + Q_6 + Q_7 + Q_8, U_4 + Q_4 + Q_5 + Q_6 + Q_7,$
 $U_4 + Q_4 + Q_5 + Q_6 + Q_8, U_4 + Q_4 + Q_6 + Q_7 + Q_8, U_4 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_1 + Q_2$
20 $+ Q_3 + Q_4 + Q_5, U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_6, U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_7, U_4 + Q_1 +$
 $Q_2 + Q_3 + Q_4 + Q_8, U_4 + Q_1 + Q_3 + Q_4 + Q_5 + Q_6, U_4 + Q_1 + Q_3 + Q_4 + Q_5 + Q_7, U_4 + Q_1$
 $+ Q_3 + Q_4 + Q_5 + Q_8, U_4 + Q_1 + Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_1 + Q_4 + Q_5 + Q_6 + Q_8, U_4 +$
 $Q_1 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6, U_4 + Q_2 + Q_3 + Q_4 + Q_5 + Q_7, U_4$
 $+ Q_2 + Q_3 + Q_4 + Q_5 + Q_8, U_4 + Q_2 + Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_2 + Q_4 + Q_5 + Q_6 + Q_8,$
25 $U_4 + Q_2 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_3 + Q_4 + Q_5 + Q_6 +$
 $Q_8, U_4 + Q_3 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_1 + Q_2 + Q_3 + Q_4$
 $+ Q_5 + Q_6, U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_7, U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_8, U_4 +$
 $Q_1 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_1 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8, U_4 + Q_1 + Q_4 + Q_5 +$
 $Q_6 + Q_7 + Q_8, U_4 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8, U_4$
30 $+ Q_2 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8, U_4 + Q_1 + Q_2 + Q_3 +$
 $Q_4 + Q_5 + Q_6 + Q_7, U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_8, U_4 + Q_1 + Q_3 + Q_4 + Q_5 +$
 $Q_6 + Q_7 + Q_8, U_4 + Q_2 + Q_3 + Q_4 + Q_5 + Q_6 + Q_7 + Q_8, \text{ or } U_4 + Q_1 + Q_2 + Q_3 + Q_4 + Q_5 +$
 $Q_6 + Q_7 + Q_8.$

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, **C**, and R^b , and independently in combination with any embodiments of any other relevant substituent classes, **B**, **C**, and R^b can be, independently, absent, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

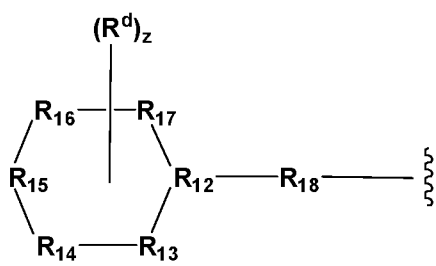
Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_1 .

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_2 .

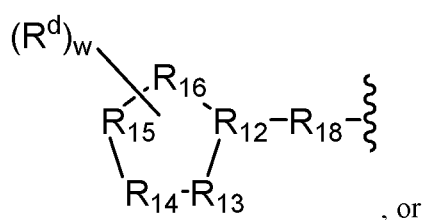
Independently in some embodiments of **B**, **C**, and R^b , and independently in combination with any embodiments of any other relevant substituent classes, **B**, **C**, and R^b can be, independently, absent, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_1 .

Independently in some embodiments of **B**, **C**, and R^b , and independently in combination with any embodiments of any other relevant substituent classes, **B**, **C**, and R^b can be, independently, absent, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_2 .

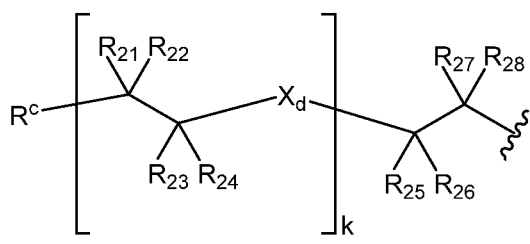
Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VI



Formula IX



Formula VIII

wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

wherein R^d are independently **B**, **C**, **-B(-C)_δ**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

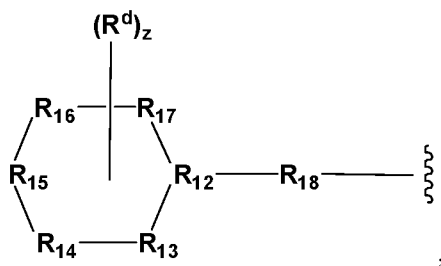
wherein R^c is **B**, **C**, **-B(-C)_δ**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

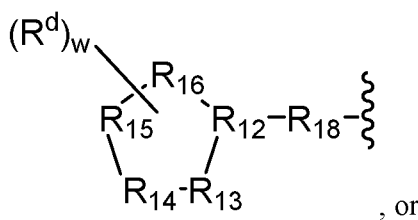
- 5 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

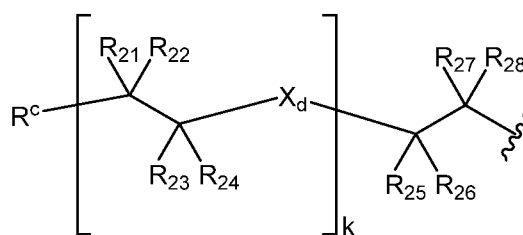
- Independently in some embodiments of **B**, and independently in combination
15 with any embodiments of any other relevant substituent classes, **B** can be



Formula VI



Formula IX



Formula VIII

wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

- 5 wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or
- 10 heterocyclic ring;

wherein X_d are independently absent, O, or S;

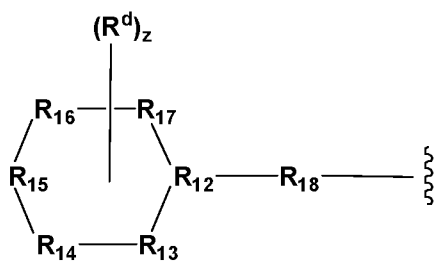
- wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
- 15 embodiments, $U_3 + Q_1 + Q_3$);

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

- 20 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, R^b , absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
- 25 these embodiments, $U_1 + Q_1 + Q_3$); and

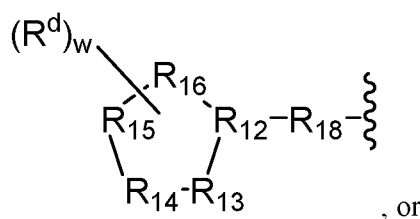
wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be

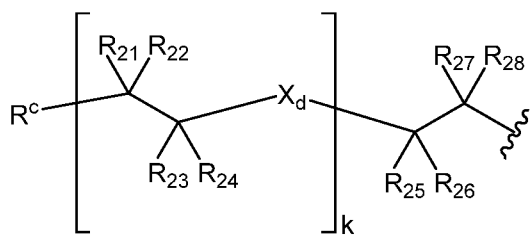


Formula VI

5



Formula IX



Formula VIII

10

wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

15

wherein X_d are independently absent, O, or S;

wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);

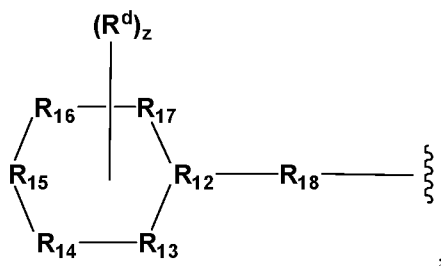
20

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

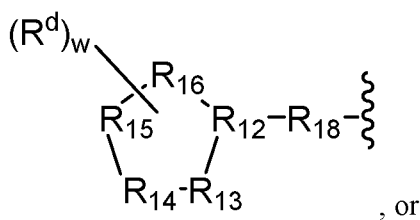
- 5 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

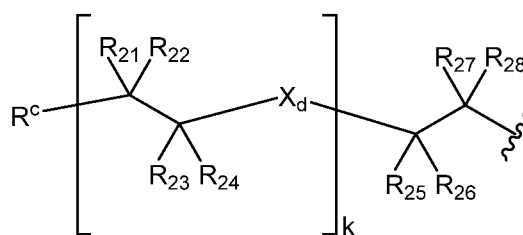
- Independently in some embodiments of **C**, and independently in combination
15 with any embodiments of any other relevant substituent classes **C** can be



Formula VI



Formula IX



Formula VIII

wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

5 wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

10 wherein X_d are independently absent, O, or S;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);

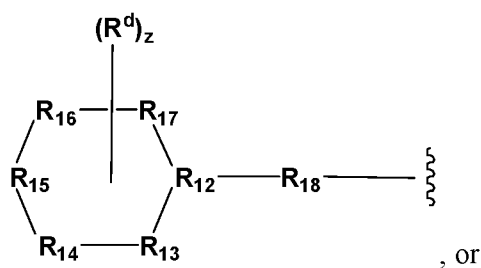
15 wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

20 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

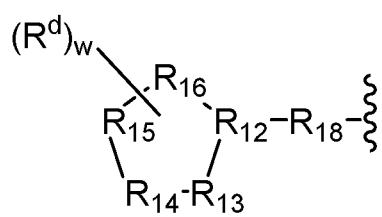
25 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,

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Formula VI



Formula IX

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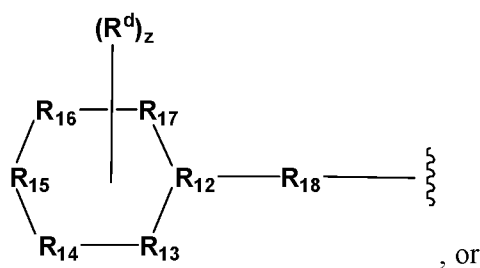
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

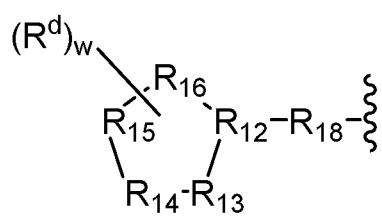
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula VI



Formula IX

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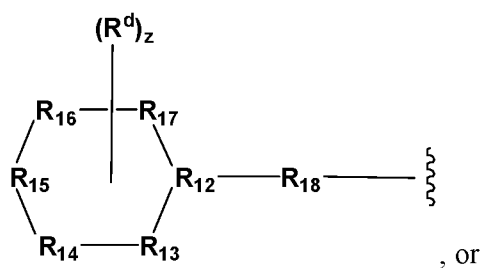
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1$
 10 $+ Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
 embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are
 attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or
 heterocyclic ring;

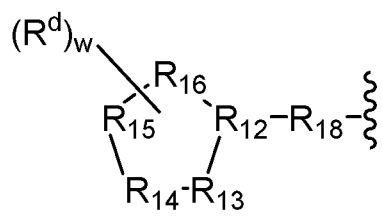
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently **C**, **O**, **N**, **S**, **S(O)**, or
 15 **S(O)₂**, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to
 valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to
 valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$
 , wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-$
 20 $S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **C**, R^b ,
 absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, U_1
 $+ Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
 these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R^b , and independently in combination
 25 with any embodiments of any other relevant substituent classes, R^b can be



Formula VI



Formula IX

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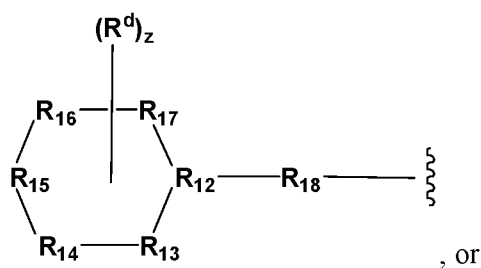
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

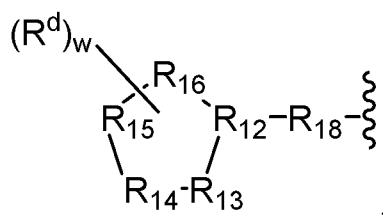
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula VI



Formula IX

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wherein z is an integer from 0-11; wherein w is an integer from 0-9;

wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

10

membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

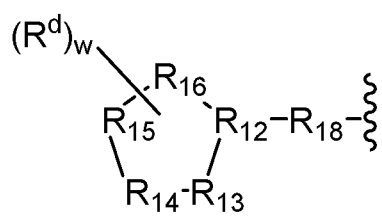
15

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

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Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,

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Formula IX

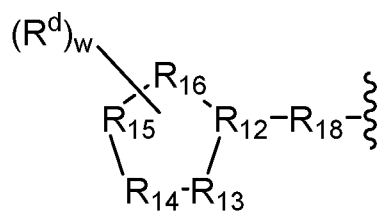
wherein w is an integer from 0-9;

- 5 wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or
- 10 heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

- 15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
- 20 these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula IX

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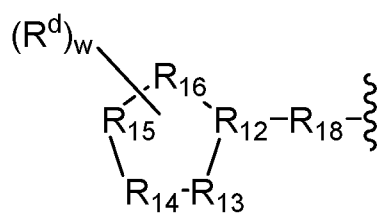
wherein w is an integer from 0-9;

wherein R^d are independently **C**, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are
 5 attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;
 10 and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, R^b , absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).
 15

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula IX

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wherein w is an integer from 0-9;

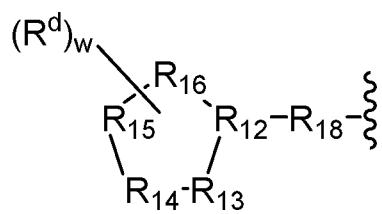
wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to
 25 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency,

and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;
and

- wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

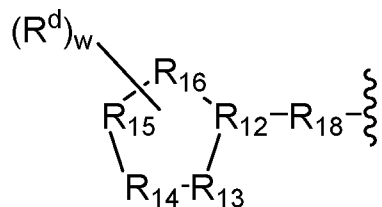
- Independently in some embodiments of **C**, and independently in combination
with any embodiments of any other relevant substituent classes, **C** can be



Formula IX

- wherein w is an integer from 0-9;
- wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;
- wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently **C**, **O**, **N**, **S**, **S(O)**, or **S(O)₂**, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;
and
- wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula IX

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wherein w is an integer from 0-9;

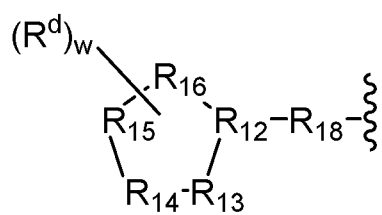
wherein R^d are independently **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently **B**, **C**, absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be

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Formula IX

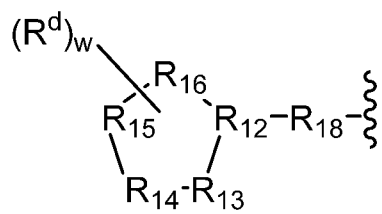
wherein w is an integer from 0-9;

- 5 wherein R^d are independently C , R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or
- 10 heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

- 15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently C , R^b , absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in
- 20 these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula IX

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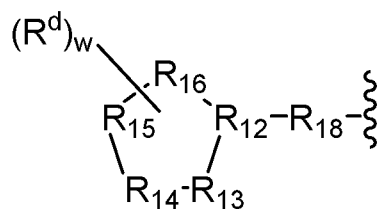
wherein w is an integer from 0-9;

wherein R^d are independently **C**, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently **C**, absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula IX

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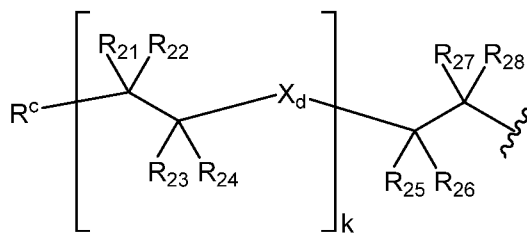
wherein w is an integer from 0-9;

wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits, independently absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VIII

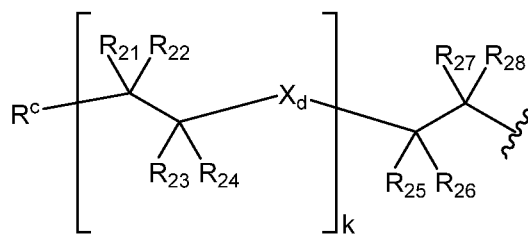
wherein k is an integer from 0 to 20;

wherein X_d are independently absent, O , or S ;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be



Formula VIII

wherein k is an integer from 0 to 20;

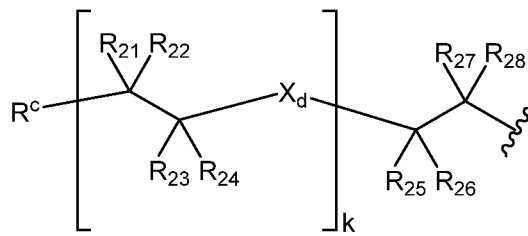
5 wherein X_d are independently absent, O, or S;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

10 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be

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Formula VIII

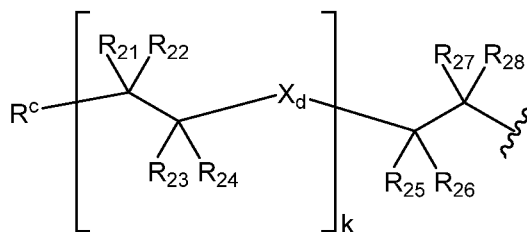
wherein k is an integer from 0 to 20;

wherein X_d are independently absent, O, or S;

20 wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination
 5 with any embodiments of any other relevant substituent classes, **C** can be



Formula VIII

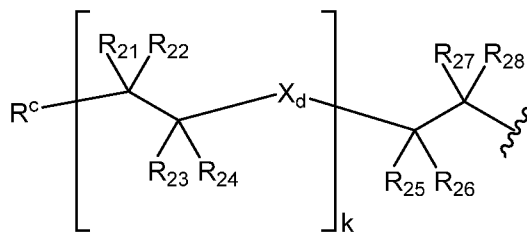
wherein k is an integer from 0 to 20;

10 wherein X_d are independently absent, O, or S;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

15 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in
 combination with any embodiments of any other relevant substituent classes, **A** and R_3
 20 can be, independently,



Formula VIII

wherein k is an integer from 0 to 20;

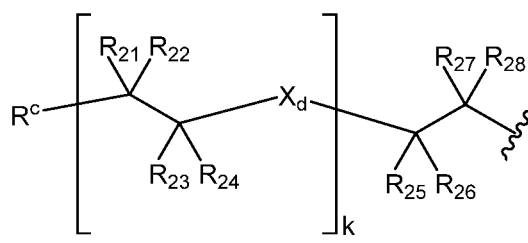
25 wherein X_d are independently O or S;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_\delta$, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination with any embodiments of any other relevant substituent classes, **B** can be

10



Formula VIII

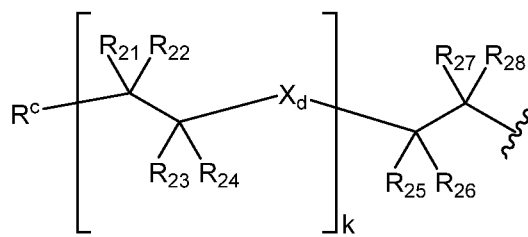
wherein k is an integer from 0 to 20;

wherein X_d are independently O or S;

- 15 wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be



Formula VIII

wherein k is an integer from 0 to 20;

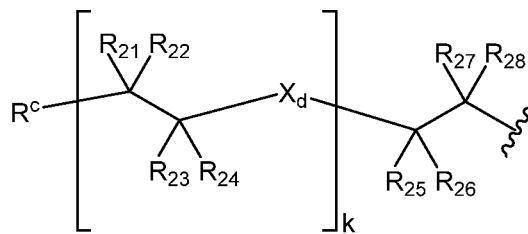
5 wherein X_d are independently O or S;

wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

10 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be

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Formula VIII

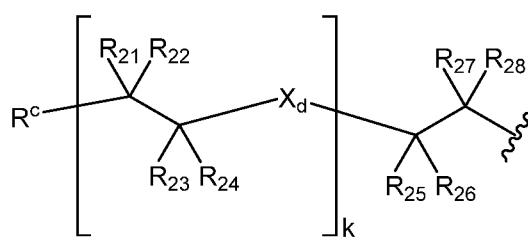
wherein k is an integer from 0 to 20;

wherein X_d are independently O or S;

20 wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **A** and R_3 , and independently in
 5 combination with any embodiments of any other relevant substituent classes, **A** and R_3 can be, independently,



Formula VIII

10 wherein k is an integer from 1 to 20;

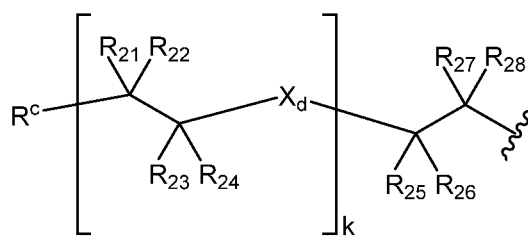
wherein X_d are O;

wherein R^c is **B**, **C**, $-\mathbf{B}(-\mathbf{C})_6$, R^b , U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these

15 embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **B**, **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **B**, and independently in combination
 20 with any embodiments of any other relevant substituent classes, **B** can be



Formula VIII

wherein k is an integer from 1 to 20;

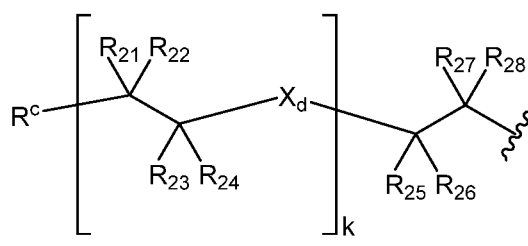
25 wherein X_d are O;

wherein R^c is **C**, R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R^b , and independently in combination with any embodiments of any other relevant substituent classes, R^b can be

10



Formula VIII

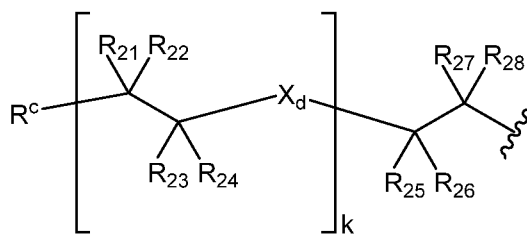
wherein k is an integer from 1 to 20;

wherein X_d are O;

- 15 wherein R^c is **C**, absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently **C**, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of **C**, and independently in combination with any embodiments of any other relevant substituent classes, **C** can be



Formula VIII

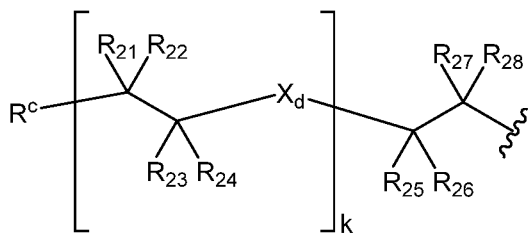
wherein k is an integer from 1 to 20;

5 wherein X_d are O;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

10 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, **A** is



Formula VIII

wherein each k is, independently, an integer from 0 to 20;

wherein R^c is **B**;

wherein each X_d is, independently, absent, O, or S; and

20 wherein each R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} is, independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J_1 ;

wherein preferably k is 1, 2, 3, 4, 5, 6, or 7; each X_d is O; and each R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} is, independently, hydrogen, C_1 - C_3 alkyl, C_1 - C_3 alkylene, C_2 - C_3 alkenyl, C_2 - C_3 alkynyl, C_1 - C_3 alkoxy, C_1 - C_3 alkylamino, C_1 - C_3 alkylthio;

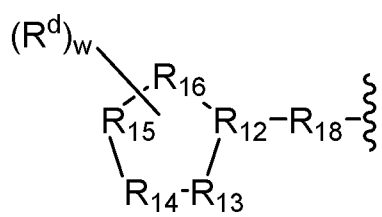
wherein more preferably k is 2, 3, or 4; each X_d is O; and each R_{21} , R_{22} , R_{23} , R_{24} ,

25 R_{25} , R_{26} , R_{27} , and R_{28} is hydrogen; and

wherein most preferably **A** is $-\text{CH}_2\text{-CH}_2\text{-(O-CH}_2\text{-CH}_2\text{)}_3\text{-}$; and

B and **C** are, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, **B** is



Formula IX

10

wherein each w is, independently, an integer from 0-9;

wherein R^d is **C**;

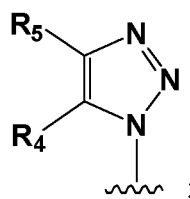
wherein each R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is, independently, C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;

preferably w is 1, 2, 3, or 4; and none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is O, and the others are C;

more preferably w is 1 or 2; and one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, none or one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is O, and the others are C;

even more preferably w is 1 or 2; and three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, none of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is O, and the others are C; and

most preferably



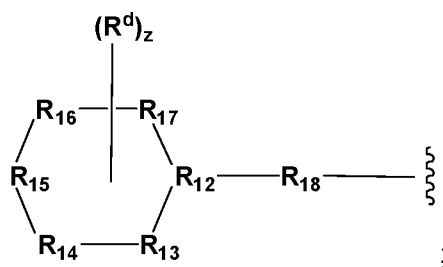
25

wherein R_4 is hydrogen and R_5 is **C**;

A is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

each **C** is, independently, absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, **C** is



Formula VI

wherein z is an integer from 0-11;

wherein each R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is, independently, C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency;

wherein each R_{18} is, independently, absent, $-(CR_{19}R_{19})_p-$, or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein each p and q is, independently, an integer from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein each R_{20} is, independently, J₂;

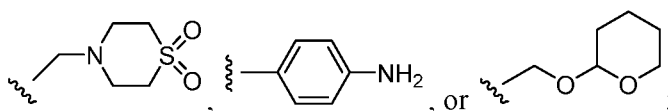
wherein each R^d is, independently, J₁;

preferably z is 0, 1, 2, 3, 4, or 5; none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, none or one is S(O)₂, and the others are C; each R₁₈ is, independently, absent, -(CR₁₉R₁₉)_p-, or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein each p is, independently, 0, 1, 2, or 3, each q is, independently, 0, 1, or 2, and X_b is O; and R^d is, independently, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amino, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₂-C₃ phosphoryl, or C₂-C₃ phosphonyl;

more preferably z is 0, 1, 2, or 3; none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, none or one is S(O)₂, and the others are C; each R₁₈ is, independently, absent, -(CR₁₉R₁₉)_p-, or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein each p is, independently, 0 or 1, each q is, independently, 0 or 1, and X_b is O; and R^d is, independently, C₁ carbonyl, C₁ carboxyl, C₁ amino, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₂ phosphoryl, or C₂ phosphonyl; and

even more preferably z is 0 or 1; none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, none or one is S(O)₂, and the others are C; each R₁₈ is, independently, absent, -(CR₁₉R₁₉)_p-, or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein each p is, independently, 0 or 1, each q is, independently, 0 or 1, and X_b is O; and R^d is, independently, C₁ carbonyl, C₁ carboxyl, C₁ amino, or C₁ sulfonyl; and

most preferably **C** is



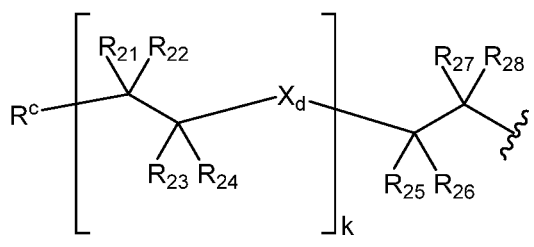
A is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃); and

B is absent, hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those

present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

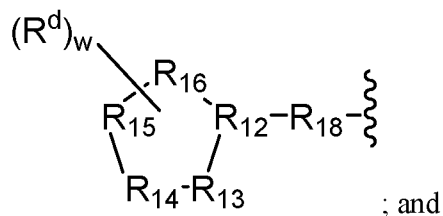
In some embodiments

A is



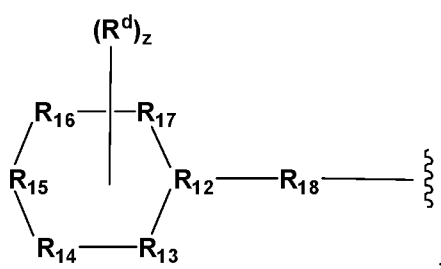
Formula VIII

B is

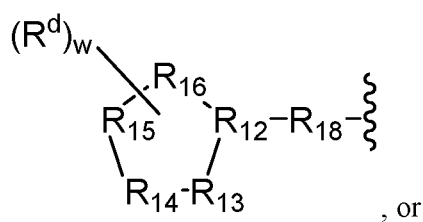


Formula IX

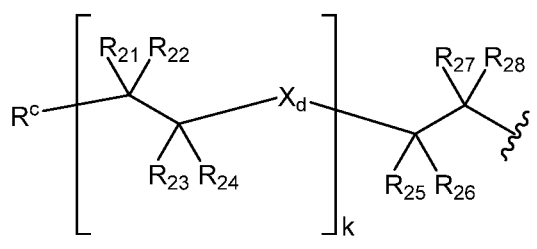
each R_4 , R_5 , and **C** are, independently,



Formula VI



Formula IX



Formula VIII

wherein each z is, independently, an integer from 0-11; wherein each w is,
independently, an integer from 0-9; wherein each k is, independently, an integer from 0
5 to 20;

wherein in **A**, R^c is **B**,

wherein in **B**, R^c and R^d are **C**,

wherein each X_d is, independently, absent, O, or S;

wherein each R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is, independently, C, O, N, S, S(O),
10 or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according
to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according
to valency; and

wherein each R₁₈ is, independently, absent, -(CR₁₉R₁₉)_p-, or
-(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein each p and q is, independently, an integer from 0 to
15 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R₁₉ is, as
valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein
each R₂₀ is, independently, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃,
U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃);
and

20 wherein each R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ is, independently,
hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or
U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

In some embodiments, each R₂₀ is, independently, J₂.

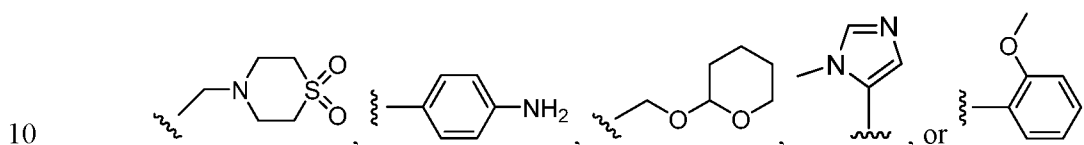
In some embodiments, each R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ is,
25 independently, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₁.

In some embodiments, independently in each Formula VI, none, one, two, three,
four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five,
or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. In some embodiments,
independently in each Formula IX, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄,

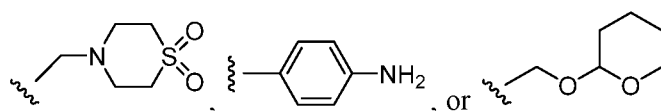
R₁₅, and R₁₆ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, and the others are C.

In some embodiments, independently in each **C**, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. In some embodiments, in **B**, three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, and the others are C.

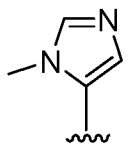
In some embodiments, R₃ and **A** are -CH₂-Ar- or -CH₂-CH₂-(O-CH₂-CH₂)₃-; R₂ is hydrogen; R₄ and **C** are hydrogen, methyl, or -CH₂-OH; and R₅ and **C** are methyl, -COCH₃, -CH₂-N(CH₂-CH₃)₂,



In some embodiments, R₄ is hydrogen; and R₅ and **C** are

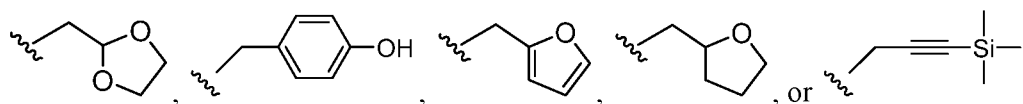


15 In some embodiments, R₄ is hydrogen; and R₅ and **C** are



In some embodiments, R₅ and **C** are methyl, -COCH₃, or -CH₂-N(CH₂-CH₃)₂.

In some embodiments, X is oxygen or NR₂, wherein R₂ is hydrogen, methyl, or -CH₂-CH₃; and R₁ is -CH₂-CH₂-CH₂-CH₂-OH, -CH₂-CH₂-(O-CH₂-CH₂)_n-O-CH₃, -CH₂-CH₂-O-CH₂-CH₂-OH, -(CH₂-CH₂)₃-NH-CH₃,



where n is an integer from 3 to 16.

Independently in some embodiments of R^c, and independently in combination with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, -**B**(-**C**)_δ, R^b, amino, hydroxyl, thiol, oxo, phosphate, or J₁.

Independently in some embodiments of R^c, and independently in combination with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, **–B(–C)**_δ, R^b, amino, hydroxyl, thiol, oxo, phosphate, or J₂.

- Independently in some embodiments of R^c, and independently in combination
- 5 with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, **–B(–C)**_δ, R^b, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁–C₅ alkyl, C₁–C₅ alkylene, C₂–C₅ alkenyl, C₂–C₅ alkynyl, C₁–C₅ alkoxy, C₁–C₅ alkylamino, C₁–C₅ alkylthio, C₁–C₅ carbonyl, C₁–C₅ carboxyl, C₁–C₅ amido, C₁–C₅ sulfonyl, C₁–C₅ sulfonic acid, C₁–C₅ sulfamoyl, C₁–C₅ sulfoxide, C₁–C₅ phosphoryl, C₁–C₅ phosphonyl,
- 10 C₁–C₄ alkyl, C₁–C₄ alkylene, C₂–C₄ alkenyl, C₂–C₄ alkynyl, C₁–C₄ alkoxy, C₁–C₄ alkylamino, C₁–C₄ alkylthio, C₁–C₄ carbonyl, C₁–C₄ carboxyl, C₁–C₄ amino, C₁–C₄ amido, C₁–C₄ sulfonyl, C₁–C₄ sulfonic acid, C₁–C₄ sulfamoyl, C₁–C₄ sulfoxide, C₁–C₄ phosphoryl, C₁–C₄ phosphonyl, C₁–C₃ alkyl, C₁–C₃ alkylene, C₂–C₃ alkenyl, C₂–C₃ alkynyl, C₁–C₃ alkoxy, C₁–C₃ alkylamino, C₁–C₃ alkylthio, C₁–C₃ carbonyl, C₁–C₃ carboxyl, C₁–C₃
- 15 amino, C₁–C₃ amido, C₁–C₃ sulfonyl, C₁–C₃ sulfonic acid, C₁–C₃ sulfamoyl, C₁–C₃ sulfoxide, C₁–C₃ phosphoryl, C₁–C₃ phosphonyl, C₁–C₂ alkyl, C₁–C₂ alkylene, C₁–C₂ alkoxy, C₁–C₂ alkylamino, C₁–C₂ alkylthio, C₁–C₂ carbonyl, C₁–C₂ carboxyl, C₁–C₂ amido, C₁–C₂ sulfonyl, C₁–C₂ sulfonic acid, C₁–C₂ sulfamoyl, C₁–C₂ sulfoxide, C₁–C₂ phosphoryl, C₁–C₂ phosphonyl, C₀–C₅ sulfonyl, C₀–C₅ sulfonic acid, C₀–C₅ sulfamoyl, C₀–C₅ sulfoxide, C₀–C₅ phosphoryl, C₀–C₅ phosphonyl, C₀–C₄ sulfonyl, C₀–C₄ sulfonic acid, C₀–C₄ sulfamoyl, C₀–C₄ sulfoxide, C₀–C₄ phosphoryl, C₀–C₄ phosphonyl, C₀–C₃ sulfonyl, C₀–C₃ sulfonic acid, C₀–C₃ sulfamoyl, C₀–C₃ sulfoxide, C₀–C₃ phosphoryl, C₀–C₃ phosphonyl, C₀–C₂ sulfonyl, C₀–C₂ sulfonic acid, C₀–C₂ sulfamoyl, C₀–C₂ sulfoxide, C₀–C₂ phosphoryl, C₀–C₂ phosphonyl, C₀–C₁ sulfonyl, C₀–C₁ sulfonic acid, C₀–C₁ sulfamoyl,
- 20 C₀–C₁ sulfoxide, C₀–C₁ phosphoryl, C₀–C₁ phosphonyl, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₅ carbonyl, C₅ carboxyl, C₅ amido, C₅ sulfonyl, C₅ sulfonic acid, C₅ sulfamoyl, C₅ sulfoxide, C₅ phosphoryl, C₅ phosphonyl, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₄ carbonyl, C₄ carboxyl, C₄ amido, C₄ sulfonyl, C₄ sulfonic acid, C₄ sulfamoyl, C₄
- 25 sulfoxide, C₄ phosphoryl, C₄ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂

carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, or C₀ phosphonyl

Independently in some embodiments of R^c, and independently in combination with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, **-B(-C)_δ**, R^b, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₅ alkyl, C₁-C₅ alkylene, C₂-C₅ alkenyl, C₂-C₅ alkynyl, C₁-C₅ alkoxy, C₁-C₅ alkylamino, C₁-C₅ alkylthio, C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino, C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, or C₁ alkylthio.

Independently in some embodiments of R^c, and independently in combination with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, **-B(-C)_δ**, R^b, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₄ carbonyl, C₁-C₄ carboxyl, C₁-C₄ amino, C₁-C₄ amido, C₁-C₄ sulfonyl, C₁-C₄ sulfonic acid, C₁-C₄ sulfamoyl, C₁-C₄ sulfoxide, C₁-C₄ phosphoryl, C₁-C₄ phosphonyl, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₃ carbonyl, C₁-C₃ carboxyl, C₁-C₃ amino, C₁-C₃ amido, C₁-C₃ sulfonyl, C₁-C₃ sulfonic acid, C₁-C₃ sulfamoyl, C₁-C₃ sulfoxide, C₁-C₃ phosphoryl, C₁-C₃ phosphonyl, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂

alkylamino, C₁-C₂ alkylthio, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₁-C₂ sulfamoyl, C₁-C₂ sulfoxide, C₁-C₂ phosphoryl, C₁-C₂ phosphonyl, C₀-C₄ sulfonyl, C₀-C₄ sulfonic acid, C₀-C₄ sulfamoyl, C₀-C₄ sulfoxide, C₀-C₄ phosphoryl, C₀-C₄ phosphonyl, C₀-C₃ sulfonyl, C₀-C₃ sulfonic acid, C₀-C₃ sulfamoyl, C₀-C₃ sulfoxide, C₀-C₃ phosphoryl, C₀-C₃ phosphonyl, C₀-C₂ sulfonyl, C₀-C₂ sulfonic acid, C₀-C₂ sulfamoyl, C₀-C₂ sulfoxide, C₀-C₂ phosphoryl, C₀-C₂ phosphonyl, C₀-C₁ sulfonyl, C₀-C₁ sulfonic acid, C₀-C₁ sulfamoyl, C₀-C₁ sulfoxide, C₀-C₁ phosphoryl, C₀-C₁ phosphonyl, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₄ carbonyl, C₄ carboxyl, C₄ amido, C₄ sulfonyl, C₄ sulfonic acid, C₄ sulfamoyl, C₄ sulfoxide, C₄ phosphoryl, C₄ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂ carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, or C₀ phosphonyl

Independently in some embodiments of R^c, and independently in combination with any embodiments of any other relevant substituent classes, R^c can be **B**, **C**, **-B(-C)₆**, R^b, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino, C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂

alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, or C₁ alkylthio.

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₁.

10 Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₂.

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈,
15 and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₅ alkyl, C₁-C₅ alkylene, C₂-C₅ alkenyl, C₂-C₅ alkynyl, C₁-C₅ alkoxy, C₁-C₅ alkylamino, C₁-C₅ alkylthio, C₁-C₅ carbonyl, C₁-C₅ carboxyl, C₁-C₅ amido, C₁-C₅ sulfonyl, C₁-C₅ sulfonic acid, C₁-C₅ sulfamoyl, C₁-C₅ sulfoxide, C₁-C₅ phosphoryl, C₁-C₅ phosphonyl, C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₄ carbonyl, C₁-C₄ carboxyl, C₁-C₄ amino, C₁-C₄ amido, C₁-C₄ sulfonyl, C₁-C₄ sulfonic acid, C₁-C₄ sulfamoyl, C₁-C₄ sulfoxide, C₁-C₄ phosphoryl, C₁-C₄ phosphonyl, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₃ carbonyl, C₁-C₃ carboxyl, C₁-C₃ amino, C₁-C₃ amido, C₁-C₃ sulfonyl, C₁-C₃ sulfonic acid, C₁-C₃ sulfamoyl, C₁-C₃ sulfoxide, C₁-C₃ phosphoryl, C₁-C₃ phosphonyl, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₁-C₂ sulfamoyl, C₁-C₂ sulfoxide, C₁-C₂ phosphoryl, C₁-C₂ phosphonyl, C₀-C₅ sulfonyl, C₀-C₅ sulfonic acid, C₀-C₅ sulfamoyl, C₀-C₅ sulfoxide, C₀-C₅ phosphoryl, C₀-C₅ phosphonyl, C₀-C₄ sulfonyl, C₀-C₄ sulfonic acid, C₀-C₄ sulfamoyl, C₀-C₄ sulfoxide, C₀-C₄ phosphoryl, C₀-C₄ phosphonyl, C₀-C₃ sulfonyl, C₀-C₃ sulfonic acid, C₀-C₃ sulfamoyl, C₀-C₃ sulfoxide, C₀-C₃ phosphoryl, C₀-C₃ phosphonyl, C₀-C₂ sulfonyl, C₀-C₂ sulfonic acid, C₀-C₂ sulfamoyl, C₀-C₂ sulfoxide, C₀-

C₂ phosphoryl, C₀-C₂ phosphonyl, C₀-C₁ sulfonyl, C₀-C₁ sulfonic acid, C₀-C₁ sulfamoyl, C₀-C₁ sulfoxide, C₀-C₁ phosphoryl, C₀-C₁ phosphonyl, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₅ carbonyl, C₅ carboxyl, C₅ amido, C₅ sulfonyl, C₅ sulfonic acid, C₅ sulfamoyl, C₅ sulfoxide, C₅ phosphoryl, C₅ phosphonyl, 5 C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₄ carbonyl, C₄ carboxyl, C₄ amido, C₄ sulfonyl, C₄ sulfonic acid, C₄ sulfamoyl, C₄ sulfoxide, C₄ phosphoryl, C₄ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂ carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, or C₀ phosphonyl. 15

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₅ 20 alkyl, C₁-C₅ alkylene, C₂-C₅ alkenyl, C₂-C₅ alkynyl, C₁-C₅ alkoxy, C₁-C₅ alkylamino, C₁-C₅ alkylthio, C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, 25 C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino, C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, or C₁ alkylthio. 30

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-C₄ alkylthio, C₁-C₄ carbonyl, C₁-C₄ carboxyl, C₁-C₄ amino, C₁-C₄ amido, C₁-C₄ sulfonyl, C₁-C₄ sulfonic acid, C₁-C₄ sulfamoyl, C₁-C₄ sulfoxide, C₁-C₄ phosphoryl, C₁-C₄ phosphonyl, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₃ carbonyl, C₁-C₃ carboxyl, C₁-C₃ amino, C₁-C₃ amido, C₁-C₃ sulfonyl, C₁-C₃ sulfonic acid, C₁-C₃ sulfamoyl, C₁-C₃ sulfoxide, C₁-C₃ phosphoryl, C₁-C₃ phosphonyl, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₁-C₂ sulfamoyl, C₁-C₂ sulfoxide, C₁-C₂ phosphoryl, C₁-C₂ phosphonyl, C₀-C₄ sulfonyl, C₀-C₄ sulfonic acid, C₀-C₄ sulfamoyl, C₀-C₄ sulfoxide, C₀-C₄ phosphoryl, C₀-C₄ phosphonyl, C₀-C₃ sulfonyl, C₀-C₃ sulfonic acid, C₀-C₃ sulfamoyl, C₀-C₃ sulfoxide, C₀-C₃ phosphoryl, C₀-C₃ phosphonyl, C₀-C₂ sulfonyl, C₀-C₂ sulfonic acid, C₀-C₂ sulfamoyl, C₀-C₂ sulfoxide, C₀-C₂ phosphoryl, C₀-C₂ phosphonyl, C₀-C₁ sulfonyl, C₀-C₁ sulfonic acid, C₀-C₁ sulfamoyl, C₀-C₁ sulfoxide, C₀-C₁ phosphoryl, C₀-C₁ phosphonyl, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₄ carbonyl, C₄ carboxyl, C₄ amido, C₄ sulfonyl, C₄ sulfonic acid, C₄ sulfamoyl, C₄ sulfoxide, C₄ phosphoryl, C₄ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂ carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, or C₀ phosphonyl.

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₄ alkyl, C₁-C₄ alkylene, C₂-C₄ alkenyl, C₂-C₄ alkynyl, C₁-C₄ alkoxy, C₁-C₄ alkylamino, C₁-

C₄ alkylthio, C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino, C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, or C₁ alkylthio.

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₃ carbonyl, C₁-C₃ carboxyl, C₁-C₃ amino, C₁-C₃ amido, C₁-C₃ sulfonyl, C₁-C₃ sulfonic acid, C₁-C₃ sulfamoyl, C₁-C₃ sulfoxide, C₁-C₃ phosphoryl, C₁-C₃ phosphonyl, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁-C₂ carbonyl, C₁-C₂ carboxyl, C₁-C₂ amido, C₁-C₂ sulfonyl, C₁-C₂ sulfonic acid, C₁-C₂ sulfamoyl, C₁-C₂ sulfoxide, C₁-C₂ phosphoryl, C₁-C₂ phosphonyl, C₀-C₃ sulfonyl, C₀-C₃ sulfonic acid, C₀-C₃ sulfamoyl, C₀-C₃ sulfoxide, C₀-C₃ phosphoryl, C₀-C₃ phosphonyl, C₀-C₂ sulfonyl, C₀-C₂ sulfonic acid, C₀-C₂ sulfamoyl, C₀-C₂ sulfoxide, C₀-C₂ phosphoryl, C₀-C₂ phosphonyl, C₀-C₁ sulfonyl, C₀-C₁ sulfonic acid, C₀-C₁ sulfamoyl, C₀-C₁ sulfoxide, C₀-C₁ phosphoryl, C₀-C₁ phosphonyl, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₃ carbonyl, C₃ carboxyl, C₃ amido, C₃ sulfonyl, C₃ sulfonic acid, C₃ sulfamoyl, C₃ sulfoxide, C₃ phosphoryl, C₃ phosphonyl, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₂ carbonyl, C₂ carboxyl, C₂ amido, C₂ sulfonyl, C₂ sulfonic acid, C₂ sulfamoyl, C₂ sulfoxide, C₂ phosphoryl, C₂ phosphonyl, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, C₁ alkylthio, C₁ carbonyl, C₁ carboxyl, C₁ amido, C₁ sulfonyl, C₁ sulfonic

acid, C₁ sulfamoyl, C₁ sulfoxide, C₁ phosphoryl, C₁ phosphonyl, C₀ sulfonyl, C₀ sulfonic acid, C₀ sulfamoyl, C₀ sulfoxide, C₀ phosphoryl, or C₀ phosphonyl.

Independently in some embodiments of R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈, and independently in combination with any embodiments of any other relevant
5 substituent classes, R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ can be, independently, R^b, hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₃ alkyl, C₁-C₃ alkylene, C₂-C₃ alkenyl, C₂-C₃ alkynyl, C₁-C₃ alkoxy, C₁-C₃ alkylamino, C₁-C₃ alkylthio, C₁-C₂ alkyl, C₁-C₂ alkylene, C₁-C₂ alkoxy, C₁-C₂ alkylamino, C₁-C₂ alkylthio, C₁₀ alkyl, C₁₀ alkylene, C₁₀ alkenyl, C₁₀ alkynyl, C₁₀ alkoxy, C₁₀ alkylamino,
10 C₁₀ alkylthio, C₉ alkyl, C₉ alkylene, C₉ alkenyl, C₉ alkynyl, C₉ alkoxy, C₉ alkylamino, C₉ alkylthio, C₈ alkyl, C₈ alkylene, C₈ alkenyl, C₈ alkynyl, C₈ alkoxy, C₈ alkylamino, C₈ alkylthio, C₇ alkyl, C₇ alkylene, C₇ alkenyl, C₇ alkynyl, C₇ alkoxy, C₇ alkylamino, C₇ alkylthio, C₆ alkyl, C₆ alkylene, C₆ alkenyl, C₆ alkynyl, C₆ alkoxy, C₆ alkylamino, C₆ alkylthio, C₅ alkyl, C₅ alkylene, C₅ alkenyl, C₅ alkynyl, C₅ alkoxy, C₅ alkylamino, C₅ alkylthio, C₄ alkyl, C₄ alkylene, C₄ alkenyl, C₄ alkynyl, C₄ alkoxy, C₄ alkylamino, C₄ alkylthio, C₃ alkyl, C₃ alkylene, C₃ alkenyl, C₃ alkynyl, C₃ alkoxy, C₃ alkylamino, C₃ alkylthio, C₂ alkyl, C₂ alkylene, C₂ alkenyl, C₂ alkynyl, C₂ alkoxy, C₂ alkylamino, C₂ alkylthio, C₁ alkyl, C₁ alkylene, C₁ alkoxy, C₁ alkylamino, or C₁ alkylthio.

Independently in some embodiments of δ , and independently in combination with
20 any embodiments of any other relevant substituent classes, δ can be an integer from 1 to 30, 2 to 30, 3 to 30, 4 to 30, 5 to 30, 6 to 30, 7 to 30, 8 to 30, 9 to 30, 10 to 30, 11 to 30, 12 to 30, 13 to 30, 14 to 30, 15 to 30, 16 to 30, 17 to 30, 18 to 30, 19 to 30, 20 to 30, 21 to 30, 22 to 30, 23 to 30, 24 to 30, 25 to 30, 26 to 30, 27 to 30, 28 to 30, 29 to 30, 1 to 29, 2 to 29, 3 to 29, 4 to 29, 5 to 29, 6 to 29, 7 to 29, 8 to 29, 9 to 29, 10 to 29, 11 to 29, 12 to
25 29, 13 to 29, 14 to 29, 15 to 29, 16 to 29, 17 to 29, 18 to 29, 19 to 29, 20 to 29, 21 to 29, 22 to 29, 23 to 29, 24 to 29, 25 to 29, 26 to 29, 27 to 29, 28 to 29, 1 to 28, 2 to 28, 3 to 28, 4 to 28, 5 to 28, 6 to 28, 7 to 28, 8 to 28, 9 to 28, 10 to 28, 11 to 28, 12 to 28, 13 to 28, 14 to 28, 15 to 28, 16 to 28, 17 to 28, 18 to 28, 19 to 28, 20 to 28, 21 to 28, 22 to 28, 23 to 28, 24 to 28, 25 to 28, 26 to 28, 27 to 28, 1 to 27, 2 to 27, 3 to 27, 4 to 27, 5 to 27, 6
30 to 27, 7 to 27, 8 to 27, 9 to 27, 10 to 27, 11 to 27, 12 to 27, 13 to 27, 14 to 27, 15 to 27, 16 to 27, 17 to 27, 18 to 27, 19 to 27, 20 to 27, 21 to 27, 22 to 27, 23 to 27, 24 to 27, 25 to 27, 26 to 27, 1 to 26, 2 to 26, 3 to 26, 4 to 26, 5 to 26, 6 to 26, 7 to 26, 8 to 26, 9 to 26, 10 to 26, 11 to 26, 12 to 26, 13 to 26, 14 to 26, 15 to 26, 16 to 26, 17 to 26, 18 to 26, 19 to 26, 20 to 26, 21 to 26, 22 to 26, 23 to 26, 24 to 26, 25 to 26, 1 to 25, 2 to 25, 3 to 25, 4

to 25, 5 to 25, 6 to 25, 7 to 25, 8 to 25, 9 to 25, 10 to 25, 11 to 25, 12 to 25, 13 to 25, 14 to 25, 15 to 25, 16 to 25, 17 to 25, 18 to 25, 19 to 25, 20 to 25, 21 to 25, 22 to 25, 23 to 25, 24 to 25, 1 to 24, 2 to 24, 3 to 24, 4 to 24, 5 to 24, 6 to 24, 7 to 24, 8 to 24, 9 to 24, 10 to 24, 11 to 24, 12 to 24, 13 to 24, 14 to 24, 15 to 24, 16 to 24, 17 to 24, 18 to 24, 19 to 24, 20 to 24, 21 to 24, 22 to 24, 23 to 24, 1 to 23, 2 to 23, 3 to 23, 4 to 23, 5 to 23, 6 to 23, 7 to 23, 8 to 23, 9 to 23, 10 to 23, 11 to 23, 12 to 23, 13 to 23, 14 to 23, 15 to 23, 16 to 23, 17 to 23, 18 to 23, 19 to 23, 20 to 23, 21 to 23, 22 to 23, 1 to 22, 2 to 22, 3 to 22, 4 to 22, 5 to 22, 6 to 22, 7 to 22, 8 to 22, 9 to 22, 10 to 22, 11 to 22, 12 to 22, 13 to 22, 14 to 22, 15 to 22, 16 to 22, 17 to 22, 18 to 22, 19 to 22, 20 to 22, 21 to 22, 1 to 21, 2 to 21, 3 to 21, 4 to 21, 5 to 21, 6 to 21, 7 to 21, 8 to 21, 9 to 21, 10 to 21, 11 to 21, 12 to 21, 13 to 21, 14 to 21, 15 to 21, 16 to 21, 17 to 21, 18 to 21, 19 to 21, 20 to 21, 1 to 20, 2 to 20, 3 to 20, 4 to 20, 5 to 20, 6 to 20, 7 to 20, 8 to 20, 9 to 20, 10 to 20, 11 to 20, 12 to 20, 13 to 20, 14 to 20, 15 to 20, 16 to 20, 17 to 20, 18 to 20, 19 to 20, 1 to 19, 2 to 19, 3 to 19, 4 to 19, 5 to 19, 6 to 19, 7 to 19, 8 to 19, 9 to 19, 10 to 19, 11 to 19, 12 to 19, 13 to 19, 14 to 19, 15 to 19, 16 to 19, 17 to 19, 18 to 19, 1 to 18, 2 to 18, 3 to 18, 4 to 18, 5 to 18, 6 to 18, 7 to 18, 8 to 18, 9 to 18, 10 to 18, 11 to 18, 12 to 18, 13 to 18, 14 to 18, 15 to 18, 16 to 18, 17 to 18, 1 to 17, 2 to 17, 3 to 17, 4 to 17, 5 to 17, 6 to 17, 7 to 17, 8 to 17, 9 to 17, 10 to 17, 11 to 17, 12 to 17, 13 to 17, 14 to 17, 15 to 17, 16 to 17, 1 to 16, 2 to 16, 3 to 16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 1 to 15, 2 to 15, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 1 to 14, 2 to 14, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 1 to 13, 2 to 13, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, δ is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30.

Independently in some embodiments of δ , and independently in combination with any embodiments of any other relevant substituent classes, δ can be an integer from 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9,

4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of δ , and independently in combination with any embodiments of any other relevant substituent classes, δ can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of δ , and independently in combination with any embodiments of any other relevant substituent classes, δ can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of δ , and independently in combination with any embodiments of any other relevant substituent classes, δ can be 1, 2, 3, 4, or 5.

Independently in some embodiments of k , and independently in combination with any embodiments of any other relevant substituent classes, k can be an integer from 1 to 20, 2 to 20, 3 to 20, 4 to 20, 5 to 20, 6 to 20, 7 to 20, 8 to 20, 9 to 20, 10 to 20, 11 to 20, 12 to 20, 13 to 20, 14 to 20, 15 to 20, 16 to 20, 17 to 20, 18 to 20, 19 to 20, 1 to 19, 2 to 19, 3 to 19, 4 to 19, 5 to 19, 6 to 19, 7 to 19, 8 to 19, 9 to 19, 10 to 19, 11 to 19, 12 to 19, 13 to 19, 14 to 19, 15 to 19, 16 to 19, 17 to 19, 18 to 19, 1 to 18, 2 to 18, 3 to 18, 4 to 18, 5 to 18, 6 to 18, 7 to 18, 8 to 18, 9 to 18, 10 to 18, 11 to 18, 12 to 18, 13 to 18, 14 to 18, 15 to 18, 16 to 18, 17 to 18, 1 to 17, 2 to 17, 3 to 17, 4 to 17, 5 to 17, 6 to 17, 7 to 17, 8 to 17, 9 to 17, 10 to 17, 11 to 17, 12 to 17, 13 to 17, 14 to 17, 15 to 17, 16 to 17, 1 to 16, 2 to 16, 3 to 16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 1 to 15, 2 to 15, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 1 to 14, 2 to 14, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 1 to 13, 2 to 13, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, k is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20.

Independently in some embodiments of k , and independently in combination with any embodiments of any other relevant substituent classes, k can be an integer from 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9,

4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of k, and independently in combination with any embodiments of any other relevant substituent classes, k can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of w, and independently in combination with any embodiments of any other relevant substituent classes, w can be an integer from 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2.

Independently in some embodiments of w, and independently in combination with any embodiments of any other relevant substituent classes, w can be 1, 2, 3, 4, 5, 6, 7, 8, or 9.

Independently in some embodiments of w, and independently in combination with any embodiments of any other relevant substituent classes, w can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred embodiments, w is 1, 2, 3, 4, or 5.

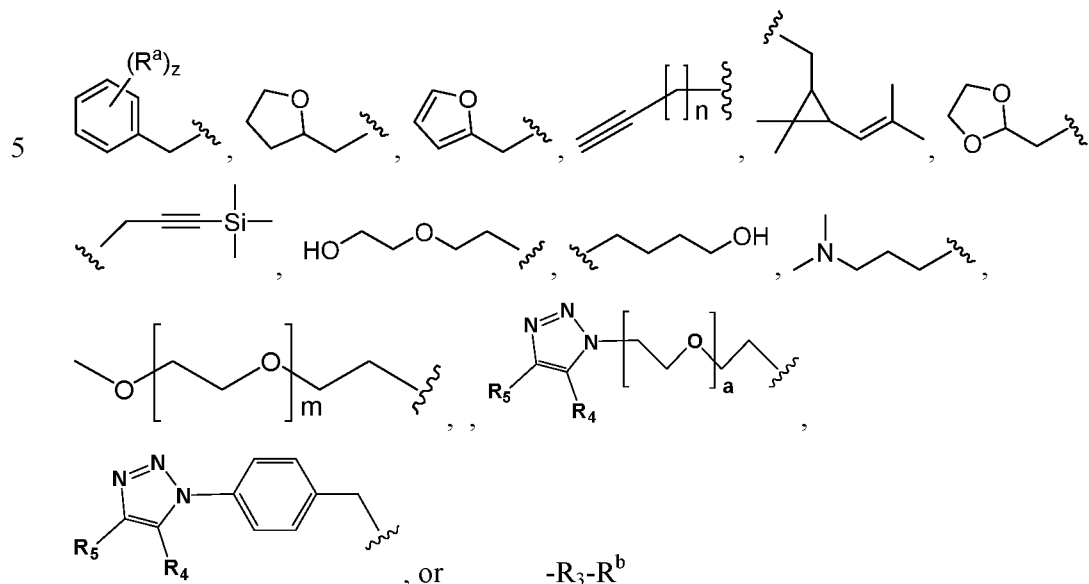
Independently in some embodiments of z, and independently in combination with any embodiments of any other relevant substituent classes, z can be an integer from 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of z, and independently in combination with any embodiments of any other relevant substituent classes, z can be 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11.

Independently in some embodiments of z, and independently in combination with any embodiments of any other relevant substituent classes, z can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of z, and independently in combination with any embodiments of any other relevant substituent classes, z can be 1, 2, 3, 4, or 5.

Independently in some embodiments of p and q, and independently in combination with any embodiments of any other relevant substituent classes, p and q can be, independently, an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some embodiments of p and q, and independently in

combination with any embodiments of any other relevant substituent classes, p and q can be, independently, 1, 2, 3, 4, or 5.

In some embodiments, R_1 is, independently in one or more sites of chemical modification,



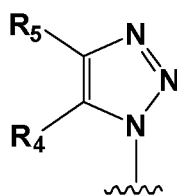
Formula II,

10 wherein a is an integer from 1 to 30, z is an integer from 0-5, n is an integer from 1 to 12, m is an integer from 3 to 16,

R^a is independently selected from U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these

15 embodiments, $U_3 + Q_1 + Q_2 + Q_3$), and

R^b , as valence permits, is



Formula III;

R_2 is hydrogen or an organic grouping containing any number of carbon atoms, 20 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_2 organic groupings being those

present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and

R_3 , R_4 , and R_5 are, independently, hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_3 , R_4 , and R_5 organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, the surface or a surface of the product includes one or more covalent modifications defined by Formula I

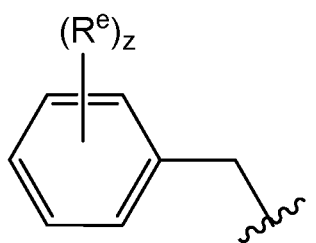


Formula I

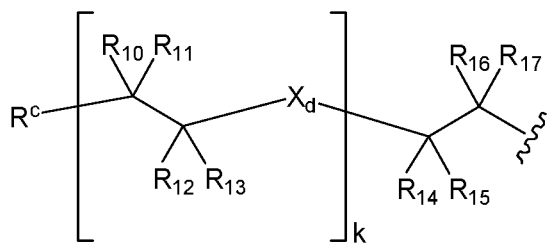
wherein,

X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

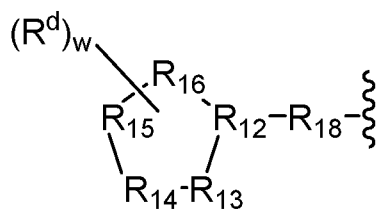
R_1 is, independently in the one or more modified monomers,



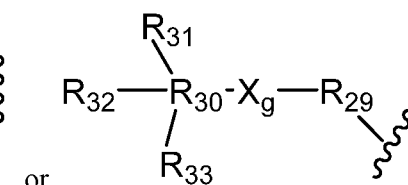
Formula VII



Formula VIII



Formula IX



Formula X

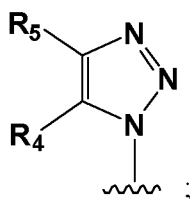
wherein k is an integer from 1 to 10; wherein z is an integer from 0 to 5; wherein w is an integer from 0 to 4; wherein X_d is absent, O or S;

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} , R_{31} , R_{32} , and R_{33} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_2$);

wherein R_{29} is C or Si;

wherein X_g and R_{30} are independently U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_2$); and

- 5 wherein R^a and R^c are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic, heterocyclic ring or

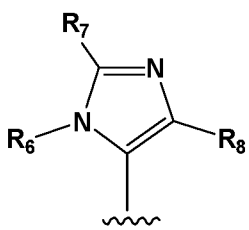


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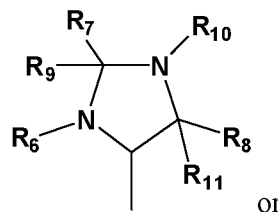
Formula III

wherein R_4 , R_5 , or both are, independently, hydrogen, alkyl, substituted alkyl, alkoxy, amino, alkylamino, dialkylamino, hydroxy, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, carbonyl, substituted carbonyl, carbinol,

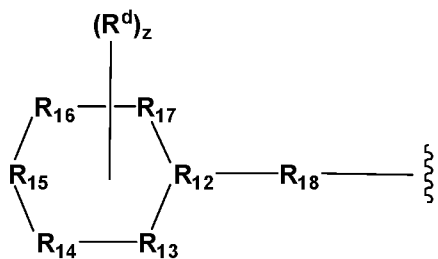
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Formula IV



Formula V



Formula VI

- 20 wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$);

wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency;

wherein z is an integer from 0 to 11; wherein w is an integer from 0-9; wherein R^d and R^e are each independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, or S, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

wherein R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -SO₂-, or NR₂, wherein each R_{19} is independently absent, hydrogen, =O, =S, -OH, -SH, -NR₂, wherein R_2 is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$);

wherein R_4 , and R_5 are not both hydrogen; wherein at least one R^b or R^c is defined by Formula III;

wherein

R_2 is hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

X is preferably oxygen, sulfur, or NR₂.

In some embodiments, z in Formula VI is an integer from 0-3; R^d is independently amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, or C₁-C₆ alkylthio;

where R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, or S, where the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and where R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

where R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, where p and q are independently integers from 0 to 3, where X_b is absent, -O-, -S-, -SO₂-, or NR₂,

where each R₁₉ is independently absent, hydrogen, =O, =S, -OH, -SH, -NR₂, where R₂ is substituted or unsubstituted C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, or C₁-C₆ alkylthio.

In some embodiments, z in Formula VI is 2, R₁₂ is N, R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇ is S, both R^d are oxo and are bonded to the S, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 2, both R^d are oxo and are bonded to R₁₅, R₁₂ is N, R₁₅ is S, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 2, both R^d are oxo and are bonded to R₁₅, R₁₂ is N, R₁₅ is S, and all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, q is 0, p is 1, and each R₁₉ is hydrogen.

In some embodiments, z in Formula VI is 1, R^{ed} is amino, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments, z in Formula VI is 0, R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 0, R₁₃ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 0, R₁₃ is O, all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is oxygen, p is 1, q is 0 and each R₁₉ is hydrogen.

In some embodiments, R₁₃ and R₁₇ of Formula VI are O and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, R₁₃ and R₁₇ of Formula VI are O, the bonds between R₁₂ and R₁₃, and between R₁₅ and R₁₆ are double bonds, and the rest of the bonds in the ring are single bonds.

In some embodiments, z in Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

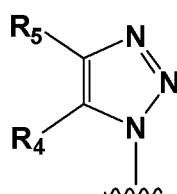
In some embodiments, z in Formula VI is 1, R^d is alkoxy and is bonded to R_{13} , three of the bonds between adjacent R_{12} to R_{17} are double and three of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments, z in Formula VI is 1, R^d is methoxy, and is bonded to R_{13} ,
 5 R_{12} to R_{17} are carbon atoms, three of the bonds between adjacent R_{12} to R_{17} are double and three of the bonds between adjacent R_{12} to R_{17} are single, X_b is absent, p is 0 and q is 0.

In some embodiments, z in Formula VI is 1, R^d is hydroxyl.

In some embodiments, z in Formula VI is 1 and R^d is hydroxyl bonded at the
 10 position *para*- to the methylene group.

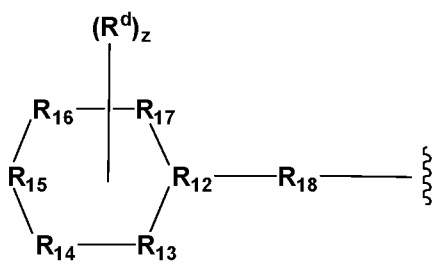
In some embodiments, z in Formula VI is 1, R^d is Formula III shown below:



Formula III

wherein R_4 is a substituted alkyl and R_5 is a dialkylamino, or R_4 is a dialkylamino
 15 and R_5 is a substituted alkyl, wherein the substituted alkyl is hydroxymethyl and the dialkylamino is *N,N*-diethylamino.

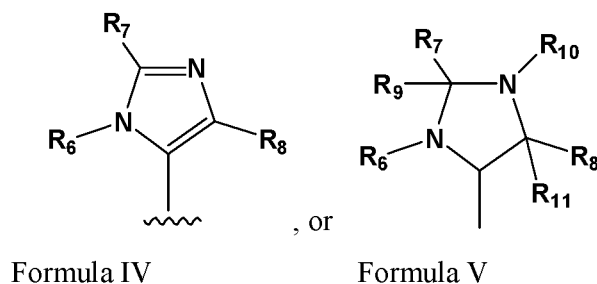
In some embodiments, z in Formula VI is 1, R^d is Formula III, wherein R_4 is hydrogen and R_5 is Formula VI shown below:



Formula VI

or R_4 is Formula VI and R_5 is hydrogen. In some embodiments, z in Formula VI is 0,
 20 R_{13} , R_{14} , R_{15} , R_{16} , or R_{17} is O, and all of the bonds between adjacent R_{12} to R_{17} are single. In some embodiments, z in Formula VI is 0, R_{13} is O, and all of the bonds between adjacent R_{12} to R_{17} are single. In some embodiments, z in Formula VI is 0, R_{13} is O, all of
 25 the bonds between adjacent R_{12} to R_{17} are single, X_b is oxygen, p is 1, q is 0 and each R_{19} is hydrogen.

In some embodiments, z in Formula VI is 1, R^d is Formula III, wherein R₄ is hydrogen and R₅ is Formula IV or Formula V shown below:



- 5 wherein R₆, R₇, R₈, R₉, R₁₀, and R₁₁ are, independently, hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁);

wherein R₆, R₉, R₁₀, and R₁₁ are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency.

- 10 In some embodiments R₆ of Formula IV is alkyl. In some embodiments, R₆ is methyl.

In some embodiments R₆ of Formula IV is methyl, R₇ and R₈ are hydrogen.

In some embodiments, z in Formula VI is 1 and R^d is hydroxyl bonded at the position *para*- to the methylene group.

- 15 In some embodiments of Formula VIII, k is 1 and R^c is hydroxyl.

In some embodiments of Formula VIII, k is 1, R^c is hydroxyl, and X_d is absent.

In some embodiments of Formula VIII, k is 1, R^c is hydroxyl, X_d is absent, and R₂₁-R₂₈ are hydrogen.

In some embodiments of Formula VIII, R^c is alkoxy.

- 20 In some embodiments of Formula VIII, R^c is methoxy and X_d is O.

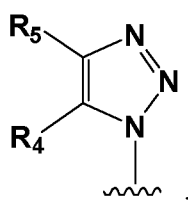
In some embodiments of Formula VIII, R^c is methoxy, X_d is O, and R₂₁-R₂₈ are hydrogen.

In some embodiments of Formula VIII, k is 2 and R^c is alkylamino.

- 25 In some embodiments of Formula VIII, k is 2, R^c is methylamino, and X_d is absent.

In some embodiments of Formula VIII, k is 2, R^c is methylamino, X_d is absent, and R₂₁-R₂₈ are hydrogen.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III shown below:



Formula III

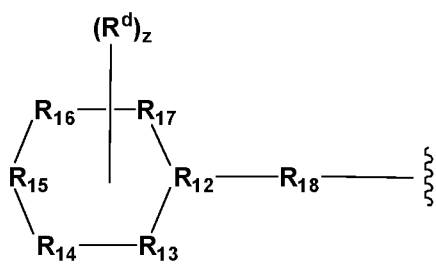
wherein R_4 and R_5 are alkyl.

In some embodiments of Formula VIII, k is 3, X_d is O, and R^c is Formula III,
 5 wherein R_4 and R_5 are methyl.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III,
 wherein R_4 is hydrogen, and R_5 is carbonyl, or R_4 is carbonyl, and R_5 is hydrogen.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III,
 wherein R_4 is hydrogen, and R_5 is acetyl, or R_4 is acetyl, and R_5 is hydrogen.

10 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, R_4 is
 hydrogen, and R_5 is Formula VI shown below:



Formula VI

or R_4 is hydrogen and R_5 is Formula VI.

15 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is
 hydrogen, and R_5 is Formula VI, or R_4 is hydrogen and R_5 is Formula VI, wherein z in
 Formula VI is 2, R_{12} is N, R_{13} , R_{14} , R_{15} , R_{16} , or R_{17} is S, both R^d are oxo and are bonded
 to the S, and all of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is
 20 hydrogen, and R_5 is Formula VI, or R_4 is hydrogen and R_5 is Formula VI, wherein z in
 Formula VI is 2, both R^d are oxo and are bonded to R_{15} , R_{12} is N, R_{15} is S, and all of the
 bonds between adjacent R_{12} to R_{17} are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is
 hydrogen, and R_5 is Formula VI, or R_4 is hydrogen and R_5 is Formula VI, wherein z in
 25 Formula VI is 2, both R^d are oxo and are bonded to R_{15} , R_{12} is N, R_{15} is S, and all of the

bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, q is 0, p is 1, and each R₁₉ is hydrogen.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
5 Formula VI is 1, R^d is amino, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
10 Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
15 Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
20 Formula VI is 0, R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
Formula VI is 0, R₁₃ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is
25 hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in Formula VI is 0, R₁₃ is O, all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is oxygen, p is 1, q is 0 and each R₁₉ is hydrogen.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
30 Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, R₁₄, R₁₅, R₁₅, R₁₆, or R₁₇, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in

Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₄ is hydrogen and R₅ is Formula VI, wherein z in
5 Formula VI is 1, R^d is alkoxy such as methoxy, and is bonded to R₁₃, R₁₂ to R₁₇ are carbon atoms, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, R₁₅, or R₁₆ is O, and, as valency permits, two of the bonds between adjacent R₁₂ to R₁₆ are double bonds, and
10 three of the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, and the rest of the bonds in the ring are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are
15 C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, the rest of the bonds in the ring are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are
20 C, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, and the bonds
25 between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, R₁₂, R₁₄ and R₁₅ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, R₁₂, R₁₄ and R₁₅
30 are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, R₁₅, or R₁₆ is N, and, as valency permits, two of the bonds between adjacent R₁₂ to R₁₆ are double bonds, and three of the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is N, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, and the rest of the bonds in the ring are single bonds.

5 In some embodiments, w in Formula IX is 0, R₁₃ is N, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, the rest of the bonds in the ring are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is N, and, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

10 In some embodiments, w in Formula IX is 0, R₁₃ is N, R₁₂, R₁₄, R₁₅ and R₁₆ are C, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is N, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

15 In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are N, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are N, R₁₂, R₁₄ and R₁₅ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

20 In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are N, R₁₂, R₁₄ and R₁₅ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, R₁₅, or R₁₆ is S, and, as valency permits, two of the bonds between adjacent R₁₂ to R₁₆ are double bonds, and three of the bonds between adjacent R₁₂ to R₁₆ are single bonds.

25 In some embodiments, w in Formula IX is 0, R₁₃ is S, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, and the rest of the bonds in the ring are single bonds.

30 In some embodiments, w in Formula IX is 0, R₁₃ is S, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, the rest of the bonds in the ring are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is S, and, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is S, R₁₂, R₁₄, R₁₅ and R₁₆ are C, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is S, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and
5 each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are S, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are S, R₁₂, R₁₄ and R₁₅ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

10 In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are S, R₁₂, R₁₄ and R₁₅ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments R₂₉ of Formula X is Si, and X_g is alkynyl.

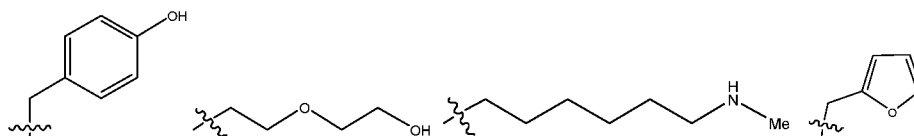
In some embodiments R₂₉ of Formula X is Si, X_g is ethynyl, and R₃₀ is alkylene.

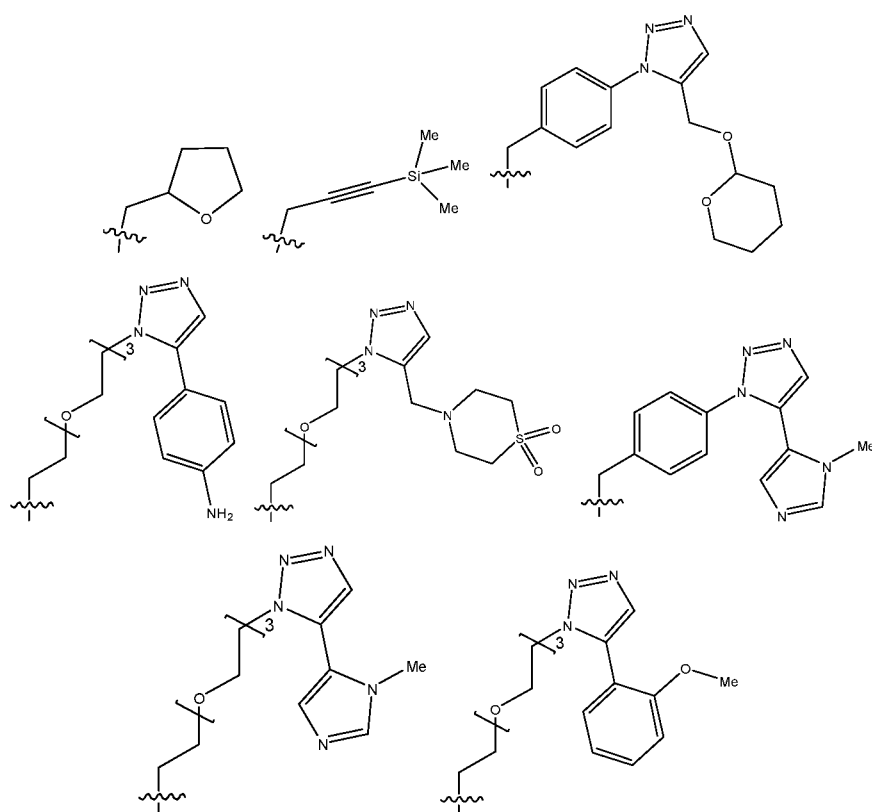
15 In some embodiments R₂₉ of Formula X is Si, X_g is ethynyl, R₃₀ is methylene, and R₃₁, R₃₂, and R₃₃ are alkyl.

In some embodiments R₂₉ of Formula X is Si, X_g is ethynyl, R₃₀ is methylene, and R₃₁, R₃₂, and R₃₃ are methyl.

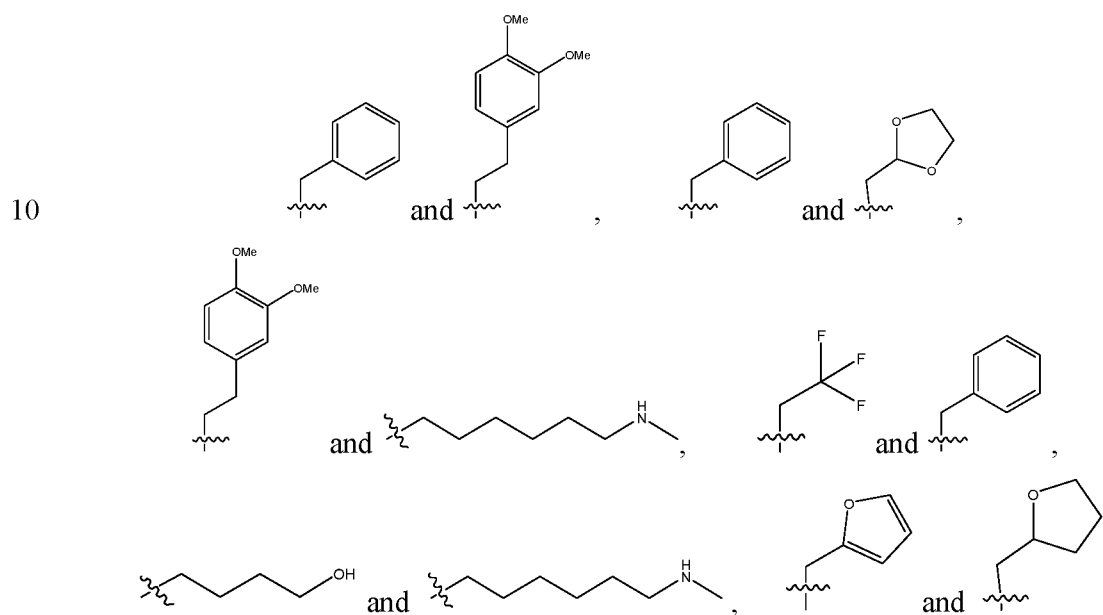
Products can be either singularly modified or multiply modified. Singularly
20 modified products are products that contain one or more covalent modifications, wherein substantially all of the covalently modified products possess the same covalent modification (*i.e.* the product contains one ‘type’ or species of covalent modification). Multiply modified products are products that contain covalent modifications, wherein substantially all of the covalently modified products do not possess the same covalent
25 modification (*i.e.* the product contains two or more ‘types’ or species of covalent modifications).

In some embodiments, the surface modified product is singularly modified. In some embodiments, the surface modification is:

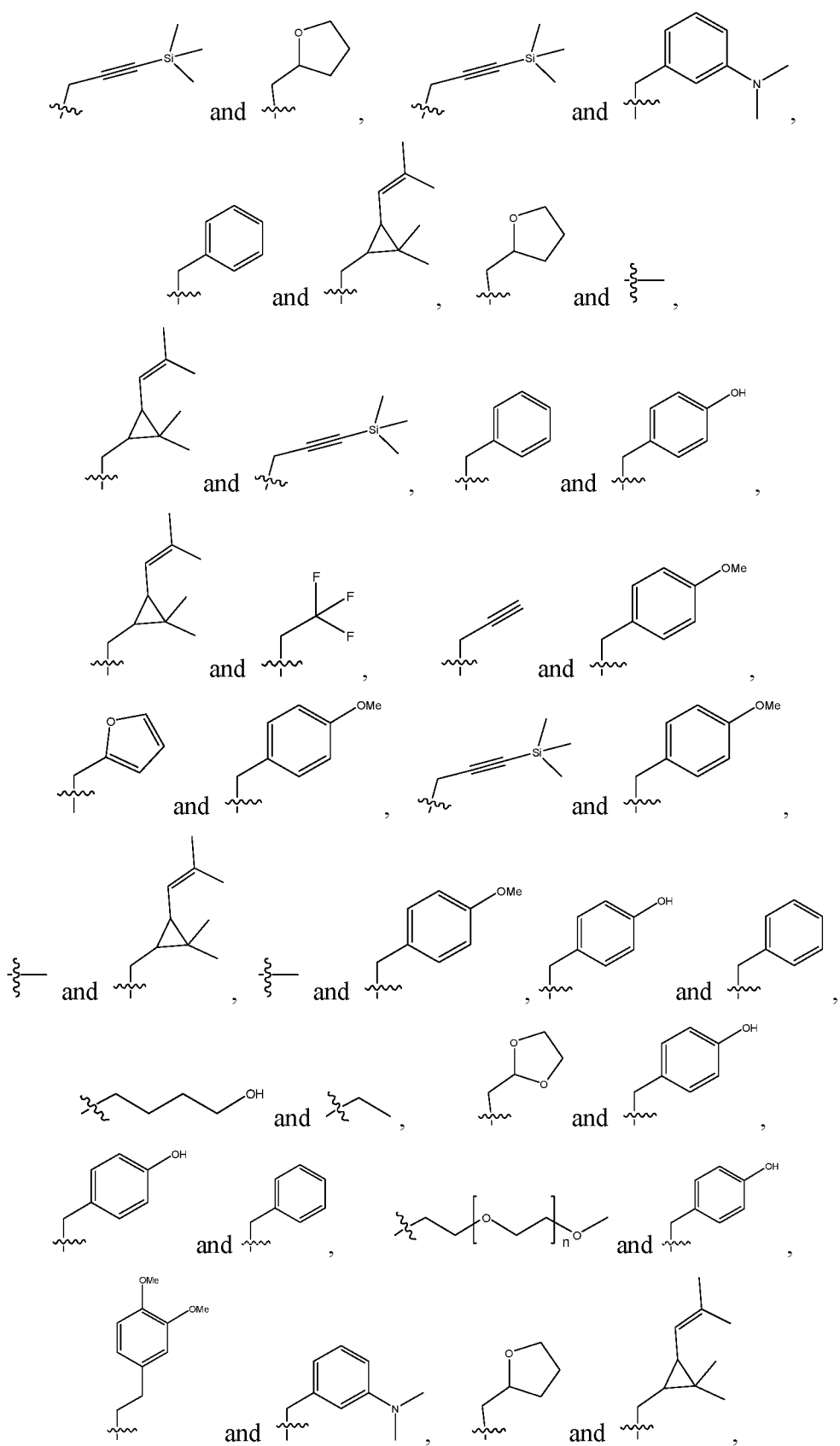


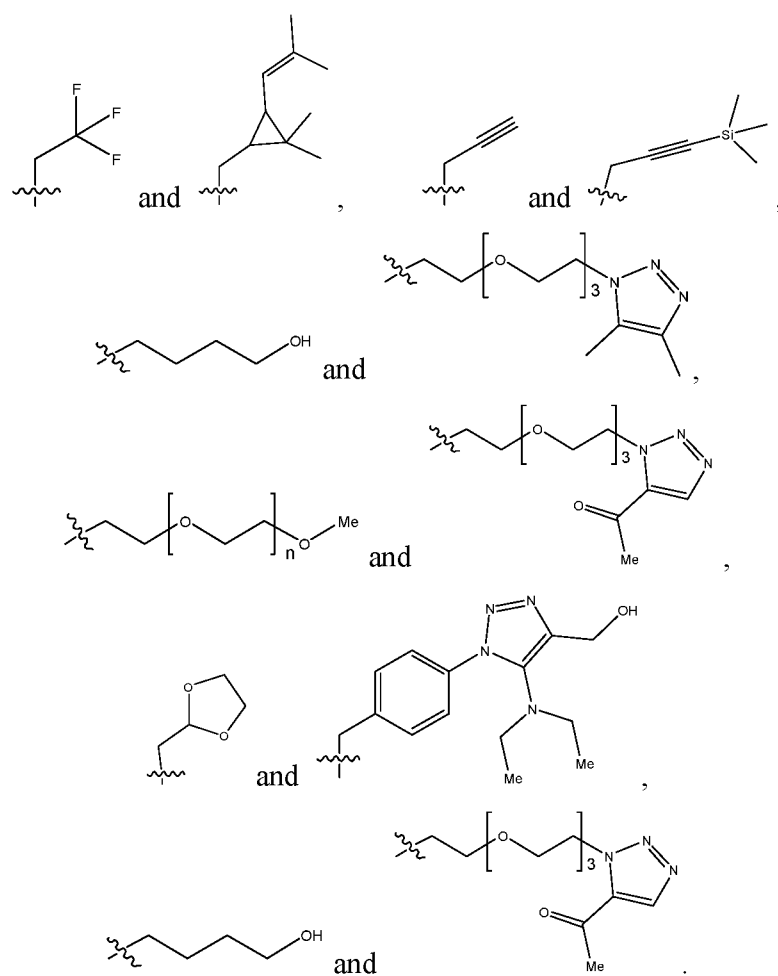


- 5 In preferred embodiments, the surface modified product is multiply modified containing a first species or type of covalent modification defined by Formula I, and a second species or type of covalent modification defined by Formula I. In some embodiments, the surface modifications are combinations of the modifications shown above. Example combinations include:



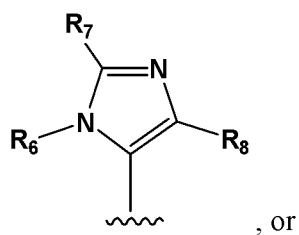
5



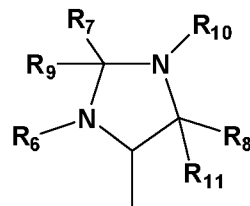


5

In some embodiments, R_4 , R_5 , or both are, independently, hydrogen,



Formula IV



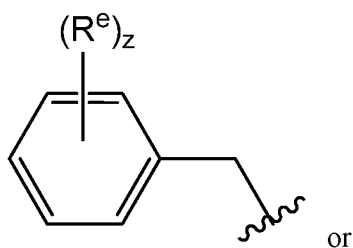
Formula V

- 10 wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$);

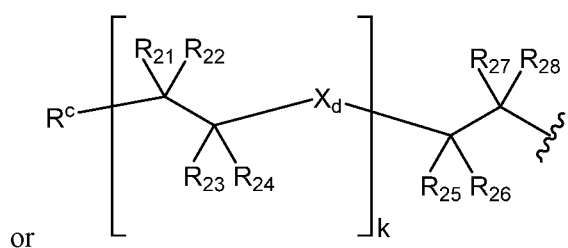
wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency.

In some embodiments, R_1 is

(A)

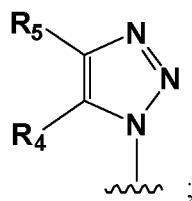


Formula VII



Formula VIII

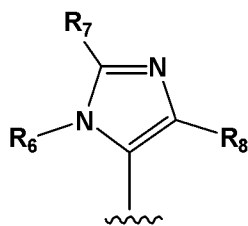
- 5 wherein k is independently an integer from 1 to 30; wherein z is an integer from 0 to 4; wherein X_d is O or S; wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_2$); and wherein R^a and R^c are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic, heterocyclic ring or
- 10



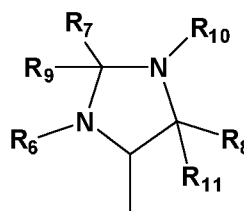
Formula III

15

wherein R_4 , R_5 , or both are, independently, hydrogen,



Formula IV



Formula V

- wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$);
- 20

wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency.

In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_2 , R_3 , R_4 , and R_5 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$); and wherein R_1 is not hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_1 , R_2 , R_3 , R_4 , and R_5 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_1 , R_3 , R_4 , and R_5 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$); and wherein R_2 is not hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$,

$U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

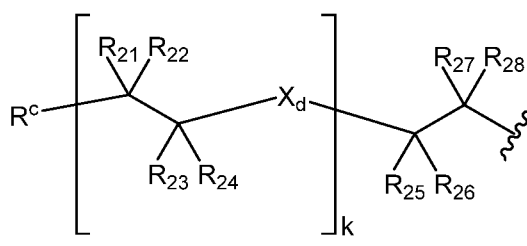
In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_1 , R_2 , R_4 , and R_5 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$); and wherein R_3 is not hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_1 , R_2 , R_3 , and R_5 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$); and wherein R_4 is not hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

In some embodiments, the surface modified products contain one or more covalent modifications described by Formula I, wherein for each formula R_1 , R_2 , R_3 , and R_4 are independently hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally

including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$); and wherein R_5 is not hydrogen or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1$).

Independently in some embodiments of R_4 and R_5 , and independently in combination with any embodiments of any other relevant substituent classes, R_4 and R_5 can be, independently,



Formula VIII

wherein k is an integer from 1 to 20;

wherein X_d are O;

wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, all of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃,

R₁₄, R₁₅, R₁₆, and R₁₇ are N. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N.

Independently in some embodiments of Formula IX, and independently in
5 combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N. Independently in some embodiments of Formula IX, and independently in combination with any
10 embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N. Independently in some
15 embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant
20 substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant
25 substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent
30 classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent

classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and
5 independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O.

Independently in some embodiments of Formula VI, and independently in
10 combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination
15 with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination
20 with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S.

Independently in some embodiments of Formula IX, and independently in
25 combination with any embodiments of any other relevant substituent classes, all of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some embodiments of Formula IX, and independently in combination with any
30 embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some

embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂,
5 R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two,
10 three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two
15 of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, all of R₁₂,
20 R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄,
25 R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂.

30 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent

classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N and one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula

VI, and independently in combination with any embodiments of any other relevant
substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one, two,
three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some
embodiments of Formula VI, and independently in combination with any embodiments
5 of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N and
one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S.

Independently in some embodiments of Formula IX, and independently in
combination with any embodiments of any other relevant substituent classes, one, two,
three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is
10 S. Independently in some embodiments of Formula IX, and independently in
combination with any embodiments of any other relevant substituent classes, one, two, or
three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are
S. Independently in some embodiments of Formula IX, and independently in
combination with any embodiments of any other relevant substituent classes, one or two
15 of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆
are S. Independently in some embodiments of Formula IX, and independently in
combination with any embodiments of any other relevant substituent classes, one of R₁₂,
R₁₃, R₁₄, R₁₅, and R₁₆ is N and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S.

Independently in some embodiments of Formula VI, and independently in
20 combination with any embodiments of any other relevant substituent classes, one, two,
three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one of R₁₂, R₁₃, R₁₄, R₁₅,
R₁₆, and R₁₇ is S(O)₂. Independently in some embodiments of Formula VI, and
independently in combination with any embodiments of any other relevant substituent
classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and one or two of
25 R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of
Formula VI, and independently in combination with any embodiments of any other
relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N
and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in
some embodiments of Formula VI, and independently in combination with any
30 embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅,
R₁₆, and R₁₇ are N and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are
S(O)₂. Independently in some embodiments of Formula VI, and independently in
combination with any embodiments of any other relevant substituent classes, one of R₁₂,

R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N and one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N and one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is

S. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S.

10 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O and one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂.

20 Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two

of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S and one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S and one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S and one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S and one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂,

R₁₃, R₁₄, R₁₅, and R₁₆ is S and one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments

of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O and the others are C.

- 5 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O and the others are C.

- Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O and the others are C.

- Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two,

three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are S and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are S and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are S and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is S and the others are C.

10 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$ and the others are C.

25 Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$ and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is $S(O)_2$ and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.

- 5 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some
10 embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and
independently in combination with any embodiments of any other relevant substituent
15 classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in
some embodiments of Formula VI, and independently in combination with any
embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄,
R₁₅, R₁₆, and R₁₇ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the
20 others are C. Independently in some embodiments of Formula VI, and independently in
combination with any embodiments of any other relevant substituent classes, none or one
of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is
O, and the others are C.

- Independently in some embodiments of Formula IX, and independently in
combination with any embodiments of any other relevant substituent classes, none, one,
25 two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, three, four,
or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, and the others are C. Independently in some
embodiments of Formula IX, and independently in combination with any embodiments
of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄,
R₁₅, and R₁₆ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, and
30 the others are C. Independently in some embodiments of Formula IX, and independently
in combination with any embodiments of any other relevant substituent classes, none,
one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, or three of R₁₂,
R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C. Independently in some embodiments of
Formula IX, and independently in combination with any embodiments of any other

relevant substituent classes, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments

of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, or three of R₁₂,

R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in
5 some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two,
10 three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C. Independently in
15 some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or
20 two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C.

25 Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent
30 classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some

embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C.

Independently in some embodiments of Formula VI, and independently in
5 combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three,
10 four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is
15 S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any
20 embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and
25 R₁₇ is S(O)₂, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂, and the others are C. Independently in
30 some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant

substituent classes, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, none, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is N, none or one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C.

10 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, one or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is N, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C.

 Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other

relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are N, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is N, one, two, 5 three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C.

10 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some 15 embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and 20 independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI, and independently in 25 combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, 30 two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, and

the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of
5 Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any
10 embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, and the others are C. Independently in some embodiments of Formula VI,
15 and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any
20 embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any
25 embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is N, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S,
30 and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of Formula

IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of

R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are O, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are O, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are O, none, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is O, none or one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, one or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is O, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are $S(O)_2$, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are O, one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent

classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are O, one, two, or
5 three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is O, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C.

Independently in some embodiments of Formula VI, and independently in
10 combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three,
15 four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is
20 S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any
25 embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and
30 R₁₇ is S(O)₂, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂, and the others are C. Independently in some

embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and

5 independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆

10 are S, none, one or two of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S(O)₂, and the others are C.

15 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant

20 substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂,

25 and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is S, one,

30 two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ are S, one of R₁₂, R₁₃, R₁₄, R₁₅, and R₁₆ is

$S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are S, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of
5 Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one or two of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are S, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, one of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} is S, one, two,
10 three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are $S(O)_2$, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three,
15 four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three, four, or five of R_{12} , R_{13} ,
20 R_{14} , R_{15} , R_{16} , and R_{17} is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is O, and the others are C. Independently in some embodiments of Formula VI, and independently
25 in combination with any embodiments of any other relevant substituent classes, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one
30

of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄,

R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇
 are S(O)₂, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the
 others are C. Independently in some embodiments of Formula VI, and independently in
 combination with any embodiments of any other relevant substituent classes, none, one,
 5 two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃,
 R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and
 R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and
 independently in combination with any embodiments of any other relevant substituent
 classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, or two of
 10 R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and
 R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and
 independently in combination with any embodiments of any other relevant substituent
 classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄,
 R₁₅, R₁₆, and R₁₇ are S(O)₂, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the
 15 others are C.

Independently in some embodiments of Formula IX, and independently in
 combination with any embodiments of any other relevant substituent classes, none, one,
 two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, three, four, or
 five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two, three, four, or five of R₁₂, R₁₃,
 20 R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of
 Formula IX, and independently in combination with any embodiments of any other
 relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are
 N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two,
 three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in
 25 some embodiments of Formula IX, and independently in combination with any
 embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂,
 R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂,
 none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C.
 Independently in some embodiments of Formula IX, and independently in combination
 30 with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂,
 R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none,
 one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some
 embodiments of Formula IX, and independently in combination with any embodiments
 of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N,

none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are $S(O)_2$, none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is O, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three, four, five, or six of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C. Independently in some embodiments

of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and

independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are N, none or one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are S, none or one of R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} is $S(O)_2$, and the others are C.

Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are N, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are S, none, one, two, three, four, or five of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is $S(O)_2$, and the others are C. Independently in some embodiments of

Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is S(O)₂, and the others are C. Independently in some
 5 embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is S(O)₂, and the others are C. Independently in some
 10 embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is S(O)₂, and the others are C. Independently in some embodiments of
 Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none or one
 15 of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is S(O)₂, and the others are C.

Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two,
 20 three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.
 Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, four, or
 25 five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and
 30 R₁₇ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and

R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.

10 Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of
15 Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any
20 embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂,
25 R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C.
30

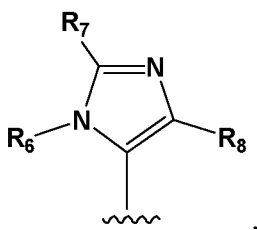
Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three,

four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, four, five, or six of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, three, or four of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, two, or three of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none, one, or two of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C. Independently in some embodiments of Formula VI, and independently in combination with any embodiments of any other relevant substituent classes, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are N, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are S(O)₂, none or one of R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ is O, and the others are C.

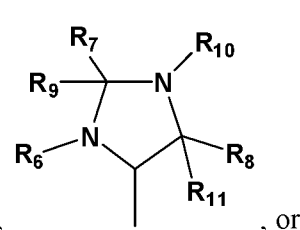
Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent classes, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are N, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ are S(O)₂, none, one, two, three, four, or five of R₁₂, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other relevant substituent

- classes, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are N, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are S, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are $S(O)_2$, none, one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is O, and the others are C. Independently in some embodiments of Formula IX, and
- 5 independently in combination with any embodiments of any other relevant substituent classes, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are N, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are S, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are $S(O)_2$, none, one, two, or three of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is O, and the others are C. Independently in some embodiments of Formula IX, and independently in
- 10 combination with any embodiments of any other relevant substituent classes, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are N, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are S, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are $S(O)_2$, none, one, or two of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is O, and the others are C. Independently in some embodiments of Formula IX, and independently in combination with any embodiments of any other
- 15 relevant substituent classes, none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are N, none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are S, none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} are $S(O)_2$, none or one of R_{12} , R_{13} , R_{14} , R_{15} , or R_{16} is O, and the others are C.

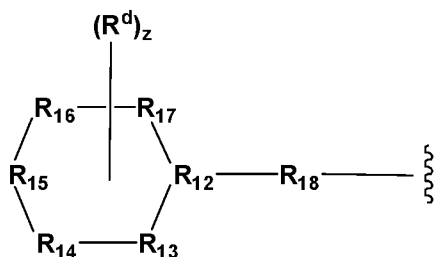
- In some embodiments, R_4 and R_5 are independently hydrogen, alkyl, alkoxy, amino, alkylamino, dialkylamino, hydroxy, alkenyl, alkynyl, substituted alkyl,
- 20 substituted alkenyl, substituted alkynyl, carbonyl, substituted carbonyl, carbinol,



Formula IV



Formula V



Formula VI

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$);

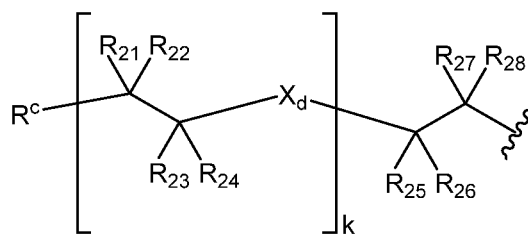
wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to
5 valency, and wherein the ring bonds are double or single according to valency;

wherein z is an integer from 0-11; wherein R^d is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to
10 which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to
15 valency; and

wherein R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these
20 embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of R_{18} , and independently in combination with any embodiments of any other relevant substituent classes, R_{18} can be



Formula VIII

wherein k is an integer from 0 to 20;

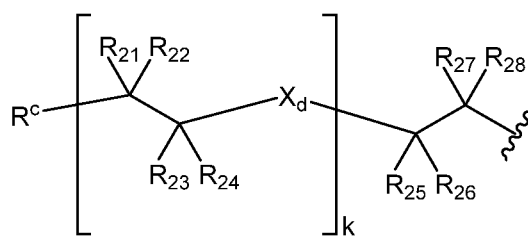
wherein X_d are absent or O;

wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$,
30 $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1$

+ Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); and

wherein R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ are independently R^b, hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

Independently in some embodiments of R₁₈, and independently in combination with any embodiments of any other relevant substituent classes, R₁₈ can be



Formula VIII

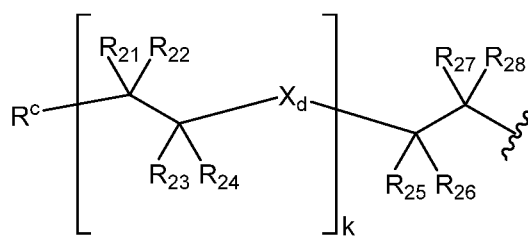
wherein k is an integer from 1 to 20;

wherein X_d are O;

wherein R^c is R^b, absent, hydrogen, U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); and

wherein R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ are independently R^b, hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

Independently in some embodiments of R₁₈, and independently in combination with any embodiments of any other relevant substituent classes, R₁₈ can be



Formula VIII

wherein k is an integer from 1 to 20;

wherein X_d are absent;

wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of R_{18} , and independently in combination with any embodiments of any other relevant substituent classes, R_{18} can be absent or -
10 $(CR_{19}R_{19})_p$, wherein p is 1.

Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, $-B$, C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, $-A-B(-C)_\delta$, $-B(-C)_\delta$, $-B$, C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently, an organic grouping containing any number of
15 carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R^b organic groupings being those present in U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).
20

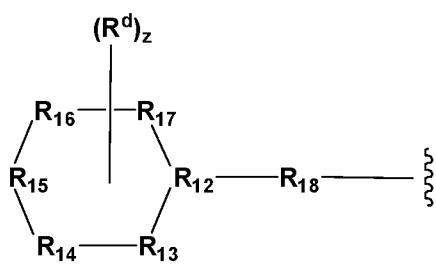
Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, A , B , C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, $-A-B(-C)_\delta$, $-B(-C)_\delta$, A , B , C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).
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Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, A , B , C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, $-A-B(-C)_\delta$, $-B(-C)_\delta$, A , B , C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently, amino, hydroxyl, thiol, oxo, phosphate, or J_1 .
30

Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, A , B , C , R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments

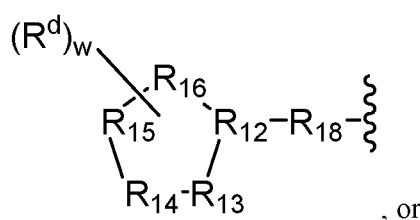
of any other relevant substituent classes, $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$ can be, independently, amino, hydroxyl, thiol, oxo, phosphate, or $\mathbf{J}_2$.

- Independently in some embodiments of $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$, and independently in combination with any embodiments of any other relevant substituent classes, $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$ can be, independently,

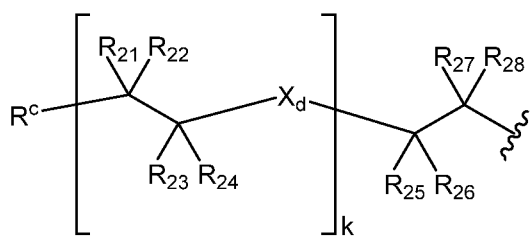


Formula VI

10



Formula IX



Formula VIII

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wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

- wherein $\mathbf{R}^d$ are independently $\mathbf{U}_2$, $\mathbf{U}_2 + \mathbf{Q}_1$, $\mathbf{U}_2 + \mathbf{Q}_2$, $\mathbf{U}_2 + \mathbf{Q}_3$, $\mathbf{U}_2 + \mathbf{Q}_1 + \mathbf{Q}_2$, $\mathbf{U}_2 + \mathbf{Q}_1 + \mathbf{Q}_3$, $\mathbf{U}_2 + \mathbf{Q}_2 + \mathbf{Q}_3$, $\mathbf{U}_2 + \mathbf{Q}_1 + \mathbf{Q}_2 + \mathbf{Q}_3$, $\mathbf{U}_3$, $\mathbf{U}_3 + \mathbf{Q}_1$, $\mathbf{U}_3 + \mathbf{Q}_2$, $\mathbf{U}_3 + \mathbf{Q}_3$, $\mathbf{U}_3 + \mathbf{Q}_1 + \mathbf{Q}_2$, $\mathbf{U}_3 + \mathbf{Q}_1 + \mathbf{Q}_3$, $\mathbf{U}_3 + \mathbf{Q}_2 + \mathbf{Q}_3$, or $\mathbf{U}_3 + \mathbf{Q}_1 + \mathbf{Q}_2 + \mathbf{Q}_3$ (preferably, in these embodiments, $\mathbf{U}_3$

20

+ Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

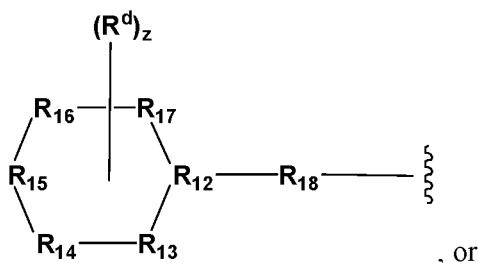
wherein R^c is absent, hydrogen, U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃);

wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and

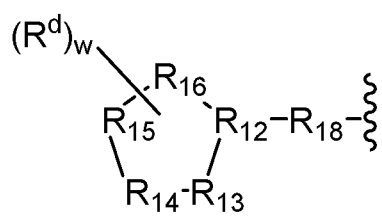
wherein R₁₈ are independently absent, -(CR₁₉R₁₉)_p- or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R₁₉ is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R₂₀ is U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃); and

wherein R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ are independently hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

Independently in some embodiments of **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R₃, R₄, R₅, R^a, R^b, R^c, R^d, and R^e, and independently in combination with any embodiments of any other relevant substituent classes, **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R₃, R₄, R₅, R^a, R^b, R^c, R^d, and R^e can be, independently,



Formula VI



Formula IX

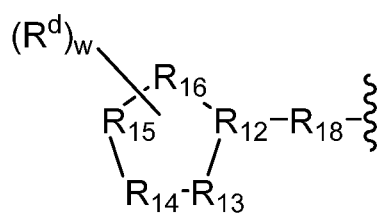
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

5 wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

10 membered unsubstituted or substituted carbocyclic or heterocyclic ring;
wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

20 Independently in some embodiments of **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently,



Formula IX

wherein w is an integer from 0-9;

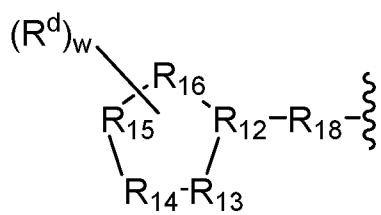
wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;

and

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, **-A-B(-C)_δ**, **-B(-C)_δ**, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently,



Formula IX

wherein w is an integer from 0-9;

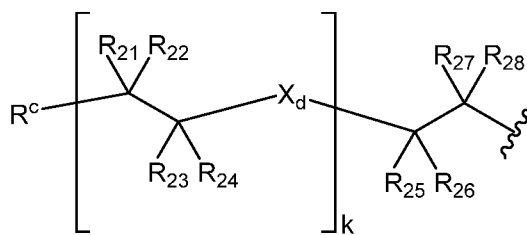
wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

- 5 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these
10 embodiments, $U_1 + Q_1 + Q_3$).

Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments of any other relevant substituent classes, $-A-B(-C)_\delta$, $-B(-C)_\delta$, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e can be, independently,

15



Formula VIII

wherein k is an integer from 0 to 20;

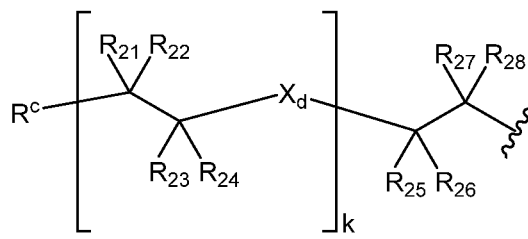
wherein X_d are independently absent, O, or S;

- 20 wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 25 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of $-A-B(-C)_\delta$, $-B(-C)_\delta$, **A**, **B**, **C**, R_3 , R_4 , R_5 , R^a , R^b , R^c , R^d , and R^e , and independently in combination with any embodiments

of any other relevant substituent classes, $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$ can be, independently,



Formula VIII

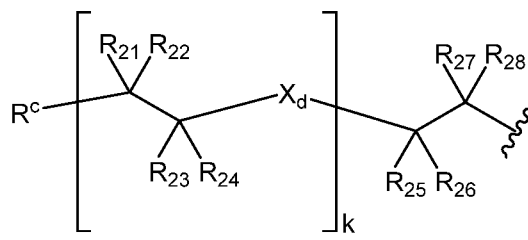
wherein k is an integer from 0 to 20;

wherein X_d are independently O or S;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

Independently in some embodiments of $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$, and independently in combination with any embodiments of any other relevant substituent classes, $-\mathbf{A}-\mathbf{B}(-\mathbf{C})_\delta$, $-\mathbf{B}(-\mathbf{C})_\delta$, $\mathbf{A}$, $\mathbf{B}$, $\mathbf{C}$, $\mathbf{R}_3$, $\mathbf{R}_4$, $\mathbf{R}_5$, $\mathbf{R}^a$, $\mathbf{R}^b$, $\mathbf{R}^c$, $\mathbf{R}^d$, and $\mathbf{R}^e$ can be, independently,



Formula VIII

wherein k is an integer from 1 to 20;

wherein X_d are O;

wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

Q_2 , $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

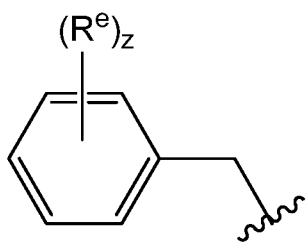
wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, R_4 , R_5 , or both are not hydrogen. In some embodiments, neither R_4 nor R_5 is hydrogen. In some embodiments, either R_4 or R_5 is hydrogen. In some embodiments, R_4 and R_5 both hydrogen.

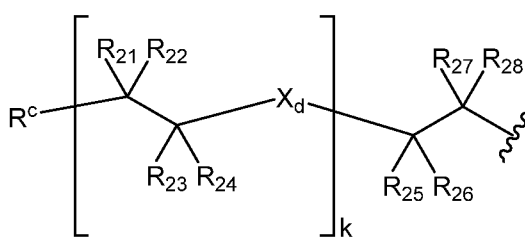
In some embodiments, the compounds are represented by Formula I

wherein X is oxygen, sulfur, or NR_2 ,

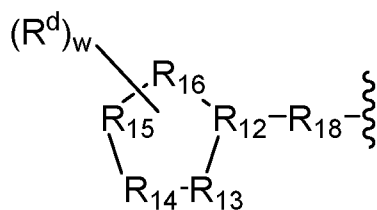
R_1 is, independently in one or more sites of chemical modification,



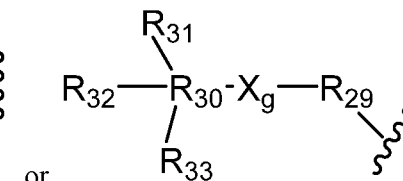
Formula VII



Formula VIII



Formula IX



Formula X

wherein k is an integer from 1 to 10; wherein w is an integer from 0-4; wherein X_d are independently absent, O or S;

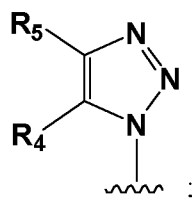
wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} , R_{31} , R_{32} , and R_{33} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$);

wherein R_{30} is C or Si;

wherein X_g and R_{29} are independently U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$); and

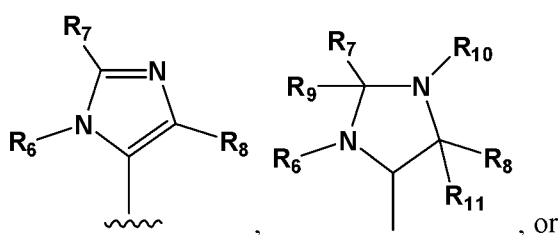
wherein R^e and R^c are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 +$

Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₃ + Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic, heterocyclic ring or



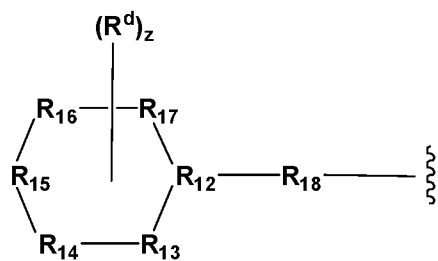
Formula III

wherein R₄, R₅, or both are, independently, hydrogen, alkyl, substituted alkyl, alkoxy, amino, alkylamino, dialkylamino, hydroxy, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, carbonyl, substituted carbonyl, carbinol,



Formula IV

Formula V



Formula VI

wherein R₆, R₇, R₈, R₉, R₁₀, and R₁₁ are, independently, hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃);

wherein R₆, R₉, R₁₀, and R₁₁ are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency;

wherein in R₄ or R₅:

z is an integer from 0-11;

R^d is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-
5 membered unsubstituted or substituted carbocyclic or heterocyclic ring;

R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

10 R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$);
15

wherein R_4 , R_5 , or both are not hydrogen; wherein at least one R^b or R^c is defined by Formula III.

In some embodiments, z in Formula VI is an integer from 0-3; R^d is independently amino, hydroxyl, thiol, oxo, phosphate, or substituted or unsubstituted C₁-
20 C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, or C₁-C₆ alkylthio;

where R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, where the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and where R_{18} to R_{23} are bound to none, one, or two hydrogens according to valency; and

25 where R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, where p and q are independently integers from 0 to 3, where X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, where each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, where R_{20} is substituted or unsubstituted C₁-C₆ alkyl, C₁-C₆ alkoxy, C₁-C₆ alkylamino, or C₁-C₆ alkylthio.

30 In some embodiments, z in Formula VI is 2, R_{12} is N, R_{13} , R_{14} , R_{15} , R_{16} , or R_{17} is S, both R^d are oxo and are bonded to the S, and all of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments, z in Formula VI is 2, both R^d are oxo and are bonded to R_{15} , R_{12} is N, R_{15} is S, and all of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments, z in Formula VI is 2, both R^d are oxo and are bonded to R₁₅, R₁₂ is N, R₁₅ is S, and all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, q is 0, p is 1, and each R₁₉ is hydrogen.

5 In some embodiments, z in Formula VI is 1, R^d is amino, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

10 In some embodiments, z in Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments, z in Formula VI is 0, R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

15 In some embodiments, z in Formula VI is 0, R₁₃ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 0, R₁₃ is O, all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is oxygen, p is 1, q is 0 and each R₁₉ is hydrogen.

20 In some embodiments, R₁₃ and R₁₇ of Formula VI are O and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments, z in Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, R₁₄, R₁₅, R₁₆, or R₁₇, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

25 In some embodiments, z in Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

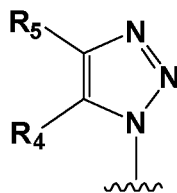
In some embodiments, z in Formula VI is 1, R^d is methoxy, and is bonded to R₁₃, R₁₂ to R₁₇ are carbon atoms, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

30 0.

In some embodiments, z in Formula VII is 1, R^e is hydroxyl.

In some embodiments, z in Formula VII is 1 and R^e is hydroxyl bonded at the position *para*- to the methylene group.

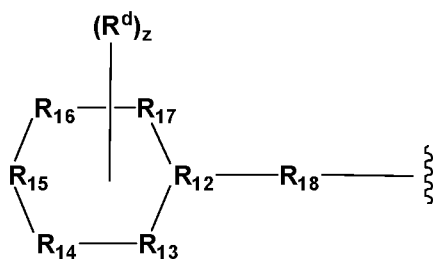
In some embodiments, z in Formula VII is 1, R^e is Formula III shown below:



Formula III

wherein R₄ is a substituted alkyl and R₅ is a dialkylamino, or R₄ is a dialkylamino
 5 and R₅ is a substituted alkyl, wherein the substituted alkyl is hydroxymethyl and the
 dialkylamino is *N,N*-diethylamino.

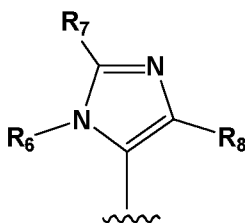
In some embodiments, z in Formula VII is 1, R^e is Formula III, wherein R₄ is
 hydrogen and R₅ is Formula VI shown below:



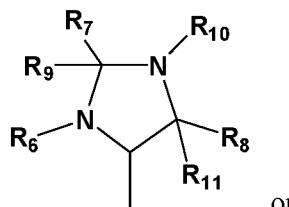
Formula VI;

or R₄ is Formula VI and R₅ is hydrogen. In some embodiments, z in Formula VI is 0,
 R₁₃, R₁₅, R₁₅, R₁₆, or R₁₇ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.
 In some embodiments, z in Formula VI is 0, R₁₃ is O, and all of the bonds between
 adjacent R₁₂ to R₁₇ are single. In some embodiments, z in Formula VI is 0, R₁₃ is O, all of
 15 the bonds between adjacent R₁₂ to R₁₇ are single, X_b is oxygen, p is 1, q is 0 and each R₁₉
 is hydrogen.

In some embodiments, z in Formula VI is 1, R^e is Formula III, wherein R₄ is
 hydrogen and R₅ is Formula IV or Formula V shown below:



Formula IV



Formula V

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments R_6 of Formula IV is alkyl. In some embodiments, R_6 is methyl.

In some embodiments R_6 of Formula IV is methyl, R_7 and R_8 are hydrogen.

In some embodiments, z in Formula VII is 1 and R^c is hydroxyl bonded at the position *para*- to the methylene group.

In some embodiments of Formula VIII, k is 1 and R^c is hydroxyl.

In some embodiments of Formula VIII, k is 1, R^c is hydroxyl, and X_d is absent.

In some embodiments of Formula VIII, k is 1, R^c is hydroxyl, X_d is absent, and R_{21} - R_{28} are hydrogen.

In some embodiments of Formula VIII, R^c is alkoxy.

In some embodiments of Formula VIII, R^c is methoxy and X_d is O.

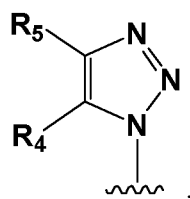
In some embodiments of Formula VIII, R^c is methoxy, X_d is O, and R_{21} - R_{28} are hydrogen.

In some embodiments of Formula VIII, k is 2 and R^c is alkylamino.

In some embodiments of Formula VIII, k is 2, R^c is methylamino, and X_d is absent.

In some embodiments of Formula VIII, k is 2, R^c is methylamino, X_d is absent, and R_{21} - R_{28} are hydrogen.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III shown below:



Formula III

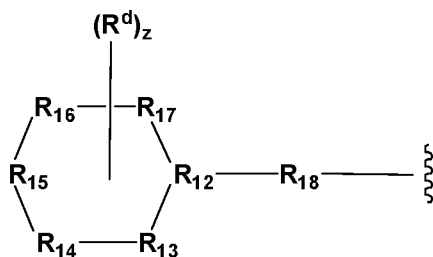
wherein R_4 and R_5 are alkyl.

In some embodiments of Formula VIII, k is 3, X_d is O, and R^c is Formula III, wherein R_4 and R_5 are methyl.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is carbonyl, or R_4 is carbonyl, and R_5 is hydrogen.

In some embodiments of Formula VIII, k is 3, X_d is O and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is acetyl, or R_4 is acetyl, and R_5 is hydrogen.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, R_4 is hydrogen, and R_5 is Formula VI shown below:



Formula VI

or R_4 is hydrogen and R_5 is Formula VI.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is Formula IX, or R_5 is hydrogen and R_4 is Formula VI, wherein z in
 10 Formula VI is 2, R_{12} is N, R_{13} , R_{14} , R_{15} , R_{16} , or R_{17} is S, both R^d are oxo and are bonded to the S, and all of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is Formula VI, or R_5 is hydrogen and R_4 is Formula VI, wherein z in
 15 Formula VI is 2, both R^d are oxo and are bonded to R_{15} , R_{12} is N, R_{15} is S, and all of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is Formula VI, or R_5 is hydrogen and R_4 is Formula VI, wherein z in
 20 Formula VI is 2, both R^d are oxo and are bonded to R_{15} , R_{12} is N, R_{15} is S, and all of the bonds between adjacent R_{12} to R_{17} are single, X_b is absent, q is 0, p is 1, and each R_{19} is hydrogen.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is Formula VI, or R_5 is hydrogen and R_4 is Formula VI, wherein z in
 Formula VI is 1, R^d is amino, and three of the bonds between adjacent R_{12} to R_{17} are double and three of the bonds between adjacent R_{12} to R_{17} are single.

25 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R_4 is hydrogen, and R_5 is Formula VI, or R_5 is hydrogen and R_4 is Formula VI, wherein z in Formula VI is 1, R^d is amino and is bonded to R_{15} , and three of the bonds between adjacent R_{12} to R_{17} are double and three of the bonds between adjacent R_{12} to R_{17} are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 1, R^d is amino and is bonded to R₁₅, and three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and all of the bonds between adjacent R₁₂ to R₁₆ are single.

10 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 0, R₁₃ is O, and all of the bonds between adjacent R₁₂ to R₁₇ are single.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 0, R₁₃ is O, all of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is oxygen, p is 1, q is 0 and each R₁₉ is hydrogen.

20 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, R₁₄, R₁₅, R₁₆, R₁₇, or R₁₈, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

25 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 1, R^d is alkoxy and is bonded to R₁₃, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single.

30 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula VI, or R₅ is hydrogen and R₄ is Formula VI, wherein z in Formula VI is 1, R^d is alkoxy such as methoxy, and is bonded to R₁₃, R₁₂ to R₁₇ are carbon atoms, three of the bonds between adjacent R₁₂ to R₁₇ are double and three of the bonds between adjacent R₁₂ to R₁₇ are single, X_b is absent, p is 0 and q is 0.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula IV or Formula V, or R₅ is hydrogen and R₄ is Formula IV or Formula V, wherein R₆ is alkyl.

In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula IV or Formula V, or R₅ is hydrogen and R₄ is Formula IV or Formula V, wherein R₆ is alkyl.

5 In some embodiments of Formula VIII, k is 3 and R^c is Formula III, wherein R₄ is hydrogen, and R₅ is Formula IV, or R₅ is hydrogen and R₄ is Formula IV, wherein R₆ is an alkyl such as a methyl, R₇ and R₈ are hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and, as valency permits, two of the bonds between adjacent R₁₂ to R₁₆ are double bonds, and three of the bonds between adjacent R₁₂ to R₁₆ are single bonds.

10 In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₄ and R₁₅, are double bonds, and the rest of the bonds in the ring are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between R₁₂ and R₁₆, and between R₁₅ and R₁₅, are double bonds, the rest of
15 the bonds in the ring are single bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments, w in Formula IX is 0, R₁₃, R₁₄, R₁₅, or R₁₆ is O, and, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

20 In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ is O, R₁₂, R₁₄, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

25 In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, and the bonds between adjacent R₁₂ to R₁₆ are single bonds.

In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, R₁₂, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds.

30 In some embodiments, w in Formula IX is 0, R₁₃ and R₁₆ are O, R₁₂, R₁₅ and R₁₆ are C, the bonds between adjacent R₁₂ to R₁₆ are single bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, X_b is absent, p is 1, q is 0, and each R₁₉ is hydrogen.

In some embodiments R₃₀ of Formula X is Si, and X_g is alkynyl.

In some embodiments R₃₀ of Formula X is Si, X_g is ethynyl, and R₂₉ is alkylene.

In some embodiments R₃₀ of Formula X is Si, X_g is ethynyl, R₂₉ is methylene, and R₃₁, R₃₂, and R₃₃ are alkyl.

In some embodiments R_{30} of Formula X is Si, X_g is ethynyl, R_{29} is methylene, and R_{31} , R_{32} , and R_{33} are methyl.

In preferred embodiments, the surface or a surface of the product described herein, is covalently modified.

5 In some embodiments the modified product is singularly modified. In specific embodiments, the singularly modified product contains one or more covalent modifications defined by Formula I, wherein R_1 includes an azide group, an alkyne group, or a 1,2,3-triazole ring.

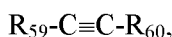
10 In some embodiments, the surface or a surface of the product is modified with a compound that contains an azide group. The azide group is further reacted with a second molecule containing a terminal or internal alkyne. Upon reaction, the azide and the alkyne groups undergo an intramolecular 1,3-dipolar cycloaddition reaction forming a 1,2,3-triazole ring, coupling the second molecule to the modified surface.

15 In alternative embodiments, the surface or a surface of the product is modified with a compound that contains an alkyne group. The alkyne group is further reacted with a second molecule containing an azide group. Upon reaction, the azide and the alkyne groups undergo an intramolecular 1,3-dipolar cycloaddition reaction forming a 1,2,3-triazole ring, coupling the second molecule to the modified surface.

20 Examples of the azide-containing compounds include $X_c-R_w-N_3$, where X_c is absent, -OH, -SH, or -NH₂ and R_w is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

25 Alkynes for use as reagents in 1,3-dipolar cycloaddition reactions include alkynes having side groups corresponding to of the moieties described herein for any of the organic groups, R groups, and substituents. For example, the alkynes can have side groups corresponding to of the moieties described herein for R_4 and R_5 .

In some embodiments, alkynes for use as reagents in 1,3-dipolar cycloaddition reactions can be



30 Formula XIII

wherein R_{59} and R_{60} are independently hydrogen, or an organic grouping containing any number of carbon atoms, 1-30 carbon atoms, 1-20 carbon atoms, or 1-14 carbon atoms, and optionally including one or more heteroatoms such as oxygen, sulfur, or nitrogen grouping in linear, branched, or cyclic structural formats, representative R_{59}

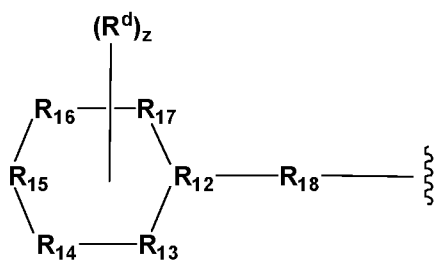
and R₆₀ organic groupings being those present in U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃).

In some embodiments, R₅₉ and R₆₀ are independently hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃).

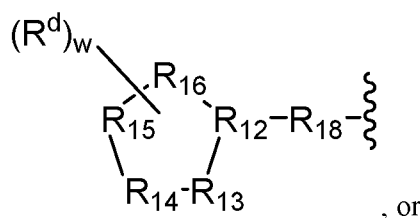
In some embodiments, R₅₉ and R₆₀ are independently hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₁.

In some embodiments, R₅₉ and R₆₀ are independently hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₂.

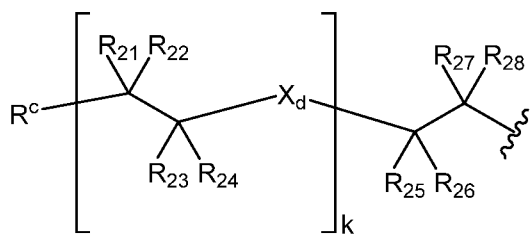
In some embodiments, R₅₉ and R₆₀ are independently,



Formula VI



Formula IX



Formula VIII

wherein z is an integer from 0-11; wherein w is an integer from 0-9; wherein k is an integer from 0 to 20;

wherein R^d are independently absent, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are
 5 attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein X_d are independently absent, O, or S;

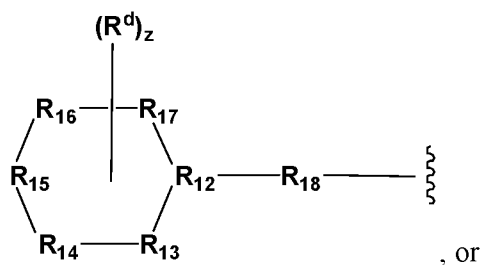
wherein R^c is absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$);
 10

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to
 15 valency; and

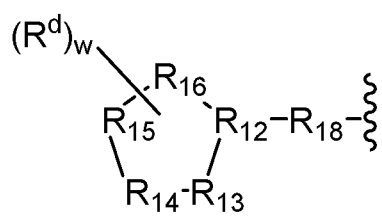
wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these
 20 embodiments, $U_1 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

25 In some embodiments, R_{59} and R_{60} are independently,



Formula VI



Formula IX

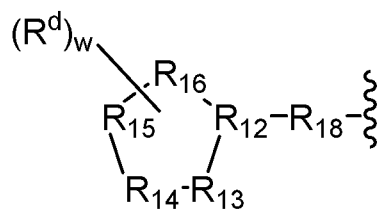
wherein z is an integer from 0-11; wherein w is an integer from 0-9;

- 5 wherein R^d are independently absent, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or
- 10 heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and

- 15 wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$
- 20 (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, R_{59} and R_{60} are independently,



Formula IX

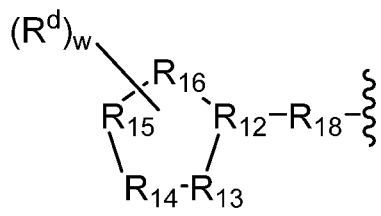
- 25 wherein w is an integer from 0-9;

wherein R^d are independently absent, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency;

and wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-$ $(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, R_{59} and R_{60} are independently,



Formula IX

20

wherein w is an integer from 0-9;

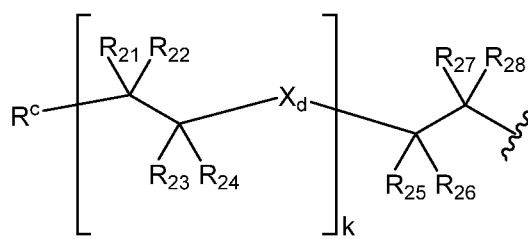
wherein R^d are independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring;

wherein R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are independently C or N, wherein the bonds between adjacent R_{12} to R_{16} are double or single according to valency, wherein one, two, three, or four of R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} are N and the others are C, and wherein R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency; and

30

wherein R_{18} are independently absent, $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-$
 $(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is
absent, $-O-$, $-S-$, $-S(O)-$, $-S(O)_2-$, or NR_{20} , wherein each R_{19} is, as valency permits,
independently absent, hydrogen, $=O$, $=S$, $-OH$, $-SH$, or $-NR_{20}$, wherein R_{20} is U_1 , $U_1 +$
5 Q_1 , $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$
(preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, R_{59} and R_{60} are independently,



10

Formula VIII

wherein k is an integer from 0 to 20;

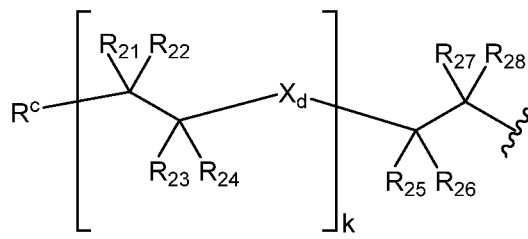
wherein X_d are independently absent, O , or S ;

wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$,
 $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1$
15 $+ Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these
embodiments, $U_3 + Q_1 + Q_3$); and

wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently R^b , hydrogen,
 U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 +$
 $Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

20

In some embodiments, R_{59} and R_{60} are independently,



Formula VIII

wherein k is an integer from 1 to 20;

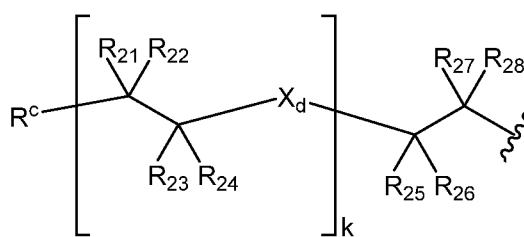
25

wherein X_d are independently O or S ;

wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 5 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, R_{59} and R_{60} are independently,



10

Formula VIII

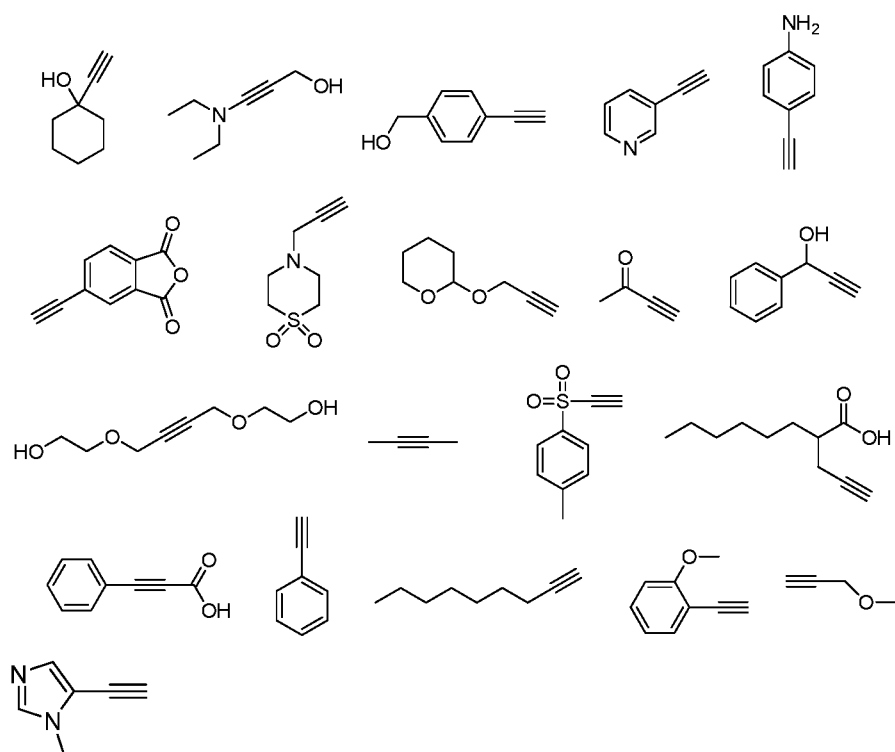
wherein k is an integer from 1 to 20;

wherein X_d are O;

- 15 wherein R^c is R^b , absent, hydrogen, U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); and

- 20 wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} are independently R^b , hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

- In some embodiments of R_6 , R_7 , R_8 , R_9 , R_{10} , R_{11} , R_{20} , R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} , R_{29} , R_{30} , R_{31} , R_{32} , R_{33} , R_{59} , R_{60} , R^a , R^c , R^d , R^e , R_w , R_x , R_z , X_g , $-A-B(-C)_\delta$, and $-B(-C)_\delta$, and independently in combination with any embodiments of any other relevant substituent classes, R_6 , R_7 , R_8 , R_9 , R_{10} , R_{11} , R_{20} , R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} , R_{29} , R_{30} , R_{31} , R_{32} , R_{33} , R_{59} , R_{60} , R^a , R^c , R^d , R^e , R_w , R_x , R_z , X_g , $-A-B(-C)_\delta$, and $-B(-C)_\delta$ can be, independently, absent, hydrogen, $U_1 + Q_1 + Q_2 + Q_3$, $U_1 + Q_5$, $U_1 + Q_1 + Q_5$, $U_1 + Q_2 + Q_5$, $U_1 + Q_3 + Q_5$, $U_1 + Q_1 + Q_2 + Q_5$, $U_1 + Q_1 + Q_3 + Q_5$, $U_1 + Q_2 + Q_3 + Q_5$, or $U_1 + Q_1 + Q_2 + Q_3 + Q_5$.
- 25



In alternative embodiments, the modified product is multiply modified. In preferred embodiments, the multiply modified product is covalently modified with a first species or type of a compound defined by Formula I, and also covalently modified with a second different species or type of compound by Formula I. In other embodiments, the multiply modified product is covalently modified with three or more different types of compounds defined by Formula I.

In some embodiments, the multiply product contains two different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in both species X is NR_2 .

In some embodiments, the multiply product contains two different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in both species X is oxygen.

In some embodiments, the multiply product contains two different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in both species X is sulfur.

In some embodiments, the multiply modified product contains two different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in one species X is oxygen, and in the second species X is NR_2 or sulfur.

In some embodiments, the multiply modified product contains two different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in one species X is sulfur, and in the second species X is NR₂.

5 In some embodiments, the multiply modified product contains three different species of compounds defined by Formula I, which covalently modify a surface of the product, wherein in the first species X is oxygen, in the second species X is sulfur, and in the third species X is NR₂.

10 In some embodiments, the multiply modified product contains two different species of compounds defined by Formula I, wherein in at least one of the species of compounds, R₁ includes one or more cyclic moieties. In preferred embodiments, the multiply modified product contains two different species of covalent modifications defined by Formula I, wherein in one or more sites of chemical modification, R₁ includes a phenyl ring, furan ring, oxolane ring, dioxolane ring, or a 1,2,3-triazole ring.

15 In certain embodiments, the multiply modified product contains two different species of compounds defined by Formula I, wherein in one or more sites of chemical modification, R₁ includes one or more halogen moieties, an azide group, or an alkyne.

In some embodiments, R₁ through R₅, R^a, R^b, R^c, R^d and R^e are independently hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₁.

20 In some embodiments, R₁ through R₅, R^a, R^b, R^c, R^d and R^e are independently hydrogen, amino, hydroxyl, thiol, oxo, phosphate, or J₂.

In some embodiments, **-A-B(-C)_δ**, **-B(-C)_δ**, **A, B, C**, R₁, R₂, R₃, R₄, R₅, R₆, R₇, R₈, R₉, R₁₀, R₁₁, R₅₉, R₆₀, R^a, R^c, R^d, and R^e are independently -R_h-(R_g)_j-R_f, wherein R_h is absent, C(R₃₉R₄₀), O, S, S(O)₂, S(O)₃, or NR₄₁; wherein each R_g is independently absent (i.e., j is 0), C(R₄₂R₄₃), O, S, S(O)₂, S(O)₃, or NR₄₄; and wherein R_f is hydrogen, 25 C(R₄₅R₄₆R₄₇), OH, SH, S(O)₂, S(O)₃, Si(R₁₀₀R₁₀₁R₁₀₂), or NR₄₈R₄₉R₅₀;

wherein j is an integer from 0 to 30,

wherein R₃₉, R₄₀, R₄₁, R₄₂, R₄₃, and R₄₄ are each independently, as valency permits, absent, hydrogen, =O, -OR₅₁, -SR₅₂, -NR₅₃R₅₄R₅₅, -C(R₅₆R₅₇R₅₈), or -R_{hx}-(R_{gx})_{jx}-R_{fx},

30 wherein R₄₅, R₄₆, R₄₇, R₄₈, R₄₉, R₅₀, R₅₁, R₅₂, R₅₃, R₅₄, R₅₅, R₅₆, R₅₇, and R₅₈ are each independently, as valency permits, absent, hydrogen, fluorine, -OH, =O, -SH, =NH, -NH₂, -NH₃, -CH₃, or -COOH,

wherein R₁₀₀, R₁₀₁, and R₁₀₂ are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic,

wherein the bond between R_h and R_g , if present, is single, double, or triple depending on the valency, wherein the bond between R_g and R_f , if present, is single, double, or triple depending on the valency, wherein the bond between each adjacent R_g is single, double, or triple depending on the valency, wherein the bond between R_h and R_f , if present, is single, double, or triple depending on the valency; wherein when R_h is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_h and R_g is not a double or triple bond; wherein when R_h is NR_{41} , the bond between R_h and R_g is not a triple bond; wherein when R_g is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_g and R_h is not a double or triple bond; wherein when R_h is NR_{44} , the bond between R_g and R_h is not a triple bond; wherein when R_g is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_g and R_f is not a double or triple bond; wherein when R_g is NR_{44} , the bond between R_g and R_f is not a triple bond; wherein when R_h is O, R_g is not O, S, or NR_{44} , and vice versa; wherein when R_h is S, R_g is not O, $S(O)_2$, $S(O)_3$, or NR_{44} , and vice versa; wherein when R_h is $S(O)_2$, R_g is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_h is $S(O)_3$, R_g is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_h is NR_{41} , R_g is not O, or S, and vice versa; wherein when R_g is O, R_f is not OH, SH, or $NR_{48}R_{49}R_{50}$, and vice versa; wherein when R_g is S, R_f is not OH, SH, $S(O)_2$ or $NR_{48}R_{49}R_{50}$, and vice versa; wherein when R_g is $S(O)_2$, R_f is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_g is $S(O)_3$, R_f is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; and wherein when R_g is NR_{44} , R_f is not OH, SH, or $S(O)_2$, and vice versa;

wherein each R_{hx} is independently absent, $C(R_{39x}R_{40x})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{41x} ; wherein each R_{gx} is independently absent (i.e., jx is 0), $C(R_{42x}R_{43x})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{44x} ; and wherein each R_{fx} is independently hydrogen, $C(R_{45x}R_{46x}R_{47x})$, OH, SH, $S(O)_2$, $S(O)_3$, $Si(R_{100x}R_{101x}R_{102x})$, or $NR_{48x}R_{49x}R_{50x}$;

wherein jx is an integer from 0 to 20,

wherein R_{39x} , R_{40x} , R_{41x} , R_{42x} , R_{43x} , and R_{44x} are each independently, as valency permits, absent, hydrogen, $=O$, $-OR_{51x}$, $-SR_{52x}$, $-NR_{53x}R_{54x}R_{55x}$, $-C(R_{56x}R_{57x}R_{58x})$, or $-R_{hy}-(R_{gy})_{jy}-R_{fy}$,

wherein R_{45x} , R_{46x} , R_{47x} , R_{48x} , R_{49x} , R_{50x} , R_{51x} , R_{52x} , R_{53x} , R_{54x} , R_{55x} , R_{56x} , R_{57x} , and R_{58x} are each independently, as valency permits, absent, hydrogen, $-OH$, $=O$, $-SH$, $=NH$, $-NH_2$, $-NH_3$, $-CH_3$, or $-COOH$,

wherein R_{100x} , R_{101x} , and R_{102x} are each independently alkyl, phenyl, aryl, or C_3 - C_{20} cyclic,

wherein the bond between each R_{hx} and each respective R_{gx} , if present, is single, double, or triple depending on the valency, wherein the bond between each R_{gx} and each

respective R_{fx} , if present, is single, double, or triple depending on the valency, wherein the bond between each adjacent R_{gx} is single, double, or triple depending on the valency, wherein the bond between each R_{hx} and each respective R_{fx} , if present, is single, double, or triple depending on the valency; wherein when R_{hx} is O, S, $S(O)_2$, or $S(O)_3$, the bond
5 between R_{hx} and R_{gx} is not a double or triple bond; wherein when R_{hx} is NR_{41x} , the bond between R_{hx} and R_{gx} is not a triple bond; wherein when R_{gx} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gx} and R_{hx} is not a double or triple bond; wherein when R_{hx} is NR_{44x} , the bond between R_{gx} and R_{hx} is not a triple bond; wherein when R_{gx} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gx} and R_{fx} is not a double or triple bond; wherein when R_{gx} is NR_{44x} ,
10 the bond between R_{gx} and R_{fx} is not a triple bond; wherein when R_{hx} is O, R_{gx} is not O, S, or NR_{44x} , and vice versa; wherein when R_{hx} is S, R_{gx} is not O, $S(O)_2$, $S(O)_3$, or NR_{44x} , and vice versa; wherein when R_{hx} is $S(O)_2$, R_{gx} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hx} is $S(O)_3$, R_{gx} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hx} is NR_{41x} , R_{gx} is not O, or S, and vice versa; wherein when R_{gx} is O, R_{fx} is not OH, SH, or $NR_{48x}R_{49x}R_{50x}$, and vice versa; wherein when R_{gx} is S, R_{fx} is not OH, SH, $S(O)_2$ or $NR_{48x}R_{49x}R_{50x}$, and vice versa; wherein when R_{gx} is $S(O)_2$, R_{fx} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{gx} is $S(O)_3$, R_{fx} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; and wherein when R_{gx} is NR_{44x} , R_{fx} is not OH, SH, or $S(O)_2$, and vice versa;

wherein each R_{hy} is independently absent, $C(R_{39y}R_{40y})$, O, S, $S(O)_2$, $S(O)_3$, or
20 NR_{41y} ; wherein each R_{gy} is independently absent (i.e., jy is 0), $C(R_{42y}R_{43y})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{44y} ; and wherein each R_{fy} is independently hydrogen, $C(R_{45y}R_{46y}R_{47y})$, OH, SH, $S(O)_2$, $S(O)_3$, $Si(R_{100y}R_{101y}R_{102y})$, or $NR_{48y}R_{49y}R_{50y}$;

wherein jy is an integer from 0 to 10,

wherein R_{39y} , R_{40y} , R_{41y} , R_{42y} , R_{43y} , and R_{44y} are each independently, as valency
25 permits, absent, hydrogen, $=O$, $-OR_{51y}$, $-SR_{52y}$, $-NR_{53y}R_{54y}R_{55y}$, $-C(R_{56y}R_{57y}R_{58y})$, or $-R_{hz}-$
 $(R_{gz})_{jz}-R_{fz}$,

wherein R_{45y} , R_{46y} , R_{47y} , R_{48y} , R_{49y} , R_{50y} , R_{51y} , R_{52y} , R_{53y} , R_{54y} , R_{55y} , R_{56y} , R_{57y} ,
and R_{58y} are each independently, as valency permits, absent, hydrogen, $-OH$, $=O$, $-SH$,
 $=NH$, $-NH_2$, $-NH_3$, $-CH_3$, or $-COOH$,

30 wherein R_{100y} , R_{101y} , and R_{102y} are each independently alkyl, phenyl, aryl, or C_3 -
 C_{20} cyclic,

wherein the bond between each R_{hy} and each respective R_{gy} , if present, is single, double, or triple depending on the valency, wherein the bond between each R_{gy} and each respective R_{fy} , if present, is single, double, or triple depending on the valency, wherein

the bond between each adjacent R_{gy} is single, double, or triple depending on the valency, wherein the bond between each R_{hy} and each respective R_{fy} , if present, is single, double, or triple depending on the valency; wherein when R_{hy} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{hy} and R_{gy} is not a double or triple bond; wherein when R_{hy} is NR_{41y} , the bond between R_{hy} and R_{gy} is not a triple bond; wherein when R_{gy} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gy} and R_{hy} is not a double or triple bond; wherein when R_{hy} is NR_{44y} , the bond between R_{gy} and R_{hy} is not a triple bond; wherein when R_{gy} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gy} and R_{fy} is not a double or triple bond; wherein when R_{gy} is NR_{44y} , the bond between R_{gy} and R_{fy} is not a triple bond; wherein when R_{hy} is O, R_{gy} is not O, S, or NR_{44y} , and vice versa; wherein when R_{hy} is S, R_{gy} is not O, $S(O)_2$, $S(O)_3$, or NR_{44y} , and vice versa; wherein when R_{hy} is $S(O)_2$, R_{gy} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hy} is $S(O)_3$, R_{gy} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hy} is NR_{41y} , R_{gy} is not O, or S, and vice versa; wherein when R_{gy} is O, R_{fy} is not OH, SH, or $NR_{48y}R_{49y}R_{50y}$, and vice versa; wherein when R_{gy} is S, R_{fy} is not OH, SH, $S(O)_2$ or $NR_{48y}R_{49y}R_{50y}$, and vice versa; wherein when R_{gy} is $S(O)_2$, R_{fy} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{gy} is $S(O)_3$, R_{fy} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; and wherein when R_{gy} is NR_{44y} , R_{fy} is not OH, SH, or $S(O)_2$, and vice versa;

wherein each R_{hz} is independently absent, $C(R_{39z}R_{40z})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{41z} ; wherein each R_{gz} is independently absent (i.e., jz is 0), $C(R_{42z}R_{43z})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{44z} ; and wherein each R_{fz} is independently hydrogen, $C(R_{45z}R_{46z}R_{47z})$, OH, SH, $S(O)_2$, $S(O)_3$, $Si(R_{100z}R_{101z}R_{102z})$, or $NR_{48z}R_{49z}R_{50z}$;

wherein jz is an integer from 0 to 6,

wherein R_{39z} , R_{40z} , R_{41z} , R_{42z} , R_{43z} , and R_{44z} are each independently, as valency permits, absent, hydrogen, =O, $-OR_{51z}$, $-SR_{52z}$, $-NR_{53z}R_{54z}R_{55z}$, or $-C(R_{56z}R_{57z}R_{58z})$,

wherein R_{45z} , R_{46z} , R_{47z} , R_{48z} , R_{49z} , R_{50z} , R_{51z} , R_{52z} , R_{53z} , R_{54z} , R_{55z} , R_{56z} , R_{57z} , and R_{58z} are each independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =NH, $-NH_2$, $-NH_3$, $-CH_3$, or $-COOH$,

wherein R_{100z} , R_{101z} , and R_{102z} are each independently alkyl, phenyl, aryl, or C_3 - C_{20} cyclic,

wherein the bond between each R_{hz} and each respective R_{gz} , if present, is single, double, or triple depending on the valency, wherein the bond between each R_{gz} and each respective R_{fz} , if present, is single, double, or triple depending on the valency, wherein the bond between each adjacent R_{gz} is single, double, or triple depending on the valency, wherein the bond between each R_{hz} and each respective R_{fz} , if present, is single, double,

or triple depending on the valency; wherein when R_{hz} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{hz} and R_{gz} is not a double or triple bond; wherein when R_{hz} is NR_{41z} , the bond between R_{hz} and R_{gz} is not a triple bond; wherein when R_{gz} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gz} and R_{hz} is not a double or triple bond; wherein when R_{hz} is NR_{44z} , the bond between R_{gz} and R_{hz} is not a triple bond; wherein when R_{gz} is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_{gz} and R_{fz} is not a double or triple bond; wherein when R_{gz} is NR_{44z} , the bond between R_{gz} and R_{fz} is not a triple bond; wherein when R_{hz} is O, R_{gz} is not O, S, or NR_{44z} , and vice versa; wherein when R_{hz} is S, R_{gz} is not O, $S(O)_2$, $S(O)_3$, or NR_{44z} , and vice versa; wherein when R_{hz} is $S(O)_2$, R_{gz} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hz} is $S(O)_3$, R_{gz} is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{hz} is NR_{41z} , R_{gz} is not O, or S, and vice versa; wherein when R_{gz} is O, R_{fz} is not OH, SH, or $NR_{48z}R_{49z}R_{50z}$, and vice versa; wherein when R_{gz} is S, R_{fz} is not OH, SH, $S(O)_2$ or $NR_{48z}R_{49z}R_{50z}$, and vice versa; wherein when R_{gz} is $S(O)_2$, R_{fz} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_{gz} is $S(O)_3$, R_{fz} is not SH, $S(O)_2$, or $S(O)_3$, and vice versa; and wherein when R_{gz} is NR_{44z} , R_{fz} is not OH, SH, or $S(O)_2$, and vice versa.

Independently in some embodiments of j, and independently in combination with any embodiments of any other relevant substituent classes, j can be an integer from 1 to 30, 2 to 30, 3 to 30, 4 to 30, 5 to 30, 6 to 30, 7 to 30, 8 to 30, 9 to 30, 10 to 30, 11 to 30, 12 to 30, 13 to 30, 14 to 30, 15 to 30, 16 to 30, 17 to 30, 18 to 30, 19 to 30, 20 to 30, 21 to 30, 22 to 30, 23 to 30, 24 to 30, 25 to 30, 26 to 30, 27 to 30, 28 to 30, 29 to 30, 1 to 29, 2 to 29, 3 to 29, 4 to 29, 5 to 29, 6 to 29, 7 to 29, 8 to 29, 9 to 29, 10 to 29, 11 to 29, 12 to 29, 13 to 29, 14 to 29, 15 to 29, 16 to 29, 17 to 29, 18 to 29, 19 to 29, 20 to 29, 21 to 29, 22 to 29, 23 to 29, 24 to 29, 25 to 29, 26 to 29, 27 to 29, 28 to 29, 1 to 28, 2 to 28, 3 to 28, 4 to 28, 5 to 28, 6 to 28, 7 to 28, 8 to 28, 9 to 28, 10 to 28, 11 to 28, 12 to 28, 13 to 28, 14 to 28, 15 to 28, 16 to 28, 17 to 28, 18 to 28, 19 to 28, 20 to 28, 21 to 28, 22 to 28, 23 to 28, 24 to 28, 25 to 28, 26 to 28, 27 to 28, 1 to 27, 2 to 27, 3 to 27, 4 to 27, 5 to 27, 6 to 27, 7 to 27, 8 to 27, 9 to 27, 10 to 27, 11 to 27, 12 to 27, 13 to 27, 14 to 27, 15 to 27, 16 to 27, 17 to 27, 18 to 27, 19 to 27, 20 to 27, 21 to 27, 22 to 27, 23 to 27, 24 to 27, 25 to 27, 26 to 27, 1 to 26, 2 to 26, 3 to 26, 4 to 26, 5 to 26, 6 to 26, 7 to 26, 8 to 26, 9 to 26, 10 to 26, 11 to 26, 12 to 26, 13 to 26, 14 to 26, 15 to 26, 16 to 26, 17 to 26, 18 to 26, 19 to 26, 20 to 26, 21 to 26, 22 to 26, 23 to 26, 24 to 26, 25 to 26, 1 to 25, 2 to 25, 3 to 25, 4 to 25, 5 to 25, 6 to 25, 7 to 25, 8 to 25, 9 to 25, 10 to 25, 11 to 25, 12 to 25, 13 to 25, 14 to 25, 15 to 25, 16 to 25, 17 to 25, 18 to 25, 19 to 25, 20 to 25, 21 to 25, 22 to 25, 23 to 25, 24 to 25, 1 to 24, 2 to 24, 3 to 24, 4 to 24, 5 to 24, 6 to 24, 7 to 24, 8 to 24, 9 to 24, 10

to 24, 11 to 24, 12 to 24, 13 to 24, 14 to 24, 15 to 24, 16 to 24, 17 to 24, 18 to 24, 19 to 24, 20 to 24, 21 to 24, 22 to 24, 23 to 24, 1 to 23, 2 to 23, 3 to 23, 4 to 23, 5 to 23, 6 to 23, 7 to 23, 8 to 23, 9 to 23, 10 to 23, 11 to 23, 12 to 23, 13 to 23, 14 to 23, 15 to 23, 16 to 23, 17 to 23, 18 to 23, 19 to 23, 20 to 23, 21 to 23, 22 to 23, 1 to 22, 2 to 22, 3 to 22, 4 to 22, 5 to 22, 6 to 22, 7 to 22, 8 to 22, 9 to 22, 10 to 22, 11 to 22, 12 to 22, 13 to 22, 14 to 22, 15 to 22, 16 to 22, 17 to 22, 18 to 22, 19 to 22, 20 to 22, 21 to 22, 1 to 21, 2 to 21, 3 to 21, 4 to 21, 5 to 21, 6 to 21, 7 to 21, 8 to 21, 9 to 21, 10 to 21, 11 to 21, 12 to 21, 13 to 21, 14 to 21, 15 to 21, 16 to 21, 17 to 21, 18 to 21, 19 to 21, 20 to 21, 1 to 20, 2 to 20, 3 to 20, 4 to 20, 5 to 20, 6 to 20, 7 to 20, 8 to 20, 9 to 20, 10 to 20, 11 to 20, 12 to 20, 13 to 20, 14 to 20, 15 to 20, 16 to 20, 17 to 20, 18 to 20, 19 to 20, 1 to 19, 2 to 19, 3 to 19, 4 to 19, 5 to 19, 6 to 19, 7 to 19, 8 to 19, 9 to 19, 10 to 19, 11 to 19, 12 to 19, 13 to 19, 14 to 19, 15 to 19, 16 to 19, 17 to 19, 18 to 19, 1 to 18, 2 to 18, 3 to 18, 4 to 18, 5 to 18, 6 to 18, 7 to 18, 8 to 18, 9 to 18, 10 to 18, 11 to 18, 12 to 18, 13 to 18, 14 to 18, 15 to 18, 16 to 18, 17 to 18, 1 to 17, 2 to 17, 3 to 17, 4 to 17, 5 to 17, 6 to 17, 7 to 17, 8 to 17, 9 to 17, 10 to 17, 11 to 17, 12 to 17, 13 to 17, 14 to 17, 15 to 17, 16 to 17, 1 to 16, 2 to 16, 3 to 16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 1 to 15, 2 to 15, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 1 to 14, 2 to 14, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 1 to 13, 2 to 13, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, j is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, or 30.

Independently in some embodiments of j, and independently in combination with any embodiments of any other relevant substituent classes, j can be an integer from 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some

embodiments of j , and independently in combination with any embodiments of any other relevant substituent classes, j can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of j , and independently in combination with any embodiments of any other relevant substituent classes, j can be an integer from 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred embodiments, j is 1, 2, 3, 4, or 5.

Independently in some embodiments of jx , and independently in combination with any embodiments of any other relevant substituent classes, jx can be an integer from 1 to 20, 2 to 20, 3 to 20, 4 to 20, 5 to 20, 6 to 20, 7 to 20, 8 to 20, 9 to 20, 10 to 20, 11 to 20, 12 to 20, 13 to 20, 14 to 20, 15 to 20, 16 to 20, 17 to 20, 18 to 20, 19 to 20, 1 to 19, 2 to 19, 3 to 19, 4 to 19, 5 to 19, 6 to 19, 7 to 19, 8 to 19, 9 to 19, 10 to 19, 11 to 19, 12 to 19, 13 to 19, 14 to 19, 15 to 19, 16 to 19, 17 to 19, 18 to 19, 1 to 18, 2 to 18, 3 to 18, 4 to 18, 5 to 18, 6 to 18, 7 to 18, 8 to 18, 9 to 18, 10 to 18, 11 to 18, 12 to 18, 13 to 18, 14 to 18, 15 to 18, 16 to 18, 17 to 18, 1 to 17, 2 to 17, 3 to 17, 4 to 17, 5 to 17, 6 to 17, 7 to 17, 8 to 17, 9 to 17, 10 to 17, 11 to 17, 12 to 17, 13 to 17, 14 to 17, 15 to 17, 16 to 17, 1 to 16, 2 to 16, 3 to 16, 4 to 16, 5 to 16, 6 to 16, 7 to 16, 8 to 16, 9 to 16, 10 to 16, 11 to 16, 12 to 16, 13 to 16, 14 to 16, 15 to 16, 1 to 15, 2 to 15, 3 to 15, 4 to 15, 5 to 15, 6 to 15, 7 to 15, 8 to 15, 9 to 15, 10 to 15, 11 to 15, 12 to 15, 13 to 15, 14 to 15, 1 to 14, 2 to 14, 3 to 14, 4 to 14, 5 to 14, 6 to 14, 7 to 14, 8 to 14, 9 to 14, 10 to 14, 11 to 14, 12 to 14, 13 to 14, 1 to 13, 2 to 13, 3 to 13, 4 to 13, 5 to 13, 6 to 13, 7 to 13, 8 to 13, 9 to 13, 10 to 13, 11 to 13, 12 to 13, 1 to 12, 2 to 12, 3 to 12, 4 to 12, 5 to 12, 6 to 12, 7 to 12, 8 to 12, 9 to 12, 10 to 12, 11 to 12, 1 to 11, 2 to 11, 3 to 11, 4 to 11, 5 to 11, 6 to 11, 7 to 11, 8 to 11, 9 to 11, 10 to 11, 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In some embodiments, jx is 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20.

Independently in some embodiments of jx , and independently in combination with any embodiments of any other relevant substituent classes, jx can be an integer from 1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8, 1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some

embodiments of j_x , and independently in combination with any embodiments of any other relevant substituent classes, j_x can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

Independently in some embodiments of j_x , and independently in combination with any embodiments of any other relevant substituent classes, j_x can be an integer from
5 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred embodiments, j_x is 1, 2, 3, 4, or 5.

Independently in some embodiments of j_y , and independently in combination with any embodiments of any other relevant substituent classes, j_y can be an integer from
1 to 10, 2 to 10, 3 to 10, 4 to 10, 5 to 10, 6 to 10, 7 to 10, 8 to 10, 9 to 10, 1 to 9, 2 to 9, 3
10 to 9, 4 to 9, 5 to 9, 6 to 9, 7 to 9, 8 to 9, 1 to 8, 2 to 8, 3 to 8, 4 to 8, 5 to 8, 6 to 8, 7 to 8,
1 to 7, 2 to 7, 3 to 7, 4 to 7, 5 to 7, 6 to 7, 1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to
5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. Independently in some
embodiments of j_y , and independently in combination with any embodiments of any
other relevant substituent classes, j_y can be 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10.

15 Independently in some embodiments of j_y , and independently in combination with any embodiments of any other relevant substituent classes, j_y can be an integer from
1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to 3, 2 to 3, or 1 to 2. In preferred
embodiments, j_y is 1, 2, 3, 4, or 5.

Independently in some embodiments of j_z , and independently in combination
20 with any embodiments of any other relevant substituent classes, j_z can be an integer from
1 to 6, 2 to 6, 3 to 6, 4 to 6, 5 to 6, 1 to 5, 2 to 5, 3 to 5, 4 to 5, 1 to 4, 2 to 4, 3 to 4, 1 to
3, 2 to 3, or 1 to 2. In preferred embodiments, j_z is 1, 2, 3, 4, or 5.

N1

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon,
25 z is 2, R^d is $-O-CH_3$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are
hydrogen, and p is 1. In some embodiments, R_d is at positions R_{14} and R_{15} .

N2

In some embodiments, R_2 is methyl, in Formula IX, R_{13} and R_{16} are oxygen, R_{12} ,
 R_{14} , and R_{15} are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is -
30 $(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and p is 1.

N3

In some embodiments R_h is absent, j is 3, and each R_g is $C(R_{42}R_{43})$, wherein R_{42}
and R_{43} are hydrogen. In some embodiments R_h is absent, j is 0 to 10, and each R_g is
 $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 3,

each R_g is $C(R_{42}R_{43})$, and R_f is $NR_{48}R_{49}R_{50}$, wherein R_{48} and R_{49} are $-CH_3$, R_{50} is absent, and R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 0 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is $NR_{48}R_{49}R_{50}$, wherein R_{48} and R_{49} are $-CH_3$, R_{50} is absent, and R_{42} and R_{43} are hydrogen. In some embodiments j is 0. In some embodiments j is 1. In some
5 embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some
embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some
embodiments j is 9. In some embodiments j is 10.

N4

In some embodiments, R_2 is methyl, and in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} ,
10 and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, both
 R_{19} are hydrogen, and p is 1.

N5

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon,
 z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and
15 p is 1.

N6

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 11, wherein the first, third, fourth,
sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, eighth, and
eleventh R_g are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

20 In some embodiments R_h is $C(R_{39}R_{40})$, j is 11, and R_f is $C(R_{45}R_{46}R_{47})$, wherein
the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second,
fifth, eighth, and eleventh R_g are O, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are
hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 5, 8, 11, 14, 17, 20, 23, 26, 29, or
25 32, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth,
fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth,
twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are
 $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth,
twenty-third, twenty-sixth, twenty-ninth, and thirty-second R_g , if present, are O, wherein
30 R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 5, 8, 11, 14, 17, 20, 23, 26, 29, or 32,
and R_f is $C(R_{45}R_{46}R_{47})$, wherein the first, third, fourth, sixth, seventh, ninth, tenth,
twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-
second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-

first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, twenty-ninth, and thirty-second R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 11, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, eighth, and eleventh R_g are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 11, and R_f is hydrogen, $C(R_{45}R_{46}R_{47})$, OH, SH, S(O)₂, S(O)₃, Si($R_{100}R_{101}R_{102}$), or NR₄₈R₄₉R₅₀, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, eighth, and eleventh R_g are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 5, 8, 11, 14, 17, 20, 23, 26, 29, or 32, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, twenty-ninth, and thirty-second R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 5, 8, 11, 14, 17, 20, 23, 26, 29, or 32, and R_f is hydrogen, $C(R_{45}R_{46}R_{47})$, OH, SH, S(O)₂, S(O)₃, Si($R_{100}R_{101}R_{102}$), or NR₄₈R₄₉R₅₀, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if

present, are C(R₄₂R₄₃) and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, twenty-ninth, and thirty-second R_g, if present, are O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen, wherein R₄₅, R₄₆, R₄₇, R₄₈, R₄₉, and R₅₀ are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R₁₀₀, R₁₀₁, and R₁₀₂ are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R₁₀₀, R₁₀₁, and R₁₀₂ are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

N7

In some embodiments R₂ is methyl, R_h is NR₄₁, j is 6, and R_g is C(R₄₂R₄₃), wherein R₄₁ is -C(R₅₆R₅₇R₅₈), wherein R₄₂, R₄₃, R₅₆, R₅₇, and R₅₈ are hydrogen. In some embodiments R₂ is methyl, R_h is NR₄₁, j is 1 to 12, and each R_g is C(R₄₂R₄₃), wherein R₄₁ is -C(R₅₆R₅₇R₅₈), wherein R₄₂, R₄₃, R₅₆, R₅₇, and R₅₈ are hydrogen. In some embodiments R₂ is methyl, R_h is NR₄₁, j is 6, R_g is C(R₄₂R₄₃), and R_f is NR₄₈R₄₉R₅₀, wherein R₄₁ is -C(R₅₆R₅₇R₅₈), wherein R₄₂, R₄₃, R₄₉, R₅₆, R₅₇, and R₅₈ are hydrogen, R₄₈ is -CH₃, and R₅₀ is absent. In some embodiments R₂ is methyl, R_h is NR₄₁, j is 1 to 12, each R_g is C(R₄₂R₄₃), and R_f is NR₄₈R₄₉R₅₀, wherein R₄₁ is -C(R₅₆R₅₇R₅₈), wherein R₄₂, R₄₃, R₄₉, R₅₆, R₅₇, and R₅₈ are hydrogen, R₄₈ is -CH₃, and R₅₀ is absent. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10. In some embodiments j is 11. In some embodiments j is 12. In some embodiments R₂ is hydrogen, methyl, ethyl, or butyl.

N8

In some embodiments R_h is C(R₃₉R₄₀), j is 4, the first, third, and fourth R_g are C(R₄₂R₄₃), and the second R_g is O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen. In some embodiments R_h is C(R₃₉R₄₀), j is 4, the first, third, and fourth R_g are C(R₄₂R₄₃), the second R_g is O, and R_f is OH, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

In some embodiments R_h is C(R₃₉R₄₀), j is 1, 4, 7, 10, 13, or 16, the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, and sixteenth R_g, if present, are C(R₄₂R₄₃), and the second, fifth, eighth, eleventh, and fourteenth R_g, if present, are O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

In some embodiments R_h is C(R₃₉R₄₀), j is 1, 4, 7, 10, 13, or 16, the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, and sixteenth R_g, if present, are C(R₄₂R₄₃), the second, fifth, eighth, eleventh, and fourteenth R_g, if present, are O, and R_f is OH, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

- In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 16, one R_g is O, and the other R_g are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some embodiments the fourth R_g is O. In some embodiments the fifth R_g is O.
- 5 In some embodiments the sixth R_g is O. In some embodiments the fifth from the last R_g is O. In some embodiments the fourth from the last R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments the penultimate R_g is not O. In some embodiments the last R_g is not O. In some embodiments neither the penultimate R_g nor the last R_g is O.
- 10 In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 16, one R_g is O, the other R_g are $C(R_{42}R_{43})$, and R_f is OH, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some embodiments the fourth R_g is O. In some embodiments the fifth R_g is O. In some embodiments the sixth R_g is O. In some
- 15 embodiments the fifth from the last R_g is O. In some embodiments the fourth from the last R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments the penultimate R_g is not O. In some embodiments the last R_g is not O. In some embodiments neither the penultimate R_g nor the last R_g is O.

N9

- 20 In some embodiments R_2 is methyl, R_h is NR_{41} , j is 4, and R_g is $C(R_{42}R_{43})$, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen.
- In some embodiments R_2 is methyl, R_h is NR_{41} , j is 4, R_g is $C(R_{42}R_{43})$, and R_f is
- 25 OH, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen.
- In some embodiments R_2 is methyl, R_h is NR_{41} , j is 0 to 10, and R_g is $C(R_{42}R_{43})$, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein R_{hx} is
- 30 $C(R_{39x}R_{40x})$, $jx = 0$ to 10, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiments R_2 is methyl, R_h is NR_{41} , j is 0 to 10, R_g is $C(R_{42}R_{43})$, and R_f is OH, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$ to 10, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiment j is 0. In some embodiments j is

1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 6. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10. In some embodiment jx is 0. In some embodiments jx is 1. In some embodiment jx is 2. In some embodiments jx is 3. In some embodiment jx is 4. In some embodiments jx is 5. In some embodiments jx is 6. In some embodiments jx is 7. In some embodiment jx is 8. In some embodiments jx is 9. In some embodiments jx is 10. In some embodiments $j = jx$. In some embodiments $j = jx + 4$. In some embodiments $j = 2 * jx$. In some embodiments R_2 is hydrogen, methyl, ethyl, or butyl.

10 In some embodiments R_2 is methyl, R_h is NR_{41} , j is 0 to 10, and R_g is $C(R_{42}R_{43})$, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$ to 10, and R_{fx} is hydrogen, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiments R_2 is methyl, R_h is NR_{41} , j is 0 to 10, R_g is $C(R_{42}R_{43})$, and R_f is OH, wherein NR_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$ and R_{42} and R_{43} are hydrogen, wherein

15 R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$ to 10, and R_{fx} is hydrogen, and wherein R_{39x} , R_{40x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiment j is 0. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 6. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10. In some embodiment jx is 0. In some embodiments jx is 1. In some embodiment jx is 2. In some embodiments jx is 3. In some embodiment jx is 4. In some embodiments jx is 5. In some embodiments jx is 6. In some embodiments jx is 7. In some embodiment jx is 8. In some embodiments jx is 9. In some embodiments jx is 10. In some embodiments $j = jx$. In some embodiments $j = jx + 4$. In some embodiments $j = 2 * jx$. In some embodiments R_2

20 is hydrogen, methyl, ethyl, or butyl.

25

O1

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and p is 1.

30 O3

In some embodiments, in Formula IX, R_{13} is oxygen, R_{12} , R_{14} , R_{15} , and R_{16} are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and p is 1.

O4

In some embodiments, R_h is $C(R_{39}R_{40})$, j is 0, R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{45} , R_{46} , and R_{47} are fluorine, wherein R_{39} and R_{40} are hydrogen. In some embodiments, j is an integer from 0 to 5, wherein each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen.

5 In some embodiments, j is 1. In some embodiments, j is 2. In some embodiments, j is 3. In some embodiments, j is 4. In some embodiments, j is 5.

O5

In some embodiments R_h is $C(R_{39}R_{40})$, j is 2, and R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are absent and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2, R_g is $C(R_{42}R_{43})$, and R_f is hydrogen, wherein R_{42} and R_{43} are absent and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2 to 12, and R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are absent on one pair of adjacent R_g , R_{42} and R_{43} are hydrogen on the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2 to 12, R_g is $C(R_{42}R_{43})$, and R_f is hydrogen, wherein R_{42} and R_{43} are absent on one pair of adjacent R_g , R_{42} and R_{43} are hydrogen on the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_{42} and R_{43} are absent on the first and second R_g . In some embodiments R_{42} and R_{43} are absent on the second and third R_g . In some embodiments R_{42} and R_{43} are absent on the third and fourth R_g . In some embodiments R_{42} and R_{43} are absent on the fourth and fifth R_g . In some embodiments R_{42} and R_{43} are absent on the fifth and sixth R_g . In some embodiments R_{42} and R_{43} are absent on the sixth and seventh R_g . In some embodiments R_{42} and R_{43} are absent on the seventh and eighth R_g . In some embodiments R_{42} and R_{43} are absent on the eighth and ninth R_g . In some embodiments R_{42} and R_{43} are absent on the ninth and tenth R_g . In some embodiments R_{42} and R_{43} are absent on the tenth and eleventh R_g . In some embodiments R_{42} and R_{43} are absent on the eleventh and twelfth R_g .

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O6

In some embodiments, in Formula IX, R_{13} is oxygen, R_{12} , R_{14} , R_{15} , and R_{16} are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p^-$, both R_{19} are hydrogen, and p is 1.

30 O7 left

In some embodiments, in Formula IX, R_{15} and R_{16} are absent, R_{12} , R_{13} , and R_{14} are carbon, w is 3, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p^-$, and p is 0, wherein each R^d is independently $-CH_3$ or $-CH_2-OH$. In some embodiments, one R^d is $-CH_3$ and two R^d are $-CH_2-OH$. In some embodiments, one R^d is $-CH_2-OH$ and two

R^d are $-CH_3$. In some embodiments, each R^d is $-CH_2-OH$. In some embodiments, each R^d is $-CH_3$. In some embodiments, w is 4. In some embodiments, w is 3. In some embodiments, w is 2. In some embodiments, w is 1. In some embodiments, w is 0.

O7 right

5 In some embodiments, R_h is $C(R_{39}R_{40})$, j is 0, R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments, j is an integer from 0 to 5, wherein each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments, j is 1. In some embodiments, j is 2. In some embodiments, j is 3. In some embodiments, j is 4. In some embodiments, j is 5.

10 **O8**

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0 to 10, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$,
15 j is 0 to 10, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiment j is 0. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 6. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

20 **O9**

In some embodiments R_h is $C(R_{39}R_{40})$, j is 2, and R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are absent and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2 to 12, and R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are absent on one pair of adjacent
25 R_g , R_{42} and R_{43} are hydrogen on the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C_1 - C_6 alkyl, phenyl, aryl, or C_5 - C_6 cyclic. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2, R_g is $C(R_{42}R_{43})$, and R_f is $Si(R_{100}R_{101}R_{102})$, wherein R_{100} , R_{101} , and R_{102} are methyl, R_{42} and R_{43} are absent and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 2 to 12, R_g is $C(R_{42}R_{43})$, and R_f is $Si(R_{100}R_{101}R_{102})$, wherein R_{100} , R_{101} , and R_{102} are each independently
30 alkyl, phenyl, aryl, or C_3 - C_{20} cyclic, R_{42} and R_{43} are absent on one pair of adjacent R_g , R_{42} and R_{43} are hydrogen on the other R_g , and R_{39} and R_{40} are hydrogen.

In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C_1 - C_3 alkyl. In some embodiments R_{42} and R_{43} are absent on the first and second R_g . In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C_1 - C_6 alkyl, phenyl, aryl, or

C₅-C₆ cyclic. In some embodiments, R₁₀₀, R₁₀₁, and R₁₀₂ are each independently C₁-C₃ alkyl.

In some embodiments R₄₂ and R₄₃ are absent on the first and second R_g. In some embodiments R₄₂ and R₄₃ are absent on the second and third R_g. In some embodiments R₄₂ and R₄₃ are absent on the third and fourth R_g. In some embodiments R₄₂ and R₄₃ are absent on the fourth and fifth R_g. In some embodiments R₄₂ and R₄₃ are absent on the fifth and sixth R_g. In some embodiments R₄₂ and R₄₃ are absent on the sixth and seventh R_g. In some embodiments R₄₂ and R₄₃ are absent on the seventh and eighth R_g. In some embodiments R₄₂ and R₄₃ are absent on the eighth and ninth R_g. In some embodiments R₄₂ and R₄₃ are absent on the ninth and tenth R_g. In some embodiments R₄₂ and R₄₃ are absent on the tenth and eleventh R_g. In some embodiments R₄₂ and R₄₃ are absent on the eleventh and twelfth R_g.

O10

In some embodiments R_h is C(R₃₉R₄₀), and j is 0, wherein R₃₉ and R₄₀ are hydrogen. In some embodiments R_h is C(R₃₉R₄₀), and j is 0, wherein R₃₉ and R₄₀ are -C(R₅₆R₅₇R₅₈), and R₅₆, R₅₇, and R₅₈ are hydrogen. In some embodiments R_h is C(R₃₉R₄₀), j is 0, and R_f is hydrogen, wherein R₃₉ and R₄₀ are hydrogen. In some embodiments R_h is C(R₃₉R₄₀), j is 0, and R_f is C(R₄₅R₄₆R₄₇), wherein R₃₉, R₄₀, R₄₅, R₄₆, and R₄₇ are hydrogen. In some embodiments R_h is C(R₃₉R₄₀), j is 0, and R_f is C(R₄₅R₄₆R₄₇), wherein R₃₉ and R₄₀ are -C(R₅₆R₅₇R₅₈), and R₄₅, R₄₆, R₄₇, R₅₆, R₅₇, and R₅₈ are hydrogen.

O11

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is -OH, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, both R₁₉ are hydrogen, and p is 1. In some embodiments, R_d is at position R₁₅.

O12

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is -O-CH₃, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, both R₁₉ are hydrogen, and p is 1. In some embodiments, R_d is at position R₁₅.

Y1

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R_d is hydroxy, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-, and p is 0. In some embodiments, R^d is at R₁₅. In some embodiments, R^d is at R₁₃. In some embodiments, R^d is at R₁₄. In some embodiments, R^d is at R₁₆. In some embodiments, R^d is at R₁₇.

Y2

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is $-O-CH_3$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0.

In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some
5 embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d
is at R_{17} .

Y3

In some embodiments, in Formula IX, R_{13} and R_{14} are oxygen, R_{12} , R_{15} , and R_{16}
are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, both
10 R_{19} are hydrogen, and p is 1.

Y4

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon,
 z is 1, R_d is $-CH_2-OH$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0.
In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some
15 embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d
is at R_{17} .

Y5

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon,
 z is 1, R_d is methyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-X_b-$
20 $(CR_{19}R_{19})_q-$, p is 0, q is 0, and X_b is $S(O)_2$.

Y6 left

In some embodiments R_h is NR_{41} , j is 1, and R_g is $C(R_{42}R_{43})$, wherein R_{41} is $-R_{hx}-$
 $(R_{gx})_{jx}-R_{fx}$, and R_{42} and R_{43} are hydrogen, wherein R_{hx} is absent, $jx = 1$, R_{gx} is
 $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{42x} , R_{43x} , R_{45x} , R_{46x} , R_{47x} are
25 hydrogen. In some embodiments R_h is NR_{41} , j is 1, R_g is $C(R_{42}R_{43})$, and R_f is
 $C(R_{45}R_{46}R_{47})$, wherein R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are
hydrogen, wherein R_{hx} is absent, $jx = 1$, R_{gx} is $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$,
and wherein R_{42x} , R_{43x} , R_{45x} , R_{46x} , R_{47x} are hydrogen.

In some embodiments R_h is NR_{41} , j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein
30 R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$
to 10, R_{gx} is $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{42x} , R_{43x} ,
 R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiments R_h is NR_{41} , j is 0 to 10, each R_g is
 $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} , R_{43} , R_{45} , R_{46} ,
and R_{47} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$ to 10, R_{gx} is $C(R_{42x}R_{43x})$, and

R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{42x} , R_{43x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiments $j = jx$. In some embodiments j and jx are 0. In some embodiment j and jx are 2. In some embodiments j and jx are 3. In some embodiments j and jx are 4.

Y6 right

- 5 In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , R_{43} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0, and R_f is OH, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is OH, wherein R_{39} , R_{40} , R_{42} , R_{43} are hydrogen. In
10 some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiments j is 4.

Y7

- In some embodiments R_h is $C(R_{39}R_{40})$, j is 1, and R_g is O, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is absent, j is 1, and R_g is O. In
15 some embodiments R_h is $C(R_{39}R_{40})$, j is 1, R_g is O, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is absent, j is 1, R_g is O, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{45} , R_{46} , and R_{47} are hydrogen.

- In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, one R_g is O, and the other R_g are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the
20 last R_g is O. In some embodiments the penultimate R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments the fourth from the last R_g is O. In some embodiments the fifth from the last R_g is O. In some embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some embodiments the fourth R_g is O. In some embodiments the fifth R_g is O.

- 25 In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, one R_g is O, the other R_g are $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments the last R_g is O. In some embodiments the penultimate R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments the fourth from the last R_g is O. In some embodiments the fifth from the last R_g is O. In some
30 embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some embodiments the fourth R_g is O. In some embodiments the fifth R_g is O.

Y9 left

In some embodiments, R_4 is $-\text{COOH}$ and in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(\text{CR}_{19}\text{R}_{19})_{p-}$, and p is 0.

5 Y9 right

In some embodiments R_h is $\text{C}(\text{R}_{39}\text{R}_{40})$, and j is 0, wherein R_{39} is $=\text{O}$ and R_{40} is $-\text{OH}$. In some embodiments R_h is absent, j is 0 to 10, and each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 0, and R_f is $\text{C}(\text{R}_{45}\text{R}_{46}\text{R}_{47})$, wherein R_{45} is $=\text{O}$, R_{46} is $-\text{OH}$, and R_{47} is absent. In some embodiments R_h is absent, j is 0 to 10, each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, and R_f is $\text{C}(\text{R}_{45}\text{R}_{46}\text{R}_{47})$, wherein R_{45} is $=\text{O}$, R_{46} is $-\text{OH}$, R_{47} is absent, and R_{42} and R_{43} are hydrogen.

Y10

In some embodiments R_h is absent, j is 6, and each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 1 to 10, and each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 6, each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, and R_f is $\text{C}(\text{R}_{45}\text{R}_{46}\text{R}_{47})$, wherein R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is absent, j is 1 to 10, each R_g is $\text{C}(\text{R}_{42}\text{R}_{43})$, and R_f is $\text{C}(\text{R}_{45}\text{R}_{46}\text{R}_{47})$, wherein R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

Y11

In some embodiments R_h is $\text{C}(\text{R}_{39}\text{R}_{40})$, j is 3, the first R_g is O , and the second and third R_g are $\text{C}(\text{R}_{42}\text{R}_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $\text{C}(\text{R}_{39}\text{R}_{40})$, j is 1 to 10, one R_g is O , and the other R_g are $\text{C}(\text{R}_{42}\text{R}_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $\text{C}(\text{R}_{39}\text{R}_{40})$, j is 3, the first R_g is O , the second and third R_g are $\text{C}(\text{R}_{42}\text{R}_{43})$, and R_f is OH , wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $\text{C}(\text{R}_{39}\text{R}_{40})$, j is 1 to 10, one R_g is O , the other R_g are $\text{C}(\text{R}_{42}\text{R}_{43})$, and R_f is OH , wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the first R_g is O . In some embodiments the second R_g is O . In some embodiments the third R_g is O . In some embodiments the fourth R_g is O . In some embodiments the fifth R_g is O . In some embodiments the fifth from the last R_g is O . In some embodiments the fourth from the last R_g is O . In some embodiments the antepenultimate R_g is O . In some embodiments the penultimate R_g is O . In some embodiments the last R_g is O .

In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 16, two R_g are O, and the other R_g are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 16, two R_g are O, the other R_g are $C(R_{42}R_{43})$, and R_f is OH, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

- 5 In some embodiments the first and third R_g are O. In some embodiments the first and fourth R_g are O. In some embodiments the first and fifth R_g are O. In some embodiments the first and sixth R_g are O. In some embodiments the first and seventh R_g are O. In some embodiments the first and eighth R_g are O. In some embodiments the first and ninth R_g are O. In some embodiments the first and tenth R_g are O. In some
- 10 embodiments the first and eleventh R_g are O. In some embodiments the first and twelfth R_g are O. In some embodiments the first and thirteenth R_g are O. In some embodiments the first and fourteenth R_g are O. In some embodiments the first and fifteenth R_g are O. In some embodiments the second and fourth R_g are O. In some embodiments the second and fifth R_g are O. In some embodiments the second and sixth R_g are O. In some
- 15 embodiments the second and seventh R_g are O. In some embodiments the second and eighth R_g are O. In some embodiments the second and ninth R_g are O. In some embodiments the second and tenth R_g are O. In some embodiments the second and eleventh R_g are O. In some embodiments the second and twelfth R_g are O. In some embodiments the second and thirteenth R_g are O. In some embodiments the second and
- 20 fourteenth R_g are O. In some embodiments the second and fifteenth R_g are O. In some embodiments the third and fifth R_g are O. In some embodiments the third and sixth R_g are O. In some embodiments the third and seventh R_g are O. In some embodiments the third and eighth R_g are O. In some embodiments the third and ninth R_g are O. In some embodiments the third and tenth R_g are O. In some embodiments the third and eleventh
- 25 R_g are O. In some embodiments the third and twelfth R_g are O. In some embodiments the third and thirteenth R_g are O. In some embodiments the third and fourteenth R_g are O. In some embodiments the third and fifteenth R_g are O. In some embodiments the fourth and sixth R_g are O. In some embodiments the fourth and seventh R_g are O. In some
- embodiments the fourth and eighth R_g are O. In some embodiments the fourth and ninth
- 30 R_g are O. In some embodiments the fourth and tenth R_g are O. In some embodiments the fourth and eleventh R_g are O. In some embodiments the fourth and twelfth R_g are O. In some embodiments the fourth and thirteenth R_g are O. In some embodiments the fourth and fourteenth R_g are O. In some embodiments the fourth and fifteenth R_g are O. In some embodiments the fifth and seventh R_g are O. In some embodiments the fifth and eighth

R_g are O. In some embodiments the fifth and ninth R_g are O. In some embodiments the fifth and tenth R_g are O. In some embodiments the fifth and eleventh R_g are O. In some embodiments the fifth and twelfth R_g are O. In some embodiments the fifth and thirteenth R_g are O. In some embodiments the fifth and fourteenth R_g are O. In some
5 embodiments the fifth and fifteenth R_g are O. In some embodiments the sixth and eighth R_g are O. In some embodiments the sixth and ninth R_g are O. In some embodiments the sixth and tenth R_g are O. In some embodiments the sixth and eleventh R_g are O. In some embodiments the sixth and twelfth R_g are O. In some embodiments the sixth and thirteenth R_g are O. In some embodiments the sixth and fourteenth R_g are O. In some
10 embodiments the sixth and fifteenth R_g are O. In some embodiments the seventh and ninth R_g are O. In some embodiments the seventh and tenth R_g are O. In some embodiments the seventh and eleventh R_g are O. In some embodiments the seventh and twelfth R_g are O. In some embodiments the seventh and thirteenth R_g are O. In some
15 embodiments the seventh and fourteenth R_g are O. In some embodiments the seventh and fifteenth R_g are O. In some embodiments the eighth and tenth R_g are O. In some embodiments the eighth and eleventh R_g are O. In some embodiments the eighth and twelfth R_g are O. In some embodiments the eighth and thirteenth R_g are O. In some
20 embodiments the eighth and fourteenth R_g are O. In some embodiments the eighth and fifteenth R_g are O. In some embodiments the ninth and eleventh R_g are O. In some embodiments the ninth and twelfth R_g are O. In some embodiments the ninth and thirteenth R_g are O. In some embodiments the ninth and fourteenth R_g are O. In some
25 embodiments the ninth and fifteenth R_g are O. In some embodiments the tenth and twelfth R_g are O. In some embodiments the tenth and thirteenth R_g are O. In some embodiments the tenth and fourteenth R_g are O. In some embodiments the tenth and fifteenth R_g are O. In some embodiments the eleventh and thirteenth R_g are O. In some
embodiments the eleventh and fourteenth R_g are O. In some embodiments the eleventh and fifteenth R_g are O. In some embodiments the twelfth and fourteenth R_g are O. In some embodiments the twelfth and fifteenth R_g are O. In some embodiments the thirteenth and fifteenth R_g are O.

30 **Y12**

In some embodiments, in Formula VI, R_{13} is O, R_{12} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-X_b-$ $(CR_{19}R_{19})_q-$, p is 0, q is 1, both R_{19} are hydrogen, and X_b is O.

Y13

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p$, one R_{19} is $-OH$, the other R_{19} is hydrogen, and p is 1.

5

Y14

In some embodiments, in Formula VI, R_{14} is N, R_{12} , R_{13} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p$, and p is 0).

Y15

10 In some embodiments, in Formula VI, R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p$, p is 1, both R_{19} are hydrogen.

Y16

15 In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0, and R_f is hydrogen, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is hydrogen, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some
20 embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, jx is 0, and R_{fx} is hydrogen, wherein R_{39x} and R_{40x} are hydrogen. In some
25 embodiments j is 0. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

30 In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, jx is 0, and R_{fx} is hydrogen, wherein R_{39x} and R_{40x} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is hydrogen, wherein R_{39} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, jx is 0, and R_{fx} is hydrogen, wherein R_{39x} and R_{40x} are hydrogen. In some

embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10. In some embodiments jx is 1. In some embodiment jx is 2. In some embodiments jx is 3. In some embodiment jx is 4. In some embodiments jx is 5. In some embodiments jx is 7. In some embodiment jx is 8. In some embodiments jx is 9. In some embodiments jx is 10. In some embodiments j = jx.

Y17

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0.

Y18

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} is =O, and R_{40} is absent. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} is =O, R_{40} is absent, and R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} is =O, R_{40} is absent, and R_{42} and R_{43} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} is =O, R_{40} is absent, and R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} is =O and R_{43} is absent for one R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{42} is =O and R_{43} is absent for one R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_{42} is =O and R_{43} is absent for the last R_g . In some embodiments R_{42} is =O and R_{43} is absent for the penultimate R_g . In some embodiments R_{42} is =O and R_{43} is absent for the antepenultimate R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fourth from the last R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fifth from the last R_g . In some embodiments R_{42} is =O and R_{43} is absent for the first R_g . In some embodiments R_{42} is =O and R_{43} is absent for the second R_g . In some embodiments R_{42} is =O and R_{43} is absent for the third R_g . In some embodiments

R_{42} is =O and R_{43} is absent for the fourth R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fifth R_g .

In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 15, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} is =O and R_{43} is absent for two R_g , R_{42} and R_{43} are hydrogen for the other

5 R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 15, each R_g is $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{42} is =O and R_{43} is absent for two R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_{42} is =O and R_{43} is absent the first and third R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fourth R_g . In some

10 embodiments R_{42} is =O and R_{43} is absent the first and fifth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and tenth R_g . In some

15 embodiments R_{42} is =O and R_{43} is absent the first and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and fourth R_g .

20 In some embodiments R_{42} is =O and R_{43} is absent the second and fifth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the

25 second and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and fourteenth R_g . In some

30 embodiments R_{42} is =O and R_{43} is absent the second and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and fifth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and tenth R_g . In

some embodiments R_{42} is =O and R_{43} is absent the third and eleventh R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the third and twelfth R_g . In some embodiments
 R_{42} is =O and R_{43} is absent the third and thirteenth R_g . In some embodiments R_{42} is =O
 and R_{43} is absent the third and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is
 5 absent the third and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the
 fourth and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and
 seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and eighth R_g .
 In some embodiments R_{42} is =O and R_{43} is absent the fourth and ninth R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the fourth and tenth R_g . In some embodiments
 10 R_{42} is =O and R_{43} is absent the fourth and eleventh R_g . In some embodiments R_{42} is =O
 and R_{43} is absent the fourth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is
 absent the fourth and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the
 fourth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth
 and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and seventh
 15 R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and eighth R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the fifth and ninth R_g . In some embodiments
 R_{42} is =O and R_{43} is absent the fifth and tenth R_g . In some embodiments R_{42} is =O and
 R_{43} is absent the fifth and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent
 the fifth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and
 20 thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and fourteenth
 R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and fifteenth R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the sixth and eighth R_g . In some embodiments
 R_{42} is =O and R_{43} is absent the sixth and ninth R_g . In some embodiments R_{42} is =O and
 R_{43} is absent the sixth and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the
 25 sixth and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and
 twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and thirteenth R_g .
 In some embodiments R_{42} is =O and R_{43} is absent the sixth and fourteenth R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the sixth and fifteenth R_g . In some
 embodiments R_{42} is =O and R_{43} is absent the seventh and ninth R_g . In some embodiments
 30 R_{42} is =O and R_{43} is absent the seventh and tenth R_g . In some embodiments R_{42} is =O
 and R_{43} is absent the seventh and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is
 absent the seventh and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the
 seventh and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the seventh
 and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the seventh and

fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eighth and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eighth and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the eighth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eighth and thirteenth R_g . In some
5 embodiments R_{42} is =O and R_{43} is absent the eighth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eighth and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the ninth and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the ninth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the ninth and thirteenth R_g . In some embodiments R_{42} is =O
10 and R_{43} is absent the ninth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the ninth and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the tenth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the tenth and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the tenth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the tenth and fifteenth R_g . In some
15 embodiments R_{42} is =O and R_{43} is absent the eleventh and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eleventh and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the eleventh and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the twelfth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the twelfth and fifteenth R_g . In some
20 embodiments the thirteenth and fifteenth R_g .

Y19

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, Z is 1, R^d is $-NH_2$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_{p-}$, and p is 0. In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some
25 embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} .

Y20

In some embodiments R_h is $C(R_{39}R_{40})$, j is 6, each R_g is $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen, wherein R_{42} of the first
30 R_g is $C(R_{56}R_{57}R_{58})$, R_{43} of the first through sixth R_g are hydrogen, and R_{42} of the second through sixth R_g are hydrogen, wherein R_{56} is =O, R_{57} is $-OH$, and R_{58} is absent. In some embodiments R_h is $C(R_{39}R_{40})$, j is 6, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} and R_{40} are hydrogen, wherein R_{42} of the first R_g is $C(R_{56}R_{57}R_{58})$, R_{43} of the first through sixth R_g are

hydrogen, and R_{42} of the second through sixth R_g are hydrogen, wherein R_{56} is =O, R_{57} is –OH, and R_{58} is absent.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, each R_g is $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{45} , R_{46} , and R_{47} are hydrogen, wherein R_{42} of one R_g is $C(R_{56}R_{57}R_{58})$, R_{42} of the other R_g are hydrogen, and R_{43} is hydrogen, and, wherein R_{56} is =O, R_{57} is –OH, and R_{58} is absent. In some embodiments R_{42} of the first R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} and R_{40} are hydrogen, wherein R_{42} of one R_g is $C(R_{56}R_{57}R_{58})$, R_{42} of the other R_g are hydrogen, and R_{43} is hydrogen, and, wherein R_{56} is =O, R_{57} is –OH, and R_{58} is absent. In some embodiments R_{42} of the first R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the second R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the third R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the fourth R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the fifth R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the sixth R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the seventh R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the eighth R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the ninth R_g is $C(R_{56}R_{57}R_{58})$. In some embodiments R_{42} of the tenth R_g is $C(R_{56}R_{57}R_{58})$.

Z1

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 10, and R_f is $C(R_{45}R_{46}R_{47})$, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 31, and R_f is $C(R_{45}R_{46}R_{47})$, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and

twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 10, and R_f is hydrogen, $C(R_{45}R_{46}R_{47})$, OH, SH, S(O)₂, S(O)₃, Si($R_{100}R_{101}R_{102}$), or NR₄₈R₄₉R₅₀, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some embodiments, R_{100} , R_{101} , and R_{102} are each independently C₁-C₆ alkyl, phenyl, aryl, or C₅-C₆ cyclic.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 31, and R_f is hydrogen, $C(R_{45}R_{46}R_{47})$, OH, SH, S(O)₂, S(O)₃, Si($R_{100}R_{101}R_{102}$), or NR₄₈R₄₉R₅₀, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen, wherein R_{45} , R_{46} , R_{47} , R_{48} , R_{49} , and R_{50} are independently, as valency permits, absent, hydrogen, -OH, =O, -SH, =N, -NH₂, -NH₃, -CH₃, or -COOH, and wherein R_{100} , R_{101} , and R_{102} are each independently alkyl, phenyl, aryl, or C₃-C₂₀ cyclic. In some

embodiments, R_{100} , R_{101} , and R_{102} are each independently C_1 - C_6 alkyl, phenyl, aryl, or C_5 - C_6 cyclic.

In some embodiments, **A**, R_3 , R_{18} , and R^b are independently $-R_h-(R_g)_j$, wherein R_h is $C(R_{39}R_{40})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{41} ; and wherein each R_g is independently absent
5 (i.e., j is 0), $C(R_{42}R_{43})$, O, S, $S(O)_2$, $S(O)_3$, or NR_{44} ;

wherein j is an integer from 0 to 30,

wherein R_{39} , R_{40} , R_{41} , R_{42} , R_{43} , and R_{44} are each independently, as valency permits, absent, hydrogen, $=O$, $-OR_{51}$, $-SR_{52}$, $-NR_{53}R_{54}R_{55}$, $-C(R_{56}R_{57}R_{58})$, or $-R_{hx}-(R_{gx})_{jx}-R_{fx}$,

10 wherein R_{51} , R_{52} , R_{53} , R_{54} , R_{55} , R_{56} , R_{57} , and R_{58} are each independently, as valency permits, absent, hydrogen, $-OH$, $=O$, $-SH$, $=NH$, $-NH_2$, $-NH_3$, $-CH_3$, or $-COOH$,
wherein the bond between R_h and R_g , if present, is single, double, or triple depending on the valency, wherein the bond between each adjacent R_g is single, double, or triple depending on the valency; wherein when R_h is O, S, $S(O)_2$, or $S(O)_3$, the bond
15 between R_h and R_g is not a double or triple bond; wherein when R_h is NR_{41} , the bond between R_h and R_g is not a triple bond; wherein when R_g is O, S, $S(O)_2$, or $S(O)_3$, the bond between R_g and R_h is not a double or triple bond; wherein when R_h is NR_{44} , the bond between R_g and R_h is not a triple bond; wherein when R_h is O, R_g is not O, S, or NR_{44} , and vice versa; wherein when R_h is S, R_g is not O, $S(O)_2$, $S(O)_3$, or NR_{44} , and vice
20 versa; wherein when R_h is $S(O)_2$, R_g is not S, $S(O)_2$, or $S(O)_3$, and vice versa; wherein when R_h is $S(O)_3$, R_g is not S, $S(O)_2$, or $S(O)_3$, and vice versa; and wherein when R_h is NR_{41} , R_g is not O, or S, and vice versa.

Z2

In some embodiments where **A** or R_3 is Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and
25 R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and R_{19} are independently hydrogen or C_1 - C_3 alkyl. In some embodiments, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 1, and R_{19} are hydrogen.

In some embodiments where **A** or R_3 is Formula VI, R^d is at R_{15} . In some
30 embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} . In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some

embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

5 **Z2-Y12, Z1-Y15, AND Z1-Y19**

Preferred compounds are represented by the general formula:

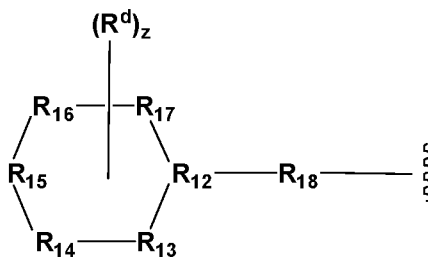


Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or
10 coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

wherein **A** and R₃ are -R_h-(R_g)_j or

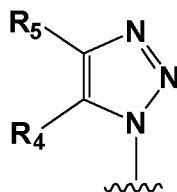


Formula VI

15 wherein R_h is C(R₃₉R₄₀), and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g, if present, are C(R₄₂R₄₃) and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-
20 ninth, R_g, if present, are O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are independently hydrogen or C₁-C₃ alkyl;

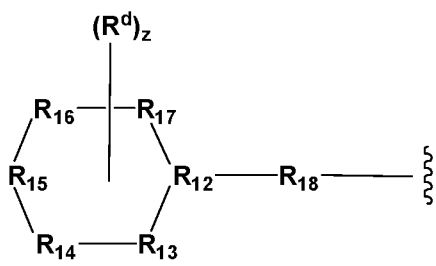
wherein in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, p is 0 to 10, and R₁₉ are independently hydrogen or C₁-C₃ alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein R_{12} is carbon, one or two of nonadjacent R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are
O, the rest of R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C₁-
C₃ alkyl, C₁-C₃ alkoxy, amino, C₁-C₃ alkylamino, C₁-C₃ dialkylamino, hydroxy, C₁-C₃
alkenyl, or C₁-C₃ alkynyl, the ring of Formula VI has no double bonds, R_{18} is -
($CR_{19}R_{19}$)_p-X_b-($CR_{19}R_{19}$)_q-, p is 0 to 5, q is 0 to 5, R_{19} are independently hydrogen or C₁-
C₃ alkyl, and X_b is O;

wherein R_{12} is N, R_{15} is S(O)₂, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of
Formula VI has no double bonds, R_{18} is -($CR_{19}R_{19}$)_p-, p is 0 to 10, and R_{19} are
independently hydrogen or C₁-C₃ alkyl; or

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 5, R^d are
independently independently C₁-C₃ alkyl, C₁-C₃ alkoxy, amino, C₁-C₃ alkylamino, C₁-C₃
dialkylamino, hydroxy, C₁-C₃ alkenyl, or C₁-C₃ alkynyl, the ring of Formula VI is
aromatic, R_{18} is -($CR_{19}R_{19}$)_p-, p is 0 to 5, and R_{19} are independently hydrogen or C₁-C₃
alkyl;

wherein R_4 and R_5 are not both hydrogen, wherein at least one **C** is not hydrogen.
X is preferably oxygen, sulfur, or NR₂.

In some embodiments where **A** or R_3 is -R_h-(R_g)_j, R_h is C(R₃₉R₄₀), and j is 4 to
31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth,
fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth,

twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In
 5 some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some
 10 embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but
 15 one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are
 20 hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

25 In some embodiments where **A** or R_3 is Formula VI, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} . In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some
 30 embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where **A** or R_3 is Formula VI, in such **A** and R_3 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 1, and R_{19} are hydrogen.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} is carbon, one or two of nonadjacent R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, the rest of R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 0 to 5, q is 0 to 5, R_{19} are independently hydrogen or C_1 - C_3 alkyl, and X_b is O. In some embodiments R_4 is hydrogen. In some embodiments, R_5 is hydrogen. In some embodiments, R_{13} is O and R_{14} , R_{15} , R_{16} , and R_{17} are carbon. In some embodiments, R_{14} is O and R_{13} , R_{15} , R_{16} , and R_{17} are carbon. In some embodiments, R_{15} is O and R_{13} , R_{14} , R_{16} , and R_{17} are carbon. In some embodiments, R_{16} is O and R_{13} , R_{14} , R_{15} , and R_{17} are carbon. In some embodiments, R_{17} is O and R_{13} , R_{14} , R_{15} , and R_{16} are carbon. In some embodiments, R_{13} and R_{15} are O. In some embodiments, R_{13} and R_{16} are O. In some embodiments, R_{13} and R_{17} are O. In some embodiments, R_{14} and R_{16} are O. In some embodiments, R_{14} and R_{17} are O. In some embodiments, R_{15} and R_{17} are O. In some embodiments z is 0. In some embodiments z is 1. In some embodiments z is 2. In some embodiments z is 3. In some embodiments R^d is independently methyl, ethyl, methoxy, ethoxy, amino methyl, amino ethyl, hydroxyl, or amino. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiments p is 4. In some embodiments p is 5. In some embodiments, q is 0. In some embodiments q is 1. In some embodiment q is 2. In some embodiments q is 3. In some embodiments q is 4. In some embodiments q is 5. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where at least one **C** is Formula VI, R_4 is hydrogen, and R_5 is Formula VI, in such **C** and R_5 : R_{13} is O, R_{12} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 0, q is 1, both R_{19} are hydrogen, and X_b is O.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of

Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and R_{19} are independently hydrogen or C_1-C_3 alkyl. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where at least one **C** is Formula VI, R_4 is hydrogen, and R_5 is Formula VI, in such **C** and R_5 : R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, p is 1, and both R_{19} are hydrogen.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 5, R^d are independently independently C_1-C_3 alkyl, C_1-C_3 alkoxy, amino, C_1-C_3 alkylamino, C_1-C_3 dialkylamino, hydroxy, C_1-C_3 alkenyl, or C_1-C_3 alkynyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 5, and R_{19} are independently hydrogen or C_1-C_3 alkyl. In some embodiments, z is 0. In some embodiments z is 1. In some embodiment z is 2. In some embodiments z is 3. In some embodiment z is 4. In some embodiments z is 5. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen. In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} .

In some embodiments where at least one **C** is Formula VI, R_4 is hydrogen, and R_5 is Formula VI, in such **C** and R_5 : R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is $-NH_2$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0, and R^d is at R_{15} .

30 **Z2-Y12**

In some embodiments, the compounds are represented by the general formula:



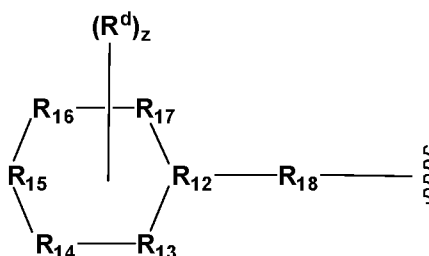
Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)₆** or -R₃-R^b;

wherein **A** and R₃ are

5

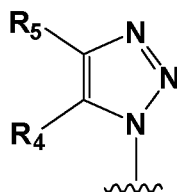


Formula VI

wherein for **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, p is 0 to 10, and R₁₉ are independently hydrogen or C₁-C₃ alkyl;

10

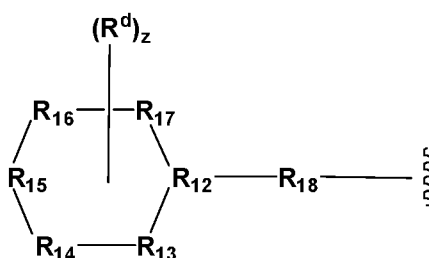
wherein **B** and R^b are:



Formula III

wherein each **C**, R₄, and R₅ are independently hydrogen or

15



Formula VI

wherein for **C**, R₄, and R₅, R₁₂ is carbon, one or two of nonadjacent R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, the rest of R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0 to 3, R^d are independently C₁-C₃ alkyl, C₁-C₃ alkoxy, amino, C₁-C₃ alkylamino, C₁-C₃ dialkylamino, hydroxy, C₁-C₃ alkenyl, or C₁-C₃ alkynyl, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, p is 0 to 5, q is 0 to 5, R₁₉ are independently hydrogen or C₁-C₃ alkyl, and X_b is O.

20

X is preferably oxygen, sulfur, or NR₂.

In some embodiments where **A** or R₃ is Formula VI, R^d is at R₁₅. In some embodiments, R^d is at R₁₃. In some embodiments, R^d is at R₁₄. In some embodiments, R^d is at R₁₆. In some embodiments, R^d is at R₁₇. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

10 In some embodiments where **A** or R₃ is Formula VI, in such **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p⁻, p is 1, and R₁₉ are hydrogen.

In some embodiments where one or more of **C**, R₄, and R₅ are Formula VI, in such **C**, R₄, and R₅: R₁₂ is carbon, one or two of nonadjacent R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are O, the rest of R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0 to 3, R^d are independently C₁-C₃ alkyl, C₁-C₃ alkoxy, amino, C₁-C₃ alkylamino, C₁-C₃ dialkylamino, hydroxy, C₁-C₃ alkenyl, or C₁-C₃ alkynyl, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q⁻, p is 0 to 5, q is 0 to 5, R₁₉ are independently hydrogen or C₁-C₃ alkyl, and X_b is O. In some embodiments R₄ is hydrogen. In some embodiments, R₅ is hydrogen. In some embodiments, R₁₃ is O and R₁₄, R₁₅, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₄ is O and R₁₃, R₁₅, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₅ is O and R₁₃, R₁₄, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₆ is O and R₁₃, R₁₄, R₁₅, and R₁₇ are carbon. In some embodiments, R₁₇ is O and R₁₃, R₁₄, R₁₅, and R₁₆ are carbon. In some embodiments, R₁₃ and R₁₅ are O. In some embodiments, R₁₃ and R₁₆ are O. In some embodiments, R₁₃ and R₁₇ are O. In some embodiments, R₁₄ and R₁₆ are O. In some embodiments, R₁₄ and R₁₇ are O. In some embodiments, R₁₅ and R₁₇ are O. In some embodiments z is 0. In some embodiments z is 1. In some embodiments z is 2. In some embodiments z is 3. In some embodiments R^d is independently methyl, ethyl, methoxy, ethoxy, amino methyl, amino ethyl, hydroxyl, or amino. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiments p is 4. In some embodiments p is 5. In some embodiments, q is 0. In some embodiments q is 1. In some embodiment q is 2. In some embodiments q is 3. In some embodiments q is 4. In some embodiments q is 5. In some embodiments all

R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

- 5 In some embodiments where at least one **C** is Formula VI, R₄ is hydrogen, and R₅ is Formula VI, in such **C** and R₅: R₁₃ is O, R₁₂, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, p is 0, q is 1, both R₁₉ are hydrogen, and X_b is O.

Z1-Y15

In some embodiments the compounds are represented by the general formula:

10



Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

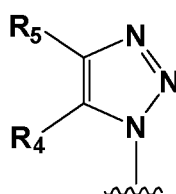
15

wherein **A** and R₃ are -R_h-(R_g)_j,

20

wherein R_h is C(R₃₉R₄₀), and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g, if present, are C(R₄₂R₄₃) and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g, if present, are O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are independently hydrogen or C₁-C₃ alkyl;

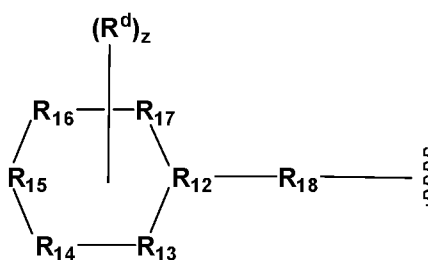
wherein **B** and R^b is:



25

Formula III

wherein each **C**, R₄, and R₅ are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and
 5 R_{19} are independently hydrogen or C_1 - C_3 alkyl;

wherein R_4 and R_5 are not both hydrogen, wherein at least one **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth,
 10 fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In
 15 some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some
 20 embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but
 25 one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are

hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and R_{19} are independently hydrogen or C_1 - C_3 alkyl. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where at least one **C** is Formula VI, R_4 is hydrogen, and R_5 is Formula VI, in such **C** and R_5 : R_{12} is N, R_{15} is $S(O)_2$, R_{13} , R_{14} , R_{16} , and R_{17} are carbon, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, p is 1, and both R_{19} are hydrogen.

Z1-Y19

In some embodiments, compounds are represented by the general formula:



Formula I

wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

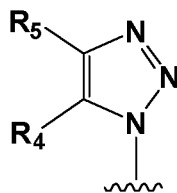
wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-

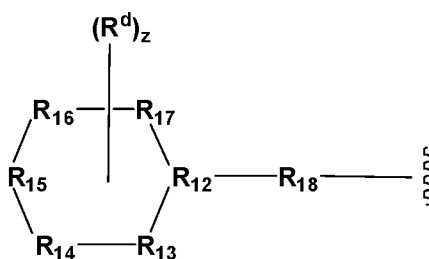
ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 5, R^d are independently independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p$, p is 0 to 5, and R_{19} are independently hydrogen or C_1 - C_3 alkyl;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are

hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

15 In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 5, R^d are independently independently C_1-C_3 alkyl, C_1-C_3 alkoxy, amino, C_1-C_3 alkylamino, C_1-C_3 dialkylamino, hydroxy, C_1-C_3 alkenyl, or C_1-C_3 alkynyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 5, and R_{19} are independently hydrogen or C_1-C_3 alkyl. In some embodiments, z is 0. In some embodiments z is 1. In some embodiment z is 2. In some embodiments z is 3. In some embodiment z is 4. In some embodiments z is 5. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen. In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen. In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} .

In some embodiments where at least one **C** is Formula VI, R_4 is hydrogen, and R_5 is Formula VI, in such **C** and R_5 : R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is - NH_2 , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0, and R^d is at R_{15} .

Z1-Y18

5 In some embodiments, compounds are represented by the general formula:



Formula I

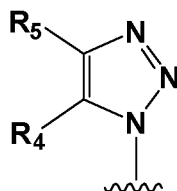
wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

10 wherein R_1 is $-A-B(-C)_6$ or $-R_3-R^b$;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, 15 thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



20

Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, j is 1 to 15, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} is =O and R_{43} is absent for two R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} and R_{40} 25 are hydrogen;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 30 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth,

fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} is $=O$, and R_{40} is absent. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} is $=O$, R_{40} is absent, and R_{42} and R_{43} are hydrogen. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} is $=O$ and R_{43} is absent for one R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_{42} is $=O$ and R_{43} is absent for

the last R_g . In some embodiments R_{42} is =O and R_{43} is absent for the penultimate R_g . In some embodiments R_{42} is =O and R_{43} is absent for the antepenultimate R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fourth from the last R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fifth from the last R_g . In some
5 embodiments R_{42} is =O and R_{43} is absent for the first R_g . In some embodiments R_{42} is =O and R_{43} is absent for the second R_g . In some embodiments R_{42} is =O and R_{43} is absent for the third R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fourth R_g . In some embodiments R_{42} is =O and R_{43} is absent for the fifth R_g .

 In some embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 15, and each R_g is $C(R_{42}R_{43})$,
10 wherein R_{42} is =O and R_{43} is absent for two R_g , R_{42} and R_{43} are hydrogen for the other R_g , and R_{39} and R_{40} are hydrogen. In some embodiments R_{42} is =O and R_{43} is absent the first and third R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fourth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fifth R_g . In some
15 embodiments R_{42} is =O and R_{43} is absent the first and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and eleventh R_g . In some
20 embodiments R_{42} is =O and R_{43} is absent the first and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the first and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and fourth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and
25 fifth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and seventh R_g . In some
embodiments R_{42} is =O and R_{43} is absent the second and eighth R_g . In some
embodiments R_{42} is =O and R_{43} is absent the second and ninth R_g . In some embodiments
 R_{42} is =O and R_{43} is absent the second and tenth R_g . In some embodiments R_{42} is =O and
 R_{43} is absent the second and eleventh R_g . In some embodiments R_{42} is =O and R_{43} is
30 absent the second and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the second and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and fifth R_g . In
some embodiments R_{42} is =O and R_{43} is absent the third and sixth R_g . In some

embodiments R_{42} is =O and R_{43} is absent the third and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and
5 eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the third and fifteenth R_g . In some
10 embodiments R_{42} is =O and R_{43} is absent the fourth and sixth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and
15 eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and fourteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fourth and fifteenth R_g . In some
20 embodiments R_{42} is =O and R_{43} is absent the fifth and seventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and
25 eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and twelfth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and thirteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the fifth and fourteenth R_g . In some
30 embodiments R_{42} is =O and R_{43} is absent the fifth and fifteenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and eighth R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and ninth R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and tenth R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and
eleventh R_g . In some embodiments R_{42} is =O and R_{43} is absent the sixth and twelfth R_g . In some
35 In some embodiments R_{42} is =O and R_{43} is absent the sixth and thirteenth R_g . In some
embodiments R_{42} is =O and R_{43} is absent the sixth and fourteenth R_g . In some
embodiments R_{42} is =O and R_{43} is absent the sixth and fifteenth R_g . In some
embodiments R_{42} is =O and R_{43} is absent the seventh and ninth R_g . In some embodiments
 R_{42} is =O and R_{43} is absent the seventh and tenth R_g . In some embodiments R_{42} is =O

and R₄₃ is absent the seventh and eleventh R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the seventh and twelfth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the seventh and thirteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the seventh and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the seventh and
5 fifteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eighth and tenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eighth and eleventh R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eighth and twelfth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eighth and thirteenth R_g. In some
10 embodiments R₄₂ is =O and R₄₃ is absent the eighth and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eighth and fifteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the ninth and eleventh R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the ninth and twelfth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the ninth and thirteenth R_g. In some embodiments R₄₂ is =O
15 and R₄₃ is absent the ninth and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the ninth and fifteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the tenth and twelfth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the tenth and thirteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the tenth and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the tenth and fifteenth R_g. In some
20 embodiments R₄₂ is =O and R₄₃ is absent the eleventh and thirteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eleventh and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the eleventh and fifteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the twelfth and fourteenth R_g. In some embodiments R₄₂ is =O and R₄₃ is absent the twelfth and fifteenth R_g. In some
25 embodiments the thirteenth and fifteenth R_g.

25 Z1-Y12

In some embodiments, compounds are represented by the general formula:



Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or
30 coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

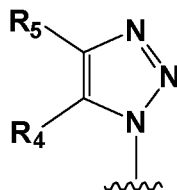
wherein **A** and R₃ are -R_h-(R_g)_j,

wherein R_h is C(R₃₉R₄₀), and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth,

twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or

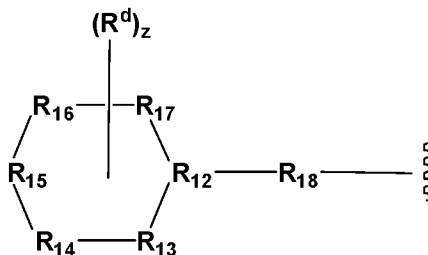
5 C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} is carbon, one or two of nonadjacent R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, the rest of R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 0 to 5, q is 0 to 5, R_{19} are independently hydrogen or C_1 - C_3 alkyl, and X_b is O;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

20 X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} ,

and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} is carbon, one or two of nonadjacent R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, the rest of R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q$, p is 0 to 5, q is 0 to 5, R_{19} are independently hydrogen or C_1 - C_3 alkyl, and X_b is O.

In some embodiments where one or more of **C**, R_4 , and R_5 are Formula VI, in such **C**, R_4 , and R_5 : R_{12} is carbon, one or two of nonadjacent R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are O, the rest of R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI has no double bonds, R_{18} is -

(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, p is 0 to 5, q is 0 to 5, R₁₉ are independently hydrogen or C₁-C₃ alkyl, and X_b is O. In some embodiments R₄ is hydrogen. In some embodiments, R₅ is hydrogen. In some embodiments, R₁₃ is O and R₁₄, R₁₅, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₄ is O and R₁₃, R₁₅, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₅ is O and R₁₃, R₁₄, R₁₆, and R₁₇ are carbon. In some embodiments, R₁₆ is O and R₁₃, R₁₄, R₁₅, and R₁₇ are carbon. In some embodiments, R₁₇ is O and R₁₃, R₁₄, R₁₅, and R₁₆ are carbon. In some embodiments, R₁₃ and R₁₅ are O. In some embodiments, R₁₃ and R₁₆ are O. In some embodiments, R₁₃ and R₁₇ are O. In some embodiments, R₁₄ and R₁₆ are O. In some embodiments, R₁₄ and R₁₇ are O. In some embodiments, R₁₅ and R₁₇ are O. In some embodiments z is 0. In some embodiments z is 1. In some embodiments z is 2. In some embodiments z is 3. In some embodiments R^d is independently methyl, ethyl, methoxy, ethoxy, amino methyl, amino ethyl, hydroxyl, or amino. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiments p is 4. In some embodiments p is 5. In some embodiments, q is 0. In some embodiments q is 1. In some embodiment q is 2. In some embodiments q is 3. In some embodiments q is 4. In some embodiments q is 5. In some embodiments all R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

20 In some embodiments where at least one **C** is Formula VI, R₄ is hydrogen, and R₅ is Formula VI, in such **C** and R₅: R₁₃ is O, R₁₂, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, p is 0, q is 1, both R₁₉ are hydrogen, and X_b is O.

Z1-Y17

25 In some embodiments, compounds are represented by the general formula:



Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

30 wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

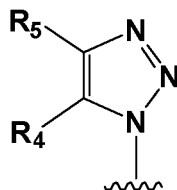
wherein **A** and R₃ are -R_h-(R_g)_j,

wherein R_h is C(R₃₉R₄₀), and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth,

twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or

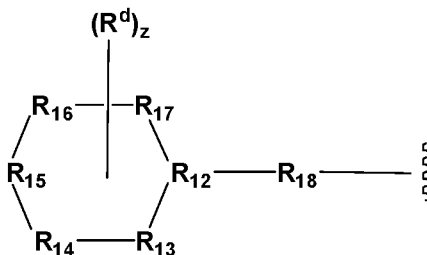
5 C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0 to 3, R^d are independently C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI is

10 aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to

20 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} ,

25 and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39}

and R₄₀ are C₁-C₃ alkyl. In some embodiments all R₄₂ are hydrogen. In some
embodiments all but one R₄₂ are hydrogen. In some embodiments all but two R₄₂ are
hydrogen. In some embodiments all but three R₄₂ are hydrogen. In some embodiments all
5 but four R₄₂ are hydrogen. In some embodiments all but five R₄₂ are hydrogen. In some
embodiments all but six R₄₂ are hydrogen. In some embodiments all but seven R₄₂ are
hydrogen. In some embodiments all but eight R₄₂ are hydrogen. In some embodiments all
but nine R₄₂ are hydrogen. In some embodiments all but ten R₄₂ are hydrogen. In some
embodiments all but eleven R₄₂ are hydrogen. In some embodiments all but twelve R₄₂
are hydrogen. In some embodiments all R₄₃ are hydrogen. In some embodiments all but
10 one R₄₃ are hydrogen. In some embodiments all but two R₄₃ are hydrogen. In some
embodiments all but three R₄₃ are hydrogen. In some embodiments all but four R₄₃ are
hydrogen. In some embodiments all but five R₄₃ are hydrogen. In some embodiments all
but six R₄₃ are hydrogen. In some embodiments all but seven R₄₃ are hydrogen. In some
embodiments all but eight R₄₃ are hydrogen. In some embodiments all but nine R₄₃ are
15 hydrogen. In some embodiments all but ten R₄₃ are hydrogen. In some embodiments all
but eleven R₄₃ are hydrogen. In some embodiments all but twelve R₄₃ are hydrogen.

In some embodiments where **A** or R₃ is -R_h-(R_g)_j, R_h is C(R₃₉R₄₀), and j is 10,
wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are C(R₄₂R₄₃) and the
second, fifth, and eighth R_g are O, and wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

20 In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon,
z is 0, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, and p is 0.

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon,
z is 1, R^d are independently C₁-C₃ alkyl, C₁-C₃ alkoxy, amino, C₁-C₃ alkylamino, C₁-C₃
dialkylamino, hydroxy, C₁-C₃ alkenyl, or C₁-C₃ alkynyl, the ring of Formula VI is
25 aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, and p is 0.

Z1-Y1

In some embodiments, compounds are represented by the general formula:



Formula I

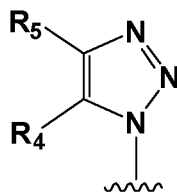
30 wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or
coupling of the compound to a product or surface;

wherein R₁ is -**A**-**B**(-**C**)_δ or -R₃-R^b;

wherein **A** and R₃ are -R_h-(R_g)_j,

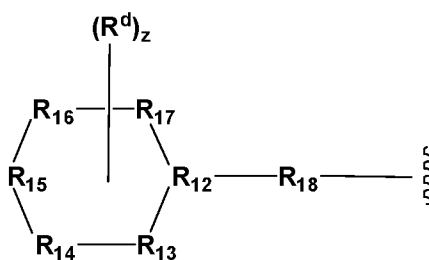
wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, 5 eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is 15 hydroxy, C_1 - C_3 alkyl, C_1 - C_3 alkoxy, amino, C_1 - C_3 alkylamino, C_1 - C_3 dialkylamino, hydroxy, C_1 - C_3 alkenyl, or C_1 - C_3 alkynyl, the ring of Formula VI has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

20 X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are 25 $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} ,

and R₄₃ are hydrogen or C₁-C₃ alkyl. In some embodiments R₃₉ and R₄₀ are hydrogen. In some embodiments R₃₉ is hydrogen and R₄₀ is C₁-C₃ alkyl. In some embodiments R₃₉ and R₄₀ are C₁-C₃ alkyl. In some embodiments all R₄₂ are hydrogen. In some embodiments all but one R₄₂ are hydrogen. In some embodiments all but two R₄₂ are hydrogen. In some embodiments all but three R₄₂ are hydrogen. In some embodiments all but four R₄₂ are hydrogen. In some embodiments all but five R₄₂ are hydrogen. In some embodiments all but six R₄₂ are hydrogen. In some embodiments all but seven R₄₂ are hydrogen. In some embodiments all but eight R₄₂ are hydrogen. In some embodiments all but nine R₄₂ are hydrogen. In some embodiments all but ten R₄₂ are hydrogen. In some embodiments all but eleven R₄₂ are hydrogen. In some embodiments all but twelve R₄₂ are hydrogen. In some embodiments all R₄₃ are hydrogen. In some embodiments all but one R₄₃ are hydrogen. In some embodiments all but two R₄₃ are hydrogen. In some embodiments all but three R₄₃ are hydrogen. In some embodiments all but four R₄₃ are hydrogen. In some embodiments all but five R₄₃ are hydrogen. In some embodiments all but six R₄₃ are hydrogen. In some embodiments all but seven R₄₃ are hydrogen. In some embodiments all but eight R₄₃ are hydrogen. In some embodiments all but nine R₄₃ are hydrogen. In some embodiments all but ten R₄₃ are hydrogen. In some embodiments all but eleven R₄₃ are hydrogen. In some embodiments all but twelve R₄₃ are hydrogen.

In some embodiments where **A** or R₃ is -R_h-(R_g)_j, R_h is C(R₃₉R₄₀), and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are C(R₄₂R₄₃) and the second, fifth, and eighth R_g are O, and wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R_d is hydroxy, the ring of Formula VI has no double bonds, R₁₈ is -(CR₁₉R₁₉)_p-, and p is 0. In some embodiments, R^d is at R₁₅. In some embodiments, R^d is at R₁₃. In some embodiments, R^d is at R₁₄. In some embodiments, R^d is at R₁₆. In some embodiments, R^d is at R₁₇.

Z1-Y9

In some embodiments, compounds are represented by the general formula:



Formula I

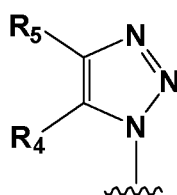
wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

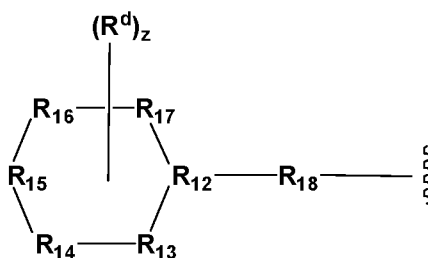
wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein **C** and R_5 are independently hydrogen or



Formula VI

wherein **C** and R_4 , independently hydrogen or $-R_h-(R_g)_j$,

wherein for **C** and R_5 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 0, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0; wherein R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} is $=O$ and R_{40} is $-OH$. In some embodiments R_h is absent, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are

C(R₄₂R₄₃) and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g, if present, are O, wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen or C₁-C₃ alkyl. In some embodiments R₃₉ and R₄₀ are hydrogen. In some embodiments R₃₉ is hydrogen and R₄₀ is C₁-C₃ alkyl. In some embodiments R₃₉ and R₄₀ are C₁-C₃ alkyl. In some embodiments all R₄₂ are hydrogen. In some embodiments all but one R₄₂ are hydrogen. In some embodiments all but two R₄₂ are hydrogen. In some embodiments all but three R₄₂ are hydrogen. In some embodiments all but four R₄₂ are hydrogen. In some embodiments all but five R₄₂ are hydrogen. In some embodiments all but six R₄₂ are hydrogen. In some embodiments all but seven R₄₂ are hydrogen. In some embodiments all but eight R₄₂ are hydrogen. In some embodiments all but nine R₄₂ are hydrogen. In some embodiments all but ten R₄₂ are hydrogen. In some embodiments all but eleven R₄₂ are hydrogen. In some embodiments all but twelve R₄₂ are hydrogen. In some embodiments all R₄₃ are hydrogen. In some embodiments all but one R₄₃ are hydrogen. In some embodiments all but two R₄₃ are hydrogen. In some embodiments all but three R₄₃ are hydrogen. In some embodiments all but four R₄₃ are hydrogen. In some embodiments all but five R₄₃ are hydrogen. In some embodiments all but six R₄₃ are hydrogen. In some embodiments all but seven R₄₃ are hydrogen. In some embodiments all but eight R₄₃ are hydrogen. In some embodiments all but nine R₄₃ are hydrogen. In some embodiments all but ten R₄₃ are hydrogen. In some embodiments all but eleven R₄₃ are hydrogen. In some embodiments all but twelve R₄₃ are hydrogen.

In some embodiments where **A** or R₃ is -R_h-(R_g)_j, R_h is C(R₃₉R₄₀), and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are C(R₄₂R₄₃) and the second, fifth, and eighth R_g are O, and wherein R₃₉, R₄₀, R₄₂, and R₄₃ are hydrogen.

In some embodiments, one **C** or R₄ is -R_h-(R_g)_j, and one **C** or R₅ is, wherein in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, and p is 0, wherein R_h is C(R₃₉R₄₀), and j is 0, wherein R₃₉ is =O and R₄₀ is -OH. In some embodiments R_h is absent, j is 0 to 10, and each R_g is C(R₄₂R₄₃), wherein R₄₂ and R₄₃ are hydrogen.

Z1-Y2

In some embodiments, compounds are represented by the general formula:



Formula I

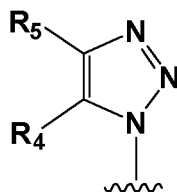
wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

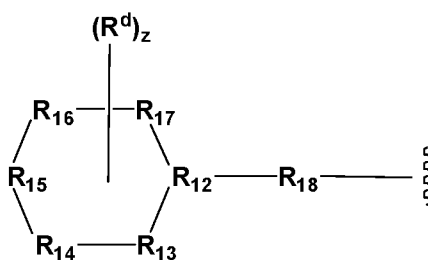
wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C₁-C₃ alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is $-O-CH_3$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0. In some embodiments, R^d is at R_{15} ;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth,

twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C₁-C₃ alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C₁-C₃ alkyl. In some embodiments R_{39} and R_{40} are C₁-C₃ alkyl. In some embodiments all R_{42} are hydrogen. In some
5 embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all
10 but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are
15 hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

20 In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is C($R_{39}R_{40}$), and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are C($R_{42}R_{43}$) and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is $-O-CH_3$, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, and p is 0.
25 In some embodiments, R^d is at R_{15} . In some embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} .

Z2-Y13

In some embodiments, the compounds are represented by the general formula:

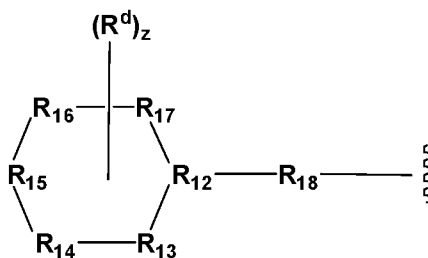
30 $-X-R_1$

Formula I

wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

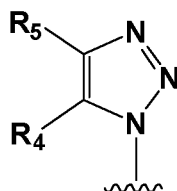
wherein **A** and R₃ are



Formula VI

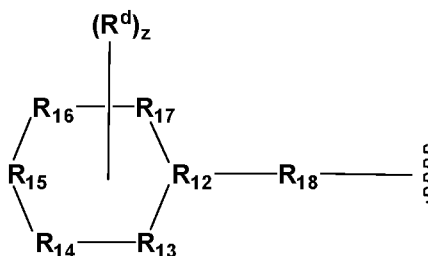
- wherein for **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b,
 5 the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, p is 0 to 10, and R₁₉ are independently hydrogen or C₁-C₃ alkyl;

wherein **B** and R^b are:



Formula III

- 10 wherein each **C**, R₄, and R₅ are independently hydrogen or



Formula VI

- wherein for **C**, R₄, and R₅, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0, the
 ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, one R₁₉ is -OH, the other R₁₉ is
 15 hydrogen, and p is 1;

wherein R₄ and R₅ are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR₂.

- In some embodiments where **A** or R₃ is Formula VI, R^d is at R₁₅. In some
 20 embodiments, R^d is at R₁₃. In some embodiments, R^d is at R₁₄. In some embodiments, R^d
 is at R₁₆. In some embodiments, R^d is at R₁₇. In some embodiments, p is 0. In some
 embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some

embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

In some embodiments where **A** or R₃ is Formula VI, in such **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, p is 1, and R₁₉ are hydrogen.

In some embodiments, in Formula VI, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 0, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, one R₁₉ is -OH, the other R₁₉ is hydrogen, and p is 1.

Z2-Y5

In some embodiments, the compounds are represented by the general formula:



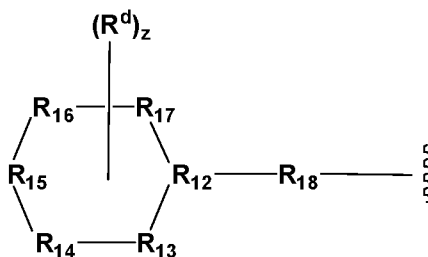
15

Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b;

wherein **A** and R₃ are

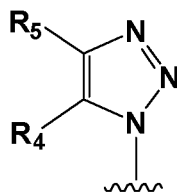


20

Formula VI

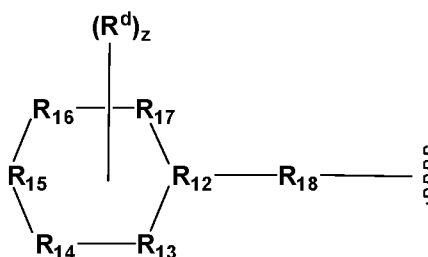
wherein for **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p-, p is 0 to 10, and R₁₉ are independently hydrogen or C₁-C₃ alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula VI

wherein for **C**, R_4 , and R_5 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is methyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 0, q is 0, and X_b is $S(O)_2$;

10 wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is Formula VI, R^d is at R_{15} . In some
 15 embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d is at R_{16} . In some embodiments, R^d is at R_{17} . In some embodiments, p is 0. In some
 embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some
 embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some
 embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some
 embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen.
 20 In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three
 R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where **A** or R_3 is Formula VI, in such **A** and R_3 , R_{12} , R_{13} ,
 R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18}
 is $-(CR_{19}R_{19})_p-$, p is 1, and R_{19} are hydrogen.

In some embodiments, in Formula VI, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R_d is methyl, the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, p is 0, q is 0, and X_b is $S(O)_2$.

Z2-Y7

5 In some embodiments, the compounds are represented by the general formula:

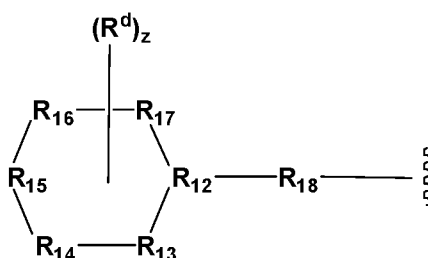


Formula I

wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

10 wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

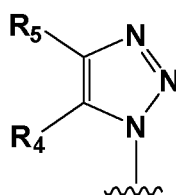
wherein A and R_3 are



Formula VI

15 wherein for A and R_3 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and R_{19} are independently hydrogen or C_1 - C_3 alkyl;

wherein B and R^b are:



Formula III

20 wherein each C , R_4 , and R_5 are independently hydrogen or $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, j is 1 to 10, one R_g is O , the other R_g are $C(R_{42}R_{43})$, and R_f is $C(R_{45}R_{46}R_{47})$, wherein R_{39} , R_{40} , R_{42} , R_{43} , R_{45} , R_{46} , and R_{47} are hydrogen;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of C is not hydrogen.

25 X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R₃ is Formula VI, R^d is at R₁₅. In some embodiments, R^d is at R₁₃. In some embodiments, R^d is at R₁₄. In some embodiments, R^d is at R₁₆. In some embodiments, R^d is at R₁₇. In some embodiments, p is 0. In some embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some embodiments all R₁₉ are hydrogen. In some embodiments all but one R₁₉ are hydrogen. In some embodiments all but two R₁₉ are hydrogen. In some embodiments all but three R₁₉ are hydrogen. In some embodiments all but four R₁₉ are hydrogen.

10 In some embodiments where **A** or R₃ is Formula VI, in such **A** and R₃, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are carbon, z is 1, R^d is R^b, the ring of Formula VI is aromatic, R₁₈ is -(CR₁₉R₁₉)_p⁻, p is 1, and R₁₉ are hydrogen.

In some embodiments R_h is C(R₃₉R₄₀), j is 1, R_g is O, and R_f is C(R₄₅R₄₆R₄₇), wherein R₃₉, R₄₀, R₄₅, R₄₆, and R₄₇ are hydrogen. In some embodiments R_h is absent, j is 1, R_g is O, and R_f is C(R₄₅R₄₆R₄₇), wherein R₄₅, R₄₆, and R₄₇ are hydrogen.

In some embodiments R_h is C(R₃₉R₄₀), j is 1 to 10, one R_g is O, the other R_g are C(R₄₂R₄₃), and R_f is C(R₄₅R₄₆R₄₇), wherein R₃₉, R₄₀, R₄₂, R₄₃, R₄₅, R₄₆, and R₄₇ are hydrogen. In some embodiments the last R_g is O. In some embodiments the penultimate R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments the fourth from the last R_g is O. In some embodiments the fifth from the last R_g is O. In some embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some embodiments the fourth R_g is O. In some embodiments the fifth R_g is O.

Z2-Y6

25 In some embodiments, the compounds are represented by the general formula:

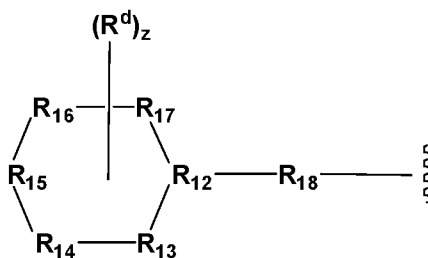


Formula I

wherein X is oxygen, sulfur, NR₂, or another group compatible with attachment or coupling of the compound to a product or surface;

30 wherein R₁ is **-A-B(-C)_δ** or -R₃-R^b,

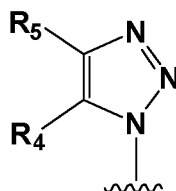
wherein **A** and R_3 are



Formula VI

- wherein for **A** and R_3 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b ,
 5 the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p-$, p is 0 to 10, and R_{19} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

- wherein each **C**, R_4 , and R_5 are independently hydrogen or $-R_h-(R_g)_j$,
 wherein for **C** and R_5 , R_h is NR_{41} , j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein
 R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$
 to 10, R_{gx} is $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{42x} , R_{43x} ,
 R_{45x} , R_{46x} , R_{47x} are hydrogen; wherein for **C** and R_4 , R_h is $C(R_{39}R_{40})$, j is 0 to 10, and
 15 each R_g is $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , R_{43} are hydrogen;
 wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not
 hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

- In some embodiments where **A** or R_3 is Formula VI, R^d is at R_{15} . In some
 20 embodiments, R^d is at R_{13} . In some embodiments, R^d is at R_{14} . In some embodiments, R^d
 is at R_{16} . In some embodiments, R^d is at R_{17} . In some embodiments, p is 0. In some
 embodiments p is 1. In some embodiment p is 2. In some embodiments p is 3. In some
 embodiment p is 4. In some embodiments p is 5. In some embodiments p is 7. In some
 embodiment p is 8. In some embodiments p is 9. In some embodiments p is 10. In some
 25 embodiments all R_{19} are hydrogen. In some embodiments all but one R_{19} are hydrogen.

In some embodiments all but two R_{19} are hydrogen. In some embodiments all but three R_{19} are hydrogen. In some embodiments all but four R_{19} are hydrogen.

In some embodiments where **A** or R_3 is Formula VI, in such **A** and R_3 , R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are carbon, z is 1, R^d is R^b , the ring of Formula VI is aromatic, R_{18} is $-(CR_{19}R_{19})_p$, p is 1, and R_{19} are hydrogen.

In some embodiments R_h is NR_{41} , j is 1, and R_g is $C(R_{42}R_{43})$, wherein R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} and R_{43} are hydrogen, wherein R_{hx} is absent, $jx = 1$, R_{gx} is $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{42x} , R_{43x} , R_{45x} , R_{46x} , R_{47x} are hydrogen.

In some embodiments R_h is NR_{41} , j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{41} is $-R_{hx}-(R_{gx})_{jx}-R_{fx}$, and R_{42} and R_{43} are hydrogen, wherein R_{hx} is $C(R_{39x}R_{40x})$, $jx = 0$ to 10, R_{gx} is $C(R_{42x}R_{43x})$, and R_{fx} is $C(R_{45x}R_{46x}R_{47x})$, and wherein R_{39x} , R_{40x} , R_{42x} , R_{43x} , R_{45x} , R_{46x} , R_{47x} are hydrogen. In some embodiments $j = jx$. In some embodiments j and jx are 0. In some embodiment j and jx are 2. In some embodiments j and jx are 3. In some embodiments j and jx are 4.

In some embodiments R_h is $C(R_{39}R_{40})$, and j is 0, wherein R_{39} and R_{40} are hydrogen. In some embodiments R_h is $C(R_{39}R_{40})$, j is 0 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , R_{43} are hydrogen. In some embodiments j is 1. In some embodiment j is 2. In some embodiments j is 3. In some embodiments j is 4.

Z1-Y10

In some embodiments, compounds are represented by the general formula:



Formula I

wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

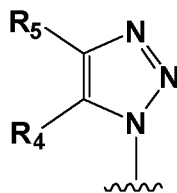
wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-

ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1 - C_3 alkyl;

wherein **B** and R^b are:



Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or $-R_h-(R_g)_j$,

wherein R_h is absent, j is 1 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not

hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are

hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments R_h is absent, j is 6, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments R_h is absent, j is 1 to 10, and each R_g is $C(R_{42}R_{43})$, wherein R_{42} and R_{43} are hydrogen. In some embodiments j is 3. In some embodiment j is 4. In some embodiments j is 5. In some embodiments j is 7. In some embodiment j is 8. In some embodiments j is 9. In some embodiments j is 10.

Z1-Y11

In some embodiments, compounds are represented by the general formula:



Formula I

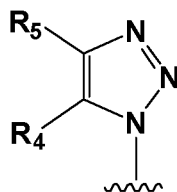
wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

wherein **A** and R_3 are $-R_h-(R_g)_j$,

wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1-C_3 alkyl;

5



Formula III

wherein each **C**₁, R₄, and R₅ are independently hydrogen or -R_h-(R_g)_i,

wherein R_h is $C(R_{39}R_{40})$, j is 1 to 10, one R_g is O, and the other R_g are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen;

wherein R₄ and R₅ are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR₂.

10 In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, 15 twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some 20 embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some 25 embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all 30 but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some

embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10,
 5 wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 3, the first R_g is O, and the second and third R_g are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some
 embodiments R_h is $C(R_{39}R_{40})$, j is 1 to 10, one R_g is O, and the other R_g are $C(R_{42}R_{43})$,
 10 wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the first R_g is O. In some embodiments the second R_g is O. In some embodiments the third R_g is O. In some
 embodiments the fourth R_g is O. In some embodiments the fifth R_g is O. In some
 embodiments the fifth from the last R_g is O. In some embodiments the fourth from the
 last R_g is O. In some embodiments the antepenultimate R_g is O. In some embodiments
 15 the penultimate R_g is O. In some embodiments the last R_g is O.

In some embodiments R_h is $C(R_{39}R_{40})$, j is 4 to 16, two R_g are O, and the other R_g
 are $C(R_{42}R_{43})$, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen. In some embodiments the
 first and third R_g are O. In some embodiments the first and fourth R_g are O. In some
 embodiments the first and fifth R_g are O. In some embodiments the first and sixth R_g are
 20 O. In some embodiments the first and seventh R_g are O. In some embodiments the first
 and eighth R_g are O. In some embodiments the first and ninth R_g are O. In some
 embodiments the first and tenth R_g are O. In some embodiments the first and eleventh R_g
 are O. In some embodiments the first and twelfth R_g are O. In some embodiments the
 first and thirteenth R_g are O. In some embodiments the first and fourteenth R_g are O. In
 25 some embodiments the first and fifteenth R_g are O. In some embodiments the second and
 fourth R_g are O. In some embodiments the second and fifth R_g are O. In some
 embodiments the second and sixth R_g are O. In some embodiments the second and
 seventh R_g are O. In some embodiments the second and eighth R_g are O. In some
 embodiments the second and ninth R_g are O. In some embodiments the second and tenth
 30 R_g are O. In some embodiments the second and eleventh R_g are O. In some embodiments
 the second and twelfth R_g are O. In some embodiments the second and thirteenth R_g are
 O. In some embodiments the second and fourteenth R_g are O. In some embodiments the
 second and fifteenth R_g are O. In some embodiments the third and fifth R_g are O. In some
 embodiments the third and sixth R_g are O. In some embodiments the third and seventh R_g

are O. In some embodiments the third and eighth R_g are O. In some embodiments the third and ninth R_g are O. In some embodiments the third and tenth R_g are O. In some embodiments the third and eleventh R_g are O. In some embodiments the third and twelfth R_g are O. In some embodiments the third and thirteenth R_g are O. In some embodiments the third and fourteenth R_g are O. In some embodiments the third and fifteenth R_g are O. In some embodiments the fourth and sixth R_g are O. In some embodiments the fourth and seventh R_g are O. In some embodiments the fourth and eighth R_g are O. In some embodiments the fourth and ninth R_g are O. In some embodiments the fourth and tenth R_g are O. In some embodiments the fourth and eleventh R_g are O. In some embodiments the fourth and twelfth R_g are O. In some embodiments the fourth and thirteenth R_g are O. In some embodiments the fourth and fourteenth R_g are O. In some embodiments the fourth and fifteenth R_g are O. In some embodiments the fifth and seventh R_g are O. In some embodiments the fifth and eighth R_g are O. In some embodiments the fifth and ninth R_g are O. In some embodiments the fifth and tenth R_g are O. In some embodiments the fifth and eleventh R_g are O. In some embodiments the fifth and twelfth R_g are O. In some embodiments the fifth and thirteenth R_g are O. In some embodiments the fifth and fourteenth R_g are O. In some embodiments the fifth and fifteenth R_g are O. In some embodiments the sixth and eighth R_g are O. In some embodiments the sixth and ninth R_g are O. In some embodiments the sixth and tenth R_g are O. In some embodiments the sixth and eleventh R_g are O. In some embodiments the sixth and twelfth R_g are O. In some embodiments the sixth and thirteenth R_g are O. In some embodiments the sixth and fourteenth R_g are O. In some embodiments the sixth and fifteenth R_g are O. In some embodiments the seventh and ninth R_g are O. In some embodiments the seventh and tenth R_g are O. In some embodiments the seventh and eleventh R_g are O. In some embodiments the seventh and twelfth R_g are O. In some embodiments the seventh and thirteenth R_g are O. In some embodiments the seventh and fourteenth R_g are O. In some embodiments the seventh and fifteenth R_g are O. In some embodiments the eighth and tenth R_g are O. In some embodiments the eighth and eleventh R_g are O. In some embodiments the eighth and twelfth R_g are O. In some embodiments the eighth and thirteenth R_g are O. In some embodiments the eighth and fourteenth R_g are O. In some embodiments the eighth and fifteenth R_g are O. In some embodiments the ninth and eleventh R_g are O. In some embodiments the ninth and twelfth R_g are O. In some embodiments the ninth and thirteenth R_g are O. In some embodiments the ninth and fourteenth R_g are O. In some embodiments the ninth and fifteenth R_g are O. In some

embodiments the tenth and twelfth R_g are O. In some embodiments the tenth and thirteenth R_g are O. In some embodiments the tenth and fourteenth R_g are O. In some embodiments the tenth and fifteenth R_g are O. In some embodiments the eleventh and thirteenth R_g are O. In some embodiments the eleventh and fourteenth R_g are O. In some
5 embodiments the eleventh and fifteenth R_g are O. In some embodiments the twelfth and fourteenth R_g are O. In some embodiments the twelfth and fifteenth R_g are O. In some embodiments the thirteenth and fifteenth R_g are O.

Z1-Y2

In some embodiments, compounds are represented by the general formula:

10



Formula I

wherein X is oxygen, sulfur, NR_2 , or another group compatible with attachment or coupling of the compound to a product or surface;

wherein R_1 is $-A-B(-C)_\delta$ or $-R_3-R^b$;

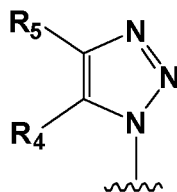
15

wherein **A** and R_3 are $-R_h-(R_g)_j$,

20

wherein R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are independently hydrogen or C_1-C_3 alkyl;

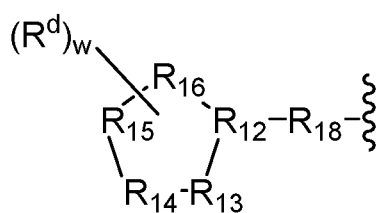
wherein **B** and R^b are:



25

Formula III

wherein each **C**, R_4 , and R_5 are independently hydrogen or



Formula IX

wherein for **C**, R_4 , and R_5 , R_{13} and R_{14} are oxygen, R_{12} , R_{15} , and R_{16} are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and p is 1;

wherein R_4 and R_5 are not both hydrogen, wherein at least one of **C** is not hydrogen.

X is preferably oxygen, sulfur, or NR_2 .

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 4 to 31, wherein the first, third, fourth, sixth, seventh, ninth, tenth, twelfth, thirteenth, fifteenth, sixteenth, eighteenth, nineteenth, twenty-first, twenty-second, twenty-fourth, twenty-fifth, twenty-seventh, twenty-eighth, thirtieth, and thirty-first R_g , if present, are $C(R_{42}R_{43})$ and the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth, twenty-third, twenty-sixth, and twenty-ninth, R_g , if present, are O, wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen or C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are hydrogen. In some embodiments R_{39} is hydrogen and R_{40} is C_1 - C_3 alkyl. In some embodiments R_{39} and R_{40} are C_1 - C_3 alkyl. In some embodiments all R_{42} are hydrogen. In some embodiments all but one R_{42} are hydrogen. In some embodiments all but two R_{42} are hydrogen. In some embodiments all but three R_{42} are hydrogen. In some embodiments all but four R_{42} are hydrogen. In some embodiments all but five R_{42} are hydrogen. In some embodiments all but six R_{42} are hydrogen. In some embodiments all but seven R_{42} are hydrogen. In some embodiments all but eight R_{42} are hydrogen. In some embodiments all but nine R_{42} are hydrogen. In some embodiments all but ten R_{42} are hydrogen. In some embodiments all but eleven R_{42} are hydrogen. In some embodiments all but twelve R_{42} are hydrogen. In some embodiments all R_{43} are hydrogen. In some embodiments all but one R_{43} are hydrogen. In some embodiments all but two R_{43} are hydrogen. In some embodiments all but three R_{43} are hydrogen. In some embodiments all but four R_{43} are hydrogen. In some embodiments all but five R_{43} are hydrogen. In some embodiments all but six R_{43} are hydrogen. In some embodiments all but seven R_{43} are hydrogen. In some embodiments all but eight R_{43} are hydrogen. In some embodiments all but nine R_{43} are

hydrogen. In some embodiments all but ten R_{43} are hydrogen. In some embodiments all but eleven R_{43} are hydrogen. In some embodiments all but twelve R_{43} are hydrogen.

In some embodiments where **A** or R_3 is $-R_h-(R_g)_j$, R_h is $C(R_{39}R_{40})$, and j is 10, wherein the first, third, fourth, sixth, seventh, ninth, and tenth R_g are $C(R_{42}R_{43})$ and the
5 second, fifth, and eighth R_g are O, and wherein R_{39} , R_{40} , R_{42} , and R_{43} are hydrogen.

In some embodiments, in Formula IX, R_{13} and R_{14} are oxygen, R_{12} , R_{15} , and R_{16} are carbon, w is 0, the ring of Formula IX has no double bonds, R_{18} is $-(CR_{19}R_{19})_p-$, both R_{19} are hydrogen, and p is 1.

The hydrophobicity/hydrophilicity of surfaces of the surface-modified product
10 can be varied by the incorporation of hydrophobic compounds, hydrophilic compounds, or both on the surfaces. In preferred embodiments, the modified surface contains one or more hydrophobic covalently attached compounds. The relative hydrophobicity/hydrophilicity of the surface or a surface of the surface-modified product can be quantitatively assessed by measuring the contact angle of a water droplet on such
15 a surface. In some embodiments, the water droplet has a contact angle of less than 90° (i.e., the surface is hydrophilic). In preferred embodiments, the water droplet has a contact angle greater than or equal to 90° (i.e., the surface is hydrophobic). In some embodiments, the water droplet has a contact angle greater than or equal to 95° , 100° , 105° , 110° , 115° , or 120° .

20 The compounds described herein, provide bioinert surfaces when used to coat the surfaces of products. In some embodiments the surface or a surface of the product is substantially covered with the compounds, wherein the surface or a surface is covalently modified as described herein.

Also contemplated are products containing a surface that has been modified using
25 a compound that renders the surface or a surface bioinert, such as those described above, and another compound that renders the surface or a surface bioactive, such as those described by Franz, Ward and Slee, the contents of which are incorporated herein by reference.

III. Products

30 The disclosed products generally can be products that (1) are useful for treating a disease or disorder in a subject and (2) have a surface that can be chemically modified with a compound as disclosed herein. Useful products include, for example, devices, prostheses, and other materials for implantation in a subject or to be in long term contact with biomaterial, such as blood or body fluids, of a subject. A product can have any

form, composition, use, and purpose that can be used to treat a subject. A product can include a biological material, such as cells, or other therapeutic agent, such as drugs, antibodies, nucleic acids, vaccines, and hormones.

5 The surfaces of products can be chemically modified as described herein to any desired density of modifications. The density of modifications is the average number of modifications (that is, attached compounds) per a given area of the surface or a surface of the product. Generally, a density at or above a threshold density can provide a beneficial effect, such as lower foreign body response. In some embodiments, a high density is not required. Without being bound to any particular theory of operation, it is
10 believed that the chemical modifications signal to, indicate to, or are identified by, one or more immune system or other body components to result in a beneficial effect, such as a lower foreign body response. In some embodiments, a lower density of modifications can be effective for this purpose.

It has been discovered that coverage of products need not be at the same or at an
15 even density. For example, in some embodiments, the density can vary over all or part of the product or surface, can be patchy, or can be uneven. Thus, in some embodiments, density can be referred to as the average over the entire product or surface or a portion or component of the product or surface. Density can be characterized as or by the local density of a portion of the product or surface. In such cases, other portions of the product
20 or surface can have densities that are the same or different from the referenced local density (in other words, reference to the density of a portion of the product or surface does not preclude density of other parts of the product or surface from being the same or different). In some embodiments, the product, surface, or portions thereof, can also have smooth or uneven gradients of density. Gradients of density can vary through any of the
25 density ranges disclosed herein.

Useful densities include densities of at least, of less than, of about, or of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500,
30 550, 600, 650, 700, 750, 800, 850, 900, and 1000 modifications per square μm . All ranges defined by any pair of these densities are also specifically contemplated and disclosed.

In some embodiments, the density of the modifications on a surface, surfaces, or portions of a surface(s) of a product that, when the product is administered to (e.g.,

implanted in the body of) a subject, would be in contact with fluid(s), cell(s), tissue(s), other component(s), or a combination thereof of the subject's body is greater than the density of the modifications on other surfaces of the product.

Density can also be expressed in terms of the concentration of the surface
5 modifications as measured by X-ray photoelectron spectroscopy (XPS). XPS is a surface-sensitive quantitative spectroscopic technique that measures the elemental composition at the parts per thousand range of the elements that exist within a material. XPS spectra are obtained by irradiating a material with a beam of X-rays while simultaneously measuring the kinetic energy and number of electrons that escape from
10 the top 0 to 10 nm of the material being analyzed. By measuring all elements present on the surface, the percentage of the elements that come from the surface modifications can be calculated. This can be accomplished by, for example, taking the percentage of nitrogen (and/or other elements in the surface modifications) in the total elemental signal measured. Nitrogen is a useful indicator for the surface modification because many
15 substrated and materials forming the product contain little nitrogen. For convenience, the percent of the element(s) used to indicate the surface modifications can be stated as the percent surface modifications. Also for convenience, the percent surface modifications can be referred to as the concentration of surface modifications. Examples of XPS analysis and concentrations of surface modifications are shown in Tables 4-7.

20 Useful percent surface modifications include concentrations of about 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100 percent surface modifications. All ranges defined by any pair of these concentrations are also specifically contemplated and disclosed.

25 Useful percent surface modifications also include concentrations of less than 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100 percent surface modifications. All ranges defined by any pair of these concentrations are also specifically contemplated and disclosed.

30 Useful percent surface modifications also include concentrations of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100 percent surface modifications. All ranges defined by any pair of these concentrations are also specifically contemplated and disclosed.

A. Materials

Useful materials that can constitute all or a part of a product (e.g., that includes its surface) include a variety of different substrates and substances that the disclosed chemical compounds can be, for example, applied to, absorbed into, or coupled to.

- 5 Examples of suitable materials include metals, metallic materials, ceramics, polymers, fibers, inert materials such as silicon, and combinations thereof.

Suitable metallic materials include, but are not limited to, metals and alloys based on titanium (such as nitinol, nickel titanium alloys, thermo-memory alloy materials), platinum, platinum group alloys, stainless steel, tantalum, palladium, zirconium,
10 niobium, molybdenum, nickel-chrome, or certain cobalt alloys including cobalt-chromium and cobalt-chromium-nickel alloys such as ELGILOY® and PHYNOX®. Useful examples include stainless steel grade 316 (SS 316L) (comprised of Fe, <0.3% C, 16-18.5% Cr, 10-14% Ni, 2-3% Mo, <2% Mn, <1% Si, <0.45% P, and <0.03% S), tantalum, chromium molybdenum alloys, nickel-titanium alloys (such as nitinol) and
15 cobalt chromium alloys (such as MP35N, ASTM Material Designation: 35Co-35Ni-20Cr-10Mo). Typical metals currently in use for stents include SS 316L steel and MP35N. See also, "Comparing and Optimizing Co-Cr Tubing for Stent Applications," Poncin, P, Millet, C., Chevy, J, and Profit, J. L., Materials & Processes for Medical Devices Conference, August 2004, ASM International.

- 20 Suitable ceramic materials include, but are not limited to, oxides, carbides, or nitrides of the transition elements such as titanium oxides, hafnium oxides, iridium oxides, chromium oxides, aluminum oxides, and zirconium oxides. Silicon based materials, such as silica, may also be used.

Suitable polymeric materials include, but are not limited to, polystyrene and
25 substituted polystyrenes, polyethylene, polypropylene, polyacetylene, TEFLON®, poly(vinyl chloride) (PVC), polyolefin copolymers, poly(urethane)s, polyacrylates and polymethacrylates, polyacrylamides and polymethacrylamides, poly(methyl methacrylate), poly(2-hydroxyethyl methacrylate), polyesters, polysiloxanes, polydimethylsiloxane (PDMS), polyethers, poly(orthoester), poly(carbonates),
30 poly(hydroxyalkanoate)s, polyfluorocarbons, PEEK®, Teflon® (polytetrafluoroethylene, PTFE), PEEK, silicones, epoxy resins, Kevlar®, Dacron® (a condensation polymer obtained from ethylene glycol and terephthalic acid), polyethylene glycol, nylon, polyalkenes, phenolic resins, natural and synthetic elastomers, adhesives and sealants, polyolefins, polysulfones, polyacrylonitrile, biopolymers such as polysaccharides and

natural latex, collagen, cellulosic polymers (e.g., alkyl celluloses, etc.), polyethylene glycol and 2-hydroxyethyl methacrylate (HEMA), polysaccharides, poly(glycolic acid), poly(L-lactic acid) (PLLA), poly(lactic glycolic acid) (PLGA), a polydioxanone (PDA), or racemic poly(lactic acid), polycarbonates, (e.g., polyamides (nylon); fluoroplastics, carbon fiber, agarose, alginate, chitsan, and blends or copolymers thereof.

In some embodiments, the polymer is alginate, e.g., a polysaccharides made up of β -D-mannuronic acid (M) and α -L-guluronic acid (G) linked together. In some embodiments, alginate is a high guluronic acid (G) alginate. In some embodiments, the alginate is a high mannuronic acid (M) alginate. In some embodiments, the ratio of M:G is about 1. In some embodiments, the ratio of M:G is less than 1. In some embodiments, the ratio of M:G is greater than 1.

The polymer can be covalently or non-covalently associated with the surface; however, in particular embodiments, the polymer is non-covalently associated with the surface. The polymer can be applied by a variety of techniques in the art including, but not limited to, spraying, wetting, immersing, dipping, such as dip coating (e.g., intraoperative dip coating), painting, or otherwise applying a hydrophobic, polycationic polymer to a surface of the implant.

B. Product Forms

A product can have any form, composition, use, and purpose that can be used to treat a subject. For example, useful products include devices, prostheses, and other components for implantation or incorporation into a subject. Products useful for surface modification include any types of medical devices used, at least in part, for implantation in the body, or in long term contact with biomaterial, of a patient or subject in need thereof. Examples include, but are not limited to, implants, implantable medical products, implantable devices, catheters and other tubes (including urological and biliary tubes, endotracheal tubes, wound drain tubes, needle injection catheters, peripherally insertable central venous catheters, dialysis catheters, long term tunneled central venous catheters peripheral venous catheters, short term central venous catheters, arterial catheters, pulmonary catheters, Swan-Ganz catheters, urinary catheters, peritoneal catheters), vascular catheter ports, blood clot filters, urinary devices (including long term urinary devices, tissue bonding urinary devices, artificial urinary sphincters, urinary dilators), shunts (including ventricular or arterio-venous shunts, stent transplants, biliary stents, intestinal stents, bronchial stents, esophageal stents, ureteral stents, and hydrocephalus shunts), cannulas, (including intravenous cannulas and nasal cannulas),

balloons, pacemakers, implantable defibrillators, orthopedic products (including pins, plates, screws, and implants), transplants (including organs, vascular transplants, vessels, aortas, heart valves, and organ replacement parts), prostheses (including breast implants, penile prostheses, vascular grafting prostheses, heart valves, artificial joints, artificial larynxes, otological implants, artificial hearts, artificial blood vessels, and artificial kidneys), aneurysm-filling coils and other coil devices, transmyocardial revascularization devices, percutaneous myocardial revascularization devices, tubes, fibers, hollow fibers, membranes, blood containers, titer plates, adsorber media, dialyzers, connecting pieces, sensors, valves, endoscopes, filters, pump chambers, scalpels, needles, scissors (and other devices used in invasive surgical, therapeutic, or diagnostic procedures), and other medical products and devices intended to have anti-fibrotic properties. The expression "medical products" is broad and refers in particular to products that come in contact with blood briefly (e.g., endoscopes) or permanently (e.g., stents).

Useful medical products are balloon catheters and endovascular prostheses, in particular stents. Stents of a conventional design have a filigree support structure composed of metallic struts. The support structure is initially provided in an unexpanded state for insertion into the body, and is then widened into an expanded state at the application site. The stent can be coated before or after it is crimped onto a balloon. A wide variety of medical endoprotheses or medical products or implants for highly diverse applications and are known. They are used, for example, to support vessels, hollow organs, and ductal systems (endovascular implants), to attach and temporarily affix tissue implants and tissue transplants, and for orthopedic purposes such as pins, plates, or screws.

Substrates can be in the form of, or form part of, films, particles (nanoparticles, microparticles, or millimeter diameter beads), fibers (wound dressings, bandages, gauze, tape, pads, sponges, including woven and non-woven sponges and those designed specifically for dental or ophthalmic surgeries), sensors, pacemaker leads, catheters, stents, contact lenses, bone implants (hip replacements, pins, rivets, plates, bone cement, etc.), or tissue regeneration or cell culture devices, or other medical devices used within or in contact with the body.

Implants with surface modifications are described herein. "Implants" are any object intended for placement in the body of a mammal, such as a human, that is not a living tissue. Implants are a form of medical product. Implants include naturally derived objects that have been processed so that their living tissues have been devitalized. As an

example, bone grafts can be processed so that their living cells are removed, but so that their shape is retained to serve as a template for ingrowth of bone from a host. As another example, naturally occurring coral can be processed to yield hydroxyapatite preparations that can be applied to the body for certain orthopedic and dental therapies.

- 5 An implant can also be an article comprising artificial components. The term "implant" can be applied to the entire spectrum of medical devices intended for placement in a human body or that of a mammal, including orthopedic applications, dental applications, ear, nose, and throat ("ENT") applications, and cardiovascular applications.

- In some embodiments, "implant" as used herein refers to a macroscopic composition including a device for implantation or a surface of a device for implantation with a covalently modified surface. In some embodiments, the implant a device for implantation or a surface of a device for implantation and a modified alginate polymer coating. In these embodiments, the term "implant" does not encompass nanoparticles and/or microparticles. "Macroscopic" as used herein generally refers to devices, implants, or compositions that can be viewed by the unaided eye. In some embodiments the implant is extravascular. In some embodiments the implant is intravascular.
- 10
15

- Examples of implantable medical devices and medical devices and mechanical structures that can use a bio-compatible coating include, but are not limited to, stents, conduits, scaffolds, cardiac valve rings, cardiovascular valves, pacemakers, hip replacement devices, implanted sensor devices, esophageal stents, heart implants, bio-compatible linings for heart valves, dialysis equipment and oxygenator tubing for heart-lung by-pass systems.
- 20

- In general, a stent is a device, typically tubular in shape, that is inserted into a lumen of the body, such as a blood vessel or duct, to prevent or counteract a localized flow constriction. The purpose of a stent, in some cases, is to mechanically prop open a bodily fluid conduit. Stents are often used to alleviate diminished blood flow to organs and extremities in order to maintain adequate delivery of oxygenated blood. The most common use of stents is in coronary arteries, but they are also widely used in other bodily conduits, such as, for example, central and peripheral arteries and veins, bile ducts, the esophagus, colon, trachea, large bronchi, ureters, and urethra. Frequently, stents inserted into a lumen are capable of being expanded after insertion or are self-expanding. For example, metal stents are deployed into an occluded artery using a balloon catheter and expanded to restore blood flow. For example, stainless steel wire mesh stents are commercially available from Boston Scientific, Natick, Mass.
- 25
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In some embodiments, the implant is an orthopedic implant. An “orthopedic implant” is defined as an implant which replaces bone or provides fixation to bone, replaces articulating surfaces of a joint, provides abutment for a prosthetic, or combinations thereof or assists in replacing bone or providing fixation to bone, replacing articulating surfaces of a joint, providing abutment for a prosthetic, and combinations thereof.

Orthopedic implants can be used to replace bone or provide fixation to bone, replace articulating surfaces of a joint, provide abutment for a prosthetic, or combinations thereof or assist in replacing bone or providing fixation to bone, replacing articulating surfaces of a joint, providing abutment for a prosthetic, including dental applications, and combinations thereof.

Suitable orthopedic implants include, but are not limited to, wire, Kirschner wire, bone plates, screws, pins, tacs, rods, nails, nuts, bolts, washers, spikes, buttons, wires, fracture plates, reconstruction and stabilizer devices, endo- and exoprostheses (articulating and non-articulating), intraosseous transcutaneous prostheses, spacers, mesh, implant abutments, anchors, barbs, clamps, suture, interbody fusion devices, tubes of any geometry, scaffolds, and combinations thereof.

In other embodiments, the implant is an ear, nose, and/or throat (“ENT”) implant. Exemplary ENT implants include, but are not limited to, ear tubes, endotracheal tubes, ventilation tubes, cochlear implants and bone anchored hearing devices.

In other embodiments, the implant is a cardiovascular implant. Exemplary cardiovascular implants are cardiac valves or alloplastic vessel wall supports, total artificial heart implants, ventricular assist devices, vascular grafts, stents, electrical signal carrying devices such as pacemaker and neurological leads, defibrillator leads, and the like.

In some embodiments, products can be surface modified artificial organs and organ-repair implants. For example, surface modified substrate material surfaces that are used in the preparation of scaffolds and/or matrices that are subsequently used to fabricate surgical implants for diseased or impaired organs or used to grow whole, artificial organs. A variety of materials have been used in scaffold applications such as, but not limited to, tubular, fibrous, filamentous, and woven polymers, and natural materials. Other starting material configurations suitable for scaffold fabrication include woven or knitted items, micro- or nano-spheres (i.e., fullerenes), micro- or nano-tubes,

cobweb-like configurations or foams/sponge-like forms. Any of these materials may be surface modified as disclosed herein.

In some embodiments, products can be chemically modified cardiovascular, vascular and associated implant devices. For example, surface modified cardiovascular or vascular implants can be used to improve the biocompatibility of medical devices
5 meant to be implanted into the body. In those cases where the implant's surface interfaces with blood, other body fluids and/or tissue, these surfaces can be modified. Such modifications can be combined with other chemical and/or biological coating of cardiovascular implants useful to prevent formation of thrombi, aggregation, and
10 ultimately emboli.

Implants can be prepared from a variety of materials. In some embodiments, the material is biocompatible. In some embodiments, the material is biocompatible and non-biodegradable. Exemplary materials include metallic materials, metal oxides, polymeric materials, including degradable and non-degradable polymeric materials, ceramics,
15 porcelains, glass, allogeneic, xenogenic bone or bone matrix; genetically engineered bone; and combinations thereof.

In some embodiments, the products can have any suitable shape. Useful shapes include spheres, sphere-like shapes, spheroids, spheroid-like shapes, ellipsoids, ellipsoid-like shapes, stadiumoids, stadiumoid-like shapes, disks, disk-like shapes, cylinders,
20 cylinder-like shapes, rods, rod-like shapes, cubes, cube-like shapes, cuboids, cuboid-like shapes, toruses, torus-like shapes, and flat and curved surfaces. Products, devices, and surfaces that have been or will be derivatized can have any of these shapes or any shape suitable for the product, device, or surface.

Spheres, spheroids, and ellipsoids are shapes with curved surfaces that can be
25 defined by rotation of circles, ellipses, or a combination around each of the three perpendicular axes, a, b, and c. For a sphere, the three axes are the same length. For oblate spheroids (also referred to as oblate ellipsoids of rotation), the length of the axes are $a = b > c$. For prolate spheroids (also referred to as prolate ellipsoids of rotation), the length of the axes are $a = b < c$. For tri-axial ellipsoids (also referred to as scalene
30 ellipsoids), the length of the axes are $a > b > c$. Stadiumoids are rotational shapes of stadiums. Cylinders are rotational shapes of rectangles rotated on the long axis. Disks are squashed cylinders where the diameter is greater than the height. Rods are elongated cylinders where the long axis is ten or more times the diameter.

“Sphere-like shape,” “spheroid-like shape,” “ellipsoid-like shape,” “stadiumoid-like shape,” “cylinder-like shape,” “rod-like shape,” “cube-like shape,” “cuboid-like shape,” and “torus-like shape” refers to an object having a surface that roughly forms a sphere, spheroid, ellipsoid, stadiumoid, cylinder, rod, cube, cuboid, or torus,
5 respectively. Beyond a perfect or classical form of the shape, a sphere-like shape, spheroid-like shape, ellipsoid-like shape, stadiumoid-like shape, cylinder-like shape, rod-like shape, cube-like shape, cuboid-like shape, and torus-like shape can have waves and undulations.

Generally, a sphere-like shape is an ellipsoid (for its averaged surface) with semi-
10 principal axes within 10% of each other. The diameter of a sphere or sphere-like shape is the average diameter, such as the average of the semi-principal axes. Generally, a spheroid-like shape is an ellipsoid (for its averaged surface) with semi-principal axes within 100% of each other. The diameter of a spheroid or spheroid-like shape is the average diameter, such as the average of the semi-principal axes. Generally, an ellipsoid-
15 like shape is an ellipsoid (for its averaged surface) with semi-principal axes within 100% of each other. The diameter of an ellipsoid or ellipsoid-like shape is the average diameter, such as the average of the semi-principal axes. Generally, a stadiumoid-like shape is a stadiumoid (for its averaged surface) with semi-principal axes of the ends within 20% of each other. The diameter of a stadiumoid or stadiumoid-like shape is the
20 average diameter, such as the average of the semi-principal axes. Alternatively, the size of a stadiumoid or stadiumoid-like shape can be given as the average of the long axis. Generally, a cylinder-like shape is a cylinder (for its averaged surface) with semi-principal axes within 20% of each other. The diameter of a cylinder or cylinder-like shape is the average diameter, such as the average of the semi-principal axes.
25 Alternatively, the size of a cylinder or cylinder-like shape can be given as the average of the long axis. Generally, a rod-like shape is a rod (for its averaged surface) with semi-principal axes within 10% of each other. The diameter of a rod or rod-like shape is the average diameter, such as the average of the semi-principal axes. Alternatively, the size of a rod or rod-like shape can be given as the average of the long axis. Generally, a cube-
30 like shape is a cube (for its averaged surface) with sides within 10% of each other. The diameter of a cube or cube-like shape is the average side length. Generally, a cuboid-like shape is a cuboid (for its averaged surface) with matching sides within 10% of each other. The diameter of a cuboid or cuboid-like shape is the average side length.

Generally, a torus-like shape is a torus (for its averaged surface) with semi-principal axes within 10% of each other. The diameter of a torus or torus-like shape is the average diameter, such as the average of the semi-principal axes. Alternatively, the size of a torus or torus-like shape can be given as the diameter across the ring.

- 5 “Flat side” refers to a contiguous area of more than 5% of a surface that has a curvature of 0.

 “Sharp angle” refers to a location on a surface across which the tangent to the surface changes by more than 10% over a distance of 2% or less of the circumference of the surface. Edges, corners, grooves, and ridges in a surface are all forms of sharp angles.

- 10 Preferred products can be made of biocompatible materials, have a diameter of at least 1 mm and less than 10 mm, has a spheroid-like shape, and have one or more of the additional characteristics: surface pores of the products greater than 0 nm and less than 10 μ m; surface of the products neutral or hydrophilic; curvature of the surface or a surface of the products at least 0.2 and is not greater than 2 on all points of the surface;
- 15 and surface of the products lacking flat sides, sharp angles, grooves, or ridges. Generally, the products elicit less of a fibrotic reaction after implantation than the same products lacking one or more of these characteristics that are present on the products.

- In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of
- 20 the products in the preparation have a shape characteristic described herein, e.g., have a spheroid-like shape, or have a curvature of the surface of at least 0.2 to 2.0 on all points of the surface.

- In some embodiments, the products have a mean diameter or size that is greater than 1 mm, preferably 1.5 mm or greater. In some embodiments, the products can be as
- 25 large as 8 mm in diameter or size. For example, the products is in a size range of 1 mm to 8 mm, 1 mm to 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm, 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm, 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 2 mm to 5 mm, 2 mm to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5 mm to 6
- 30 mm, 2.5 mm to 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm, 4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5

mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm. In some embodiments, the product has a mean diameter or size between 1 mm to 8 mm. In some embodiments, the product has a mean diameter or size between 1 mm to 4 mm. In some embodiments, the product has a mean diameter or size between 1 mm to 2 mm.

In some embodiments, the products are provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation, have a diameter or size in a size range described herein.

In some embodiments, the products have a mean pore size ranging from 0.1 μm to 10 μm . For example, the pores is in a size range of 0.1 μm to 10 μm , 0.1 μm to 9 μm , 0.1 μm to 8 μm , 0.1 μm to 7 μm , 0.1 μm to 6 μm , 0.1 μm to 5 μm , 0.1 μm to 4 μm , 0.1 μm to 3 μm , 0.1 μm to 2 μm , 0.15 μm to 10 μm , 0.15 μm to 9 μm , 0.15 μm to 8 μm , 0.15 μm to 7 μm , 0.15 μm to 6 μm , 0.15 μm to 5 μm , 0.15 μm to 4 μm , 0.15 μm to 3 μm , 0.15 μm to 2 μm , 0.2 μm to 10 μm , 0.2 μm to 9 μm , 0.2 μm to 8 μm , 0.2 μm to 7 μm , 0.2 μm to 6 μm , 0.2 μm to 5 μm , 0.2 μm to 4 μm , 0.2 μm to 3 μm , 0.25 μm to 10 μm , 0.25 μm to 9 μm , 0.25 μm to 8 μm , 0.25 μm to 7 μm , 0.25 μm to 6 μm , 0.25 μm to 5 μm , 0.25 μm to 4 μm , 0.25 μm to 3 μm , 0.3 μm to 10 μm , 0.3 μm to 9 μm , 0.3 μm to 8 μm , 0.3 μm to 7 μm , 0.3 μm to 6 μm , 0.3 μm to 5 μm , 0.3 μm to 4 μm , 0.35 μm to 10 μm , 0.35 μm to 9 μm , 0.35 μm to 8 μm , 0.35 μm to 7 μm , 0.35 μm to 6 μm , 0.35 μm to 5 μm , 0.35 μm to 4 μm , 0.4 μm to 10 μm , 0.4 μm to 9 μm , 0.4 μm to 8 μm , 0.4 μm to 7 μm , 0.4 μm to 6 μm , 0.4 μm to 5 μm , 0.45 μm to 10 μm , 0.45 μm to 9 μm , 0.45 μm to 8 μm , 0.45 μm to 7 μm , 0.45 μm to 6 μm , 0.45 μm to 5 μm , 0.5 μm to 10 μm , 0.5 μm to 9 μm , 0.5 μm to 8 μm , 0.5 μm to 7 μm , 0.5 μm to 6 μm , 0.55 μm to 10 μm , 0.55 μm to 9 μm , 0.55 μm to 8 μm , 0.55 μm to 7 μm , 0.55 μm to 6 μm , 0.6 μm to 10 μm , 0.6 μm to 9 μm , 0.6 μm to 8 μm , 0.6 μm to 7 μm , 0.65 μm to 10 μm , 0.65 μm to 9 μm , 0.65 μm to 8 μm , 0.65 μm to 7 μm , 0.7 μm to 10 μm , 0.7 μm to 9 μm , 0.7 μm to 8 μm , 0.75 μm to 10 μm , 0.75 μm to 9 μm , 0.75 μm to 8 μm , 0.8 μm to 10 μm , 0.8 μm to 9 μm , 0.85 μm to 10 μm , 0.85 μm to 9 μm , 0.9 μm to 10 μm , 0.95 μm to 10 μm , 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2

μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm . In some embodiments, the product has a mean pore size ranging from 0.1 μm to 10 μm . In some embodiments, the product has a mean pore size ranging from 0.1 μm to 5 μm . In some embodiments, the product has a mean pore size ranging from 0.1 μm to 1 μm .

In some embodiments, the products are provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have pores in a size range described herein.

In some embodiments, the chemical derivatizations of the surface or a surface of the products are expressed as a density, i.e., average number of attached compounds per given area. In some embodiments, the density is at least, is less than, or is 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 550, 600, 650, 700, 750, 800, 850, 900, or 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both. In some embodiments, the density is at least 100 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both. In some embodiments, the density is at least 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1

to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.1 to 110, 0.1 to 120, 0.1 to 130, 0.1 to 140, 0.1 to 150, 0.1 to 160, 0.1 to 170, 0.1 to 180, 0.1 to 190, 0.1 to 200, 0.1 to 210, 0.1 to 220, 0.1 to 230, 0.1 to 240, 0.1 to 250, 0.1 to 260, 5 0.1 to 270, 0.1 to 280, 0.1 to 290, 0.1 to 300, 0.1 to 320, 0.1 to 340, 0.1 to 360, 0.1 to 380, 0.1 to 400, 0.1 to 420, 0.1 to 440, 0.1 to 460, 0.1 to 480, 0.1 to 500, 0.1 to 550, 0.1 to 600, 0.1 to 650, 0.1 to 700, 0.1 to 750, 0.1 to 800, 0.1 to 850, 0.1 to 900, and 0.1 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

10 In some embodiments the density is in the range of 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.2 to 110, 0.2 to 120, 0.2 to 130, 0.2 to 140, 0.2 to 150, 0.2 to 160, 0.2 to 170, 0.2 to 180, 0.2 to 190, 0.2 to 200, 0.2 to 210, 0.2 to 220, 0.2 to 230, 0.2 to 240, 0.2 to 250, 0.2 to 260, 0.2 to 270, 15 0.2 to 280, 0.2 to 290, 0.2 to 300, 0.2 to 320, 0.2 to 340, 0.2 to 360, 0.2 to 380, 0.2 to 400, 0.2 to 420, 0.2 to 440, 0.2 to 460, 0.2 to 480, 0.2 to 500, 0.2 to 550, 0.2 to 600, 0.2 to 650, 0.2 to 700, 0.2 to 750, 0.2 to 800, 0.2 to 850, 0.2 to 900, and 0.2 to 1000 chemical 20 derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 25 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 0.5 to 110, 0.5 to 120, 0.5 to 130, 0.5 to 140, 0.5 to 150, 0.5 to 160, 0.5 to 170, 0.5 to 180, 0.5 to 190, 0.5 to 200, 0.5 to 210, 0.5 to 220, 0.5 to 230, 0.5 to 240, 0.5 to 250, 0.5 to 260, 0.5 to 270, 0.5 to 280, 0.5 to 290, 0.5 to 300, 0.5 to 320, 0.5 to 340, 0.5 to 360, 0.5 to 380, 0.5 to 400, 0.5 to 30 420, 0.5 to 440, 0.5 to 460, 0.5 to 480, 0.5 to 500, 0.5 to 550, 0.5 to 600, 0.5 to 650, 0.5 to 700, 0.5 to 750, 0.5 to 800, 0.5 to 850, 0.5 to 900, and 0.5 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 1 to 110, 1 to 120, 1 to 130, 1 to 140, 1 to 150, 1 to 160, 1 to 170, 1 to 180, 1 to 190, 1 to 200, 1 to 210, 1 to 220, 1 to 230, 1 to 240, 1 to 250, 1 to 260, 1 to 270, 1 to 280, 1 to 290, 1 to 300, 1 to 320, 1 to 340, 1 to 360, 1 to 380, 1 to 400, 1 to 420, 1 to 440, 1 to 460, 1 to 480, 1 to 500, 1 to 550, 1 to 600, 1 to 650, 1 to 700, 1 to 750, 1 to 800, 1 to 850, 1 to 900, and 1 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 2 to 110, 2 to 120, 2 to 130, 2 to 140, 2 to 150, 2 to 160, 2 to 170, 2 to 180, 2 to 190, 2 to 200, 2 to 210, 2 to 220, 2 to 230, 2 to 240, 2 to 250, 2 to 260, 2 to 270, 2 to 280, 2 to 290, 2 to 300, 2 to 320, 2 to 340, 2 to 360, 2 to 380, 2 to 400, 2 to 420, 2 to 440, 2 to 460, 2 to 480, 2 to 500, 2 to 550, 2 to 600, 2 to 650, 2 to 700, 2 to 750, 2 to 800, 2 to 850, 2 to 900, and 2 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 3 to 110, 3 to 120, 3 to 130, 3 to 140, 3 to 150, 3 to 160, 3 to 170, 3 to 180, 3 to 190, 3 to 200, 3 to 210, 3 to 220, 3 to 230, 3 to 240, 3 to 250, 3 to 260, 3 to 270, 3 to 280, 3 to 290, 3 to 300, 3 to 320, 3 to 340, 3 to 360, 3 to 380, 3 to 400, 3 to 420, 3 to 440, 3 to 460, 3 to 480, 3 to 500, 3 to 550, 3 to 600, 3 to 650, 3 to 700, 3 to 750, 3 to 800, 3 to 850, 3 to 900, and 3 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 4 to 110, 4 to 120, 4 to 130, 4 to 140, 4

to 150, 4 to 160, 4 to 170, 4 to 180, 4 to 190, 4 to 200, 4 to 210, 4 to 220, 4 to 230, 4 to 240, 4 to 250, 4 to 260, 4 to 270, 4 to 280, 4 to 290, 4 to 300, 4 to 320, 4 to 340, 4 to 360, 4 to 380, 4 to 400, 4 to 420, 4 to 440, 4 to 460, 4 to 480, 4 to 500, 4 to 550, 4 to 600, 4 to 650, 4 to 700, 4 to 750, 4 to 800, 4 to 850, 4 to 900, and 4 to 1000 chemical

5 derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5 to 25, 5 to 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5 to 80, 5 to 85, 5 to 90, 5 to 95, 5 to 100, 5 to 110, 5 to 120, 5 to 130, 5 to 140, 5 to 150, 5 to 160, 5 to 170, 5 to 180, 5 to 190, 5 to 200, 5 to 210, 5 to 220, 5 to 230, 5 to 240, 5 to 250, 5 to 260, 5 to 270, 5 to 280, 5 to 290, 5 to 300, 5 to 320, 5 to 340, 5 to 360, 5 to 380, 5 to 400, 5 to 420, 5 to 440, 5 to 460, 5 to 480, 5 to 500, 5 to 550, 5 to 600, 5 to 650, 5 to 700, 5 to 750, 5 to 800, 5 to 850, 5 to 900, and 5 to 1000 chemical derivatizations per
15 μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 6 to 7, 6 to 8, 6 to 9, 6 to 10, 6 to 11, 6 to 12, 6 to 13, 6 to 14, 6 to 15, 6 to 16, 6 to 17, 6 to 18, 6 to 19, 6 to 20, 6 to 25, 6 to 30, 6 to 35, 6 to 40, 6 to 45, 6 to 50, 6 to 55, 6 to 60, 6 to 65, 6 to 70, 6 to 75, 6 to 80, 6 to 85, 6 to 90, 6 to 95, 6 to 100, 6 to 110, 6 to 120, 6 to 130, 6 to 140, 6 to 150, 6 to 160, 6 to 170, 6 to 180, 6 to 190, 6 to 200, 6 to 210, 6 to 220, 6 to 230, 6 to 240, 6 to 250, 6 to 260, 6 to 270, 6 to 280, 6 to 290, 6 to 300, 6 to 320, 6 to 340, 6 to 360, 6 to 380, 6 to 400, 6 to 420, 6 to 440, 6 to 460, 6 to 480, 6 to 500, 6 to 550, 6 to 600, 6 to 650, 6 to 700, 6 to 750, 6 to 800, 6 to 850, 6 to 900, and 6 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 7 to 8, 7 to 9, 7 to 10, 7 to 11, 7 to 12, 7 to 13, 7 to 14, 7 to 15, 7 to 16, 7 to 17, 7 to 18, 7 to 19, 7 to 20, 7 to 25, 7 to 30, 7 to 35, 7 to 40, 7 to 45, 7 to 50, 7 to 55, 7 to 60, 7 to 65, 7 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100, 7 to 110, 7 to 120, 7 to 130, 7 to 140, 7 to 150, 7 to 160, 7 to 170, 7 to 180, 7 to 190, 7 to 200, 7 to 210, 7 to 220, 7 to 230, 7 to 240, 7 to 250, 7 to 260, 7 to 270, 7 to 280, 7 to 290, 7 to 300, 7 to 320, 7 to 340, 7 to 360, 7 to 380, 7 to 400, 7 to 420, 7 to 440, 7 to 460, 7 to 480, 7 to 500, 7 to 550, 7 to 600, 7 to 650, 7 to 700, 7 to 750, 7 to 800, 7 to 850, 7 to 900, and 7 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 8 to 9, 8 to 10, 8 to 11, 8 to 12, 8 to 13, 8 to 14, 8 to 15, 8 to 16, 8 to 17, 8 to 18, 8 to 19, 8 to 20, 8 to 25, 8 to 30, 8 to 35, 8 to 40, 8 to 45, 8 to 50, 8 to 55, 8 to 60, 8 to 65, 8 to 70, 8 to 75, 8 to 80, 8 to 85, 8 to 90, 8 to 95, 8 to 100, 8 to 110, 8 to 120, 8 to 130, 8 to 140, 8 to 150, 8 to 160, 8 to 170, 8 to 180, 8 to 190, 8 to 200, 8 to 210, 8 to 220, 8 to 230, 8 to 240, 8 to 250, 8 to 260, 8 to 270, 8 to 280, 8 to 290, 8 to 300, 8 to 320, 8 to 340, 8 to 360, 8 to 380, 8 to 400, 8 to 420, 8 to 440, 8 to 460, 8 to 480, 8 to 500, 8 to 550, 8 to 600, 8 to 650, 8 to 700, 8 to 750, 8 to 800, 8 to 850, 8 to 900, and 8 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 9 to 10, 9 to 11, 9 to 12, 9 to 13, 9 to 14, 9 to 15, 9 to 16, 9 to 17, 9 to 18, 9 to 19, 9 to 20, 9 to 25, 9 to 30, 9 to 35, 9 to 40, 9 to 45, 9 to 50, 9 to 55, 9 to 60, 9 to 65, 9 to 70, 9 to 75, 9 to 80, 9 to 85, 9 to 90, 9 to 95, 9 to 100, 9 to 110, 9 to 120, 9 to 130, 9 to 140, 9 to 150, 9 to 160, 9 to 170, 9 to 180, 9 to 190, 9 to 200, 9 to 210, 9 to 220, 9 to 230, 9 to 240, 9 to 250, 9 to 260, 9 to 270, 9 to 280, 9 to 290, 9 to 300, 9 to 320, 9 to 340, 9 to 360, 9 to 380, 9 to 400, 9 to 420, 9 to 440, 9 to 460, 9 to 480, 9 to 500, 9 to 550, 9 to 600, 9 to 650, 9 to 700, 9 to 750, 9 to 800, 9 to 850, 9 to 900, and 9 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 10 to 11, 10 to 12, 10 to 13, 10 to 14, 10 to 15, 10 to 16, 10 to 17, 10 to 18, 10 to 19, 10 to 20, 10 to 25, 10 to 30, 10 to 35, 10 to 40, 10 to 45, 10 to 50, 10 to 55, 10 to 60, 10 to 65, 10 to 70, 10 to 75, 10 to 80, 10 to 85, 10 to 90, 10 to 95, 10 to 100, 10 to 110, 10 to 120, 10 to 130, 10 to 140, 10 to 150, 10 to 160, 10 to 170, 10 to 180, 10 to 190, 10 to 200, 10 to 210, 10 to 220, 10 to 230, 10 to 240, 10 to 250, 10 to 260, 10 to 270, 10 to 280, 10 to 290, 10 to 300, 10 to 320, 10 to 340, 10 to 360, 10 to 380, 10 to 400, 10 to 420, 10 to 440, 10 to 460, 10 to 480, 10 to 500, 10 to 550, 10 to 600, 10 to 650, 10 to 700, 10 to 750, 10 to 800, 10 to 850, 10 to 900, and 10 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 20 to 25, 20 to 30, 20 to 35, 20 to 40, 20 to 45, 20 to 50, 20 to 55, 20 to 60, 20 to 65, 20 to 70, 20 to 75, 20 to 80, 20 to 85, 20 to 90, 20 to 95, 20 to 100, 20 to 110, 20 to 120, 20 to 130, 20 to 140, 20 to 150, 20 to 160, 20 to 170, 20 to 180, 20 to 190, 20 to 200, 20 to 210, 20 to 220, 20 to 230, 20 to 240, 20 to 250, 20 to 260, 20 to 270, 20 to 280, 20 to 290, 20 to 300, 20 to 320, 20 to 340, 20 to 360, 20 to 380, 20 to 400, 20 to 420, 20 to 440, 20 to 460, 20 to 480, 20 to

500, 20 to 550, 20 to 600, 20 to 650, 20 to 700, 20 to 750, 20 to 800, 20 to 850, 20 to 900, and 20 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 30 to 35, 30 to 40, 30 to 45,
5 30 to 50, 30 to 55, 30 to 60, 30 to 65, 30 to 70, 30 to 75, 30 to 80, 30 to 85, 30 to 90, 30 to 95, 30 to 100, 30 to 110, 30 to 120, 30 to 130, 30 to 140, 30 to 150, 30 to 160, 30 to 170, 30 to 180, 30 to 190, 30 to 200, 30 to 210, 30 to 220, 30 to 230, 30 to 240, 30 to 250, 30 to 260, 30 to 270, 30 to 280, 30 to 290, 30 to 300, 30 to 320, 30 to 340, 30 to 360, 30 to 380, 30 to 400, 30 to 420, 30 to 440, 30 to 460, 30 to 480, 30 to 500, 30 to
10 550, 30 to 600, 30 to 650, 30 to 700, 30 to 750, 30 to 800, 30 to 850, 30 to 900, and 30 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 40 to 45, 40 to 50, 40 to 55,
40 to 60, 40 to 65, 40 to 70, 40 to 75, 40 to 80, 40 to 85, 40 to 90, 40 to 95, 40 to 100, 40
15 to 110, 40 to 120, 40 to 130, 40 to 140, 40 to 150, 40 to 160, 40 to 170, 40 to 180, 40 to 190, 40 to 200, 40 to 210, 40 to 220, 40 to 230, 40 to 240, 40 to 250, 40 to 260, 40 to 270, 40 to 280, 40 to 290, 40 to 300, 40 to 320, 40 to 340, 40 to 360, 40 to 380, 40 to 400, 40 to 420, 40 to 440, 40 to 460, 40 to 480, 40 to 500, 40 to 550, 40 to 600, 40 to 650, 40 to 700, 40 to 750, 40 to 800, 40 to 850, 40 to 900, and 40 to 1000 chemical
20 derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 50 to 55, 50 to 60, 50 to 65,
50 to 70, 50 to 75, 50 to 80, 50 to 85, 50 to 90, 50 to 95, 50 to 100, 50 to 110, 50 to 120,
50 to 130, 50 to 140, 50 to 150, 50 to 160, 50 to 170, 50 to 180, 50 to 190, 50 to 200, 50
25 to 210, 50 to 220, 50 to 230, 50 to 240, 50 to 250, 50 to 260, 50 to 270, 50 to 280, 50 to 290, 50 to 300, 50 to 320, 50 to 340, 50 to 360, 50 to 380, 50 to 400, 50 to 420, 50 to 440, 50 to 460, 50 to 480, 50 to 500, 50 to 550, 50 to 600, 50 to 650, 50 to 700, 50 to 750, 50 to 800, 50 to 850, 50 to 900, and 50 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

30 In some embodiments the density is in the range of 60 to 65, 60 to 70, 60 to 75, 60 to 80, 60 to 85, 60 to 90, 60 to 95, 60 to 100, 60 to 110, 60 to 120, 60 to 130, 60 to 140, 60 to 150, 60 to 160, 60 to 170, 60 to 180, 60 to 190, 60 to 200, 60 to 210, 60 to 220, 60 to 230, 60 to 240, 60 to 250, 60 to 260, 60 to 270, 60 to 280, 60 to 290, 60 to 300, 60 to 320, 60 to 340, 60 to 360, 60 to 380, 60 to 400, 60 to 420, 60 to 440, 60 to

460, 60 to 480, 60 to 500, 60 to 550, 60 to 600, 60 to 650, 60 to 700, 60 to 750, 60 to 800, 60 to 850, 60 to 900, and 60 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 70 to 75, 70 to 80, 70 to 85,
5 70 to 90, 70 to 95, 70 to 100, 70 to 110, 70 to 120, 70 to 130, 70 to 140, 70 to 150, 70 to 160, 70 to 170, 70 to 180, 70 to 190, 70 to 200, 70 to 210, 70 to 220, 70 to 230, 70 to 240, 70 to 250, 70 to 260, 70 to 270, 70 to 280, 70 to 290, 70 to 300, 70 to 320, 70 to 340, 70 to 360, 70 to 380, 70 to 400, 70 to 420, 70 to 440, 70 to 460, 70 to 480, 70 to 500, 70 to 550, 70 to 600, 70 to 650, 70 to 700, 70 to 750, 70 to 800, 70 to 850, 70 to
10 900, and 70 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 80 to 85, 80 to 90, 80 to 95,
80 to 100, 80 to 110, 80 to 120, 80 to 130, 80 to 140, 80 to 150, 80 to 160, 80 to 170, 80 to 180, 80 to 190, 80 to 200, 80 to 210, 80 to 220, 80 to 230, 80 to 240, 80 to 250, 80 to
15 260, 80 to 270, 80 to 280, 80 to 290, 80 to 300, 80 to 320, 80 to 340, 80 to 360, 80 to 380, 80 to 400, 80 to 420, 80 to 440, 80 to 460, 80 to 480, 80 to 500, 80 to 550, 80 to 600, 80 to 650, 80 to 700, 80 to 750, 80 to 800, 80 to 850, 80 to 900, and 80 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 90 to 95, 90 to 100, 90 to 110,
20 90 to 120, 90 to 130, 90 to 140, 90 to 150, 90 to 160, 90 to 170, 90 to 180, 90 to 190, 90 to 200, 90 to 210, 90 to 220, 90 to 230, 90 to 240, 90 to 250, 90 to 260, 90 to 270, 90 to 280, 90 to 290, 90 to 300, 90 to 320, 90 to 340, 90 to 360, 90 to 380, 90 to 400, 90 to 420, 90 to 440, 90 to 460, 90 to 480, 90 to 500, 90 to 550, 90 to 600, 90 to 650, 90 to
25 700, 90 to 750, 90 to 800, 90 to 850, 90 to 900, and 90 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 100 to 110, 100 to 120, 100 to 130, 100 to 140, 100 to 150, 100 to 160, 100 to 170, 100 to 180, 100 to 190, 100 to 200,
30 100 to 210, 100 to 220, 100 to 230, 100 to 240, 100 to 250, 100 to 260, 100 to 270, 100 to 280, 100 to 290, 100 to 300, 100 to 320, 100 to 340, 100 to 360, 100 to 380, 100 to 400, 100 to 420, 100 to 440, 100 to 460, 100 to 480, 100 to 500, 100 to 550, 100 to 600, 100 to 650, 100 to 700, 100 to 750, 100 to 800, 100 to 850, 100 to 900, and 100 to 1000

chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 200 to 210, 200 to 220, 200 to 230, 200 to 240, 200 to 250, 200 to 260, 200 to 270, 200 to 280, 200 to 290, 200 to 300,
5 200 to 320, 200 to 340, 200 to 360, 200 to 380, 200 to 400, 200 to 420, 200 to 440, 200 to 460, 200 to 480, 200 to 500, 200 to 550, 200 to 600, 200 to 650, 200 to 700, 200 to 750, 200 to 800, 200 to 850, 200 to 900, and 200 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 300 to 320, 300 to 340, 300 to 360, 300 to 380, 300 to 400, 300 to 420, 300 to 440, 300 to 460, 300 to 480, 300 to 500,
10 300 to 550, 300 to 600, 300 to 650, 300 to 700, 300 to 750, 300 to 800, 300 to 850, 300 to 900, and 300 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 400 to 420, 400 to 440, 400 to 460, 400 to 480, 400 to 500, 400 to 550, 400 to 600, 400 to 650, 400 to 700, 400 to 750,
15 400 to 800, 400 to 850, 400 to 900, and 400 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 500 to 550, 500 to 600, 500 to 650, 500 to 700, 500 to 750, 500 to 800, 500 to 850, 500 to 900, and 500 to 1000
20 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 600 to 650, 600 to 700, 600 to 750, 600 to 800, 600 to 850, 600 to 900, and 600 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 700 to 750, 700 to 800, 700 to 850, 700 to 900, and 700 to 1000 chemical derivatizations per μm^2 on the surface or a
25 surface of the products, in the interior of the products, or both.

In some embodiments the density is in the range of 800 to 850, 800 to 900, and 800 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products,
30 in the interior of the products, or both.

In some embodiments the density is in the range of 900 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a density of attached compounds described herein.

5 In some embodiments, density chemical derivatizations of the surface or a surface of the products are expressed as a percent surface modifications or concentration of surface modifications. In some embodiments, the concentration of surface modifications is at least, is less than, or is 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, and 100 percent.

10 In some embodiments the concentration of surface modifications is in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100 percent surface modifications.

15 In some embodiments the concentration of surface modifications is in the range of 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100 percent surface modifications.

20 In some embodiments the concentration of surface modifications is in the range of 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100 percent surface modifications.

25 In some embodiments the concentration of surface modifications is in the range of 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to

14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100 percent surface modifications.

5 In some embodiments the concentration of surface modifications is in the range of 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100 percent surface modifications.

10 In some embodiments the concentration of surface modifications is in the range of 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100 percent surface modifications.

15 In some embodiments the concentration of surface modifications is in the range of 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5 to 25, 5 to 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5 to 80, 5 to 85, 5 to 90, 5 to 95, 5 to 100 percent surface modifications.

20 In some embodiments the concentration of surface modifications is in the range of 6 to 7, 6 to 8, 6 to 9, 6 to 10, 6 to 11, 6 to 12, 6 to 13, 6 to 14, 6 to 15, 6 to 16, 6 to 17, 6 to 18, 6 to 19, 6 to 20, 6 to 25, 6 to 30, 6 to 35, 6 to 40, 6 to 45, 6 to 50, 6 to 55, 6 to 60, 6 to 65, 6 to 70, 6 to 75, 6 to 80, 6 to 85, 6 to 90, 6 to 95, 6 to 100 percent surface modifications.

25 In some embodiments the concentration of surface modifications is in the range of 7 to 8, 7 to 9, 7 to 10, 7 to 11, 7 to 12, 7 to 13, 7 to 14, 7 to 15, 7 to 16, 7 to 17, 7 to 18, 7 to 19, 7 to 20, 7 to 25, 7 to 30, 7 to 35, 7 to 40, 7 to 45, 7 to 50, 7 to 55, 7 to 60, 7 to 65, 7 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100 percent surface modifications.

30 In some embodiments the concentration of surface modifications is in the range of 8 to 9, 8 to 10, 8 to 11, 8 to 12, 8 to 13, 8 to 14, 8 to 15, 8 to 16, 8 to 17, 8 to 18, 8 to 19, 8 to 20, 8 to 25, 8 to 30, 8 to 35, 8 to 40, 8 to 45, 8 to 50, 8 to 55, 8 to 60, 8 to 65, 8 to 70, 8 to 75, 8 to 80, 8 to 85, 8 to 90, 8 to 95, 8 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 9 to 10, 9 to 11, 9 to 12, 9 to 13, 9 to 14, 9 to 15, 9 to 16, 9 to 17, 9 to 18, 9 to 19, 9 to

20, 9 to 25, 9 to 30, 9 to 35, 9 to 40, 9 to 45, 9 to 50, 9 to 55, 9 to 60, 9 to 65, 9 to 70, 9 to 75, 9 to 80, 9 to 85, 9 to 90, 9 to 95, 9 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 10 to 11, 10 to 12, 10 to 13, 10 to 14, 10 to 15, 10 to 16, 10 to 17, 10 to 18, 10 to 19,
5 10 to 20, 10 to 25, 10 to 30, 10 to 35, 10 to 40, 10 to 45, 10 to 50, 10 to 55, 10 to 60, 10 to 65, 10 to 70, 10 to 75, 10 to 80, 10 to 85, 10 to 90, 10 to 95, 10 to 100 percent surface modifications. In some embodiments, the concentration of surface modifications is in the range of 10 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range
10 of 20 to 25, 20 to 30, 20 to 35, 20 to 40, 20 to 45, 20 to 50, 20 to 55, 20 to 60, 20 to 65, 20 to 70, 20 to 75, 20 to 80, 20 to 85, 20 to 90, 20 to 95, 20 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range
15 of 30 to 35, 30 to 40, 30 to 45, 30 to 50, 30 to 55, 30 to 60, 30 to 65, 30 to 70, 30 to 75, 30 to 80, 30 to 85, 30 to 90, 30 to 95, 30 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 40 to 45, 40 to 50, 40 to 55, 40 to 60, 40 to 65, 40 to 70, 40 to 75, 40 to 80, 40 to 85, 40 to 90, 40 to 95, 40 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range
20 of 50 to 55, 50 to 60, 50 to 65, 50 to 70, 50 to 75, 50 to 80, 50 to 85, 50 to 90, 50 to 95, 50 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 60 to 65, 60 to 70, 60 to 75, 60 to 80, 60 to 85, 60 to 90, 60 to 95, 60 to 100 percent surface modifications.

25 In some embodiments the concentration of surface modifications is in the range of 70 to 75, 70 to 80, 70 to 85, 70 to 90, 70 to 95, 70 to 100 percent surface modifications.

In some embodiments the concentration of surface modifications is in the range of 80 to 85, 80 to 90, 80 to 95, 80 to 100 percent surface modifications.

30 In some embodiments the concentration of surface modifications is in the range of 90 to 95, 90 to 100 percent surface modifications.

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of

the products in the preparation have a concentration of attached compounds described herein.

In some embodiments, the products have a mean diameter or size that is greater than 1 mm and less than 8 mm, greater than 1.5 mm and less than 8 mm, greater than 2 mm and less than 8 mm, greater than 2.5 mm and less than 8 mm, greater than 3 mm and less than 8 mm, greater than 3.5 mm and less than 8 mm, greater than 4 mm and less than 8 mm, greater than 4.5 mm and less than 8 mm, greater than 5 mm and less than 8 mm, greater than 5.5 mm and less than 8 mm, greater than 6 mm and less than 8 mm, greater than 6.5 mm and less than 8 mm, greater than 7 mm and less than 8 mm, or greater than 7.5 mm and less than 8 mm, and, independently, pores in a size range of 0.1 μm to 10 μm , 0.1 μm to 9 μm , 0.1 μm to 8 μm , 0.1 μm to 7 μm , 0.1 μm to 6 μm , 0.1 μm to 5 μm , 0.1 μm to 4 μm , 0.1 μm to 3 μm , 0.1 μm to 2 μm , 0.15 μm to 10 μm , 0.15 μm to 9 μm , 0.15 μm to 8 μm , 0.15 μm to 7 μm , 0.15 μm to 6 μm , 0.15 μm to 5 μm , 0.15 μm to 4 μm , 0.15 μm to 3 μm , 0.15 μm to 2 μm , 0.2 μm to 10 μm , 0.2 μm to 9 μm , 0.2 μm to 8 μm , 0.2 μm to 7 μm , 0.2 μm to 6 μm , 0.2 μm to 5 μm , 0.2 μm to 4 μm , 0.2 μm to 3 μm , 0.25 μm to 10 μm , 0.25 μm to 9 μm , 0.25 μm to 8 μm , 0.25 μm to 7 μm , 0.25 μm to 6 μm , 0.25 μm to 5 μm , 0.25 μm to 4 μm , 0.25 μm to 3 μm , 0.3 μm to 10 μm , 0.3 μm to 9 μm , 0.3 μm to 8 μm , 0.3 μm to 7 μm , 0.3 μm to 6 μm , 0.3 μm to 5 μm , 0.3 μm to 4 μm , 0.35 μm to 10 μm , 0.35 μm to 9 μm , 0.35 μm to 8 μm , 0.35 μm to 7 μm , 0.35 μm to 6 μm , 0.35 μm to 5 μm , 0.35 μm to 4 μm , 0.4 μm to 10 μm , 0.4 μm to 9 μm , 0.4 μm to 8 μm , 0.4 μm to 7 μm , 0.4 μm to 6 μm , 0.4 μm to 5 μm , 0.45 μm to 10 μm , 0.45 μm to 9 μm , 0.45 μm to 8 μm , 0.45 μm to 7 μm , 0.45 μm to 6 μm , 0.45 μm to 5 μm , 0.5 μm to 10 μm , 0.5 μm to 9 μm , 0.5 μm to 8 μm , 0.5 μm to 7 μm , 0.5 μm to 6 μm , 0.55 μm to 10 μm , 0.55 μm to 9 μm , 0.55 μm to 8 μm , 0.55 μm to 7 μm , 0.55 μm to 6 μm , 0.6 μm to 10 μm , 0.6 μm to 9 μm , 0.6 μm to 8 μm , 0.6 μm to 7 μm , 0.65 μm to 10 μm , 0.65 μm to 9 μm , 0.65 μm to 8 μm , 0.65 μm to 7 μm , 0.7 μm to 10 μm , 0.7 μm to 9 μm , 0.7 μm to 8 μm , 0.75 μm to 10 μm , 0.75 μm to 9 μm , 0.75 μm to 8 μm , 0.8 μm to 10 μm , 0.8 μm to 9 μm , 0.85 μm to 10 μm , 0.85 μm to 9 μm , 0.9 μm to 10 μm , 0.95 μm to 10 μm , 1 μm to 10 μm , 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm

to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm .

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a combination of diameter and pore size described herein.

In some embodiments, the products have a mean diameter or size that is greater than 1 mm and less than 8 mm, greater than 1.5 mm and less than 8 mm, greater than 2 mm and less than 8 mm, greater than 2.5 mm and less than 8 mm, greater than 3 mm and less than 8 mm, greater than 3.5 mm and less than 8 mm, greater than 4 mm and less than 8 mm, greater than 4.5 mm and less than 8 mm, greater than 5 mm and less than 8 mm, greater than 5.5 mm and less than 8 mm, greater than 6 mm and less than 8 mm, greater than 6.5 mm and less than 8 mm, greater than 7 mm and less than 8 mm, or greater than 7.5 mm and less than 8 mm, and, independently, the density is at least, is less than, or is 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 550, 600, 650, 700, 750, 800, 850, 900, or 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both.

In some embodiments, the products have a mean diameter or size in a range of 1 mm to 8 mm, 1 mm to 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm, 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm, 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 2 mm to 5 mm, 2 mm to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5

mm to 6 mm, 2.5 mm to 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm, 4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5 mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm, and a density in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.1 to 110, 0.1 to 120, 0.1 to 130, 0.1 to 140, 0.1 to 150, 0.1 to 160, 0.1 to 170, 0.1 to 180, 0.1 to 190, 0.1 to 200, 0.1 to 210, 0.1 to 220, 0.1 to 230, 0.1 to 240, 0.1 to 250, 0.1 to 260, 0.1 to 270, 0.1 to 280, 0.1 to 290, 0.1 to 300, 0.1 to 320, 0.1 to 340, 0.1 to 360, 0.1 to 380, 0.1 to 400, 0.1 to 420, 0.1 to 440, 0.1 to 460, 0.1 to 480, 0.1 to 500, 0.1 to 550, 0.1 to 600, 0.1 to 650, 0.1 to 700, 0.1 to 750, 0.1 to 800, 0.1 to 850, 0.1 to 900, 0.1 to 1000, 0.2 to 0.5, 0.2 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.2 to 110, 0.2 to 120, 0.2 to 130, 0.2 to 140, 0.2 to 150, 0.2 to 160, 0.2 to 170, 0.2 to 180, 0.2 to 190, 0.2 to 200, 0.2 to 210, 0.2 to 220, 0.2 to 230, 0.2 to 240, 0.2 to 250, 0.2 to 260, 0.2 to 270, 0.2 to 280, 0.2 to 290, 0.2 to 300, 0.2 to 320, 0.2 to 340, 0.2 to 360, 0.2 to 380, 0.2 to 400, 0.2 to 420, 0.2 to 440, 0.2 to 460, 0.2 to 480, 0.2 to 500, 0.2 to 550, 0.2 to 600, 0.2 to 650, 0.2 to 700, 0.2 to 750, 0.2 to 800, 0.2 to 850, 0.2 to 900, 0.2 to 1000, 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 0.5 to 110, 0.5 to 120, 0.5 to 130, 0.5 to 140, 0.5 to 150, 0.5 to 160, 0.5 to 170, 0.5 to 180, 0.5 to 190, 0.5 to 200, 0.5 to 210, 0.5 to 220, 0.5 to 230, 0.5 to 240, 0.5 to 250, 0.5 to 260, 0.5 to 270, 0.5 to 280, 0.5 to 290, 0.5 to 300, 0.5 to 320, 0.5 to 340, 0.5 to 360, 0.5 to 380, 0.5 to 400, 0.5 to 420, 0.5 to 440, 0.5 to 460, 0.5 to 480, 0.5 to 500, 0.5 to 550, 0.5 to 600, 0.5 to 650, 0.5 to 700, 0.5 to

750, 0.5 to 800, 0.5 to 850, 0.5 to 900, 0.5 to 1000, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 1 to 110, 1 to 120, 1 to 130, 1 to 140, 1 to 150, 1 to 160, 1 to 170, 1 to 180, 1 to 190, 1 to 200, 1 to 210, 1 to 220, 1 to 230, 1 to 240, 1 to 250, 1 to 260, 1 to 270, 1 to 280, 1 to 290, 1 to 300, 1 to 320, 1 to 340, 1 to 360, 1 to 380, 1 to 400, 1 to 420, 1 to 440, 1 to 460, 1 to 480, 1 to 500, 1 to 550, 1 to 600, 1 to 650, 1 to 700, 1 to 750, 1 to 800, 1 to 850, 1 to 900, 1 to 1000, 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 2 to 110, 2 to 120, 2 to 130, 2 to 140, 2 to 150, 2 to 160, 2 to 170, 2 to 180, 2 to 190, 2 to 200, 2 to 210, 2 to 220, 2 to 230, 2 to 240, 2 to 250, 2 to 260, 2 to 270, 2 to 280, 2 to 290, 2 to 300, 2 to 320, 2 to 340, 2 to 360, 2 to 380, 2 to 400, 2 to 420, 2 to 440, 2 to 460, 2 to 480, 2 to 500, 2 to 550, 2 to 600, 2 to 650, 2 to 700, 2 to 750, 2 to 800, 2 to 850, 2 to 900, 2 to 1000, 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 3 to 110, 3 to 120, 3 to 130, 3 to 140, 3 to 150, 3 to 160, 3 to 170, 3 to 180, 3 to 190, 3 to 200, 3 to 210, 3 to 220, 3 to 230, 3 to 240, 3 to 250, 3 to 260, 3 to 270, 3 to 280, 3 to 290, 3 to 300, 3 to 320, 3 to 340, 3 to 360, 3 to 380, 3 to 400, 3 to 420, 3 to 440, 3 to 460, 3 to 480, 3 to 500, 3 to 550, 3 to 600, 3 to 650, 3 to 700, 3 to 750, 3 to 800, 3 to 850, 3 to 900, 3 to 1000, 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 4 to 110, 4 to 120, 4 to 130, 4 to 140, 4 to 150, 4 to 160, 4 to 170, 4 to 180, 4 to 190, 4 to 200, 4 to 210, 4 to 220, 4 to 230, 4 to 240, 4 to 250, 4 to 260, 4 to 270, 4 to 280, 4 to 290, 4 to 300, 4 to 320, 4 to 340, 4 to 360, 4 to 380, 4 to 400, 4 to 420, 4 to 440, 4 to 460, 4 to 480, 4 to 500, 4 to 550, 4 to 600, 4 to 650, 4 to 700, 4 to 750, 4 to 800, 4 to 850, 4 to 900, 4 to 1000, 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5 to 25, 5 to 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5 to 80, 5 to 85, 5 to 90, 5 to 95, 5 to 100, 5 to 110, 5 to 120, 5 to 130, 5 to 140, 5 to 150, 5 to 160, 5 to 170, 5 to 180, 5 to 190, 5 to 200, 5 to 210, 5 to 220, 5 to 230, 5 to 240, 5 to 250, 5 to 260, 5 to 270, 5 to 280, 5 to 290,

5 to 300, 5 to 320, 5 to 340, 5 to 360, 5 to 380, 5 to 400, 5 to 420, 5 to 440, 5 to 460, 5 to
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 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100, 7 to 110, 7 to 120, 7 to 130, 7 to
 140, 7 to 150, 7 to 160, 7 to 170, 7 to 180, 7 to 190, 7 to 200, 7 to 210, 7 to 220, 7 to 230,
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 8 to 420, 8 to 440, 8 to 460, 8 to 480, 8 to 500, 8 to 550, 8 to 600, 8 to 650, 8 to 700, 8 to
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270, 10 to 280, 10 to 290, 10 to 300, 10 to 320, 10 to 340, 10 to 360, 10 to 380, 10 to
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 to 110, 40 to 120, 40 to 130, 40 to 140, 40 to 150, 40 to 160, 40 to 170, 40 to 180, 40 to
 190, 40 to 200, 40 to 210, 40 to 220, 40 to 230, 40 to 240, 40 to 250, 40 to 260, 40 to
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 460, 60 to 480, 60 to 500, 60 to 550, 60 to 600, 60 to 650, 60 to 700, 60 to 750, 60 to
 800, 60 to 850, 60 to 900, 60 to 1000, 70 to 75, 70 to 80, 70 to 85, 70 to 90, 70 to 95, 70

to 100, 70 to 110, 70 to 120, 70 to 130, 70 to 140, 70 to 150, 70 to 160, 70 to 170, 70 to 180, 70 to 190, 70 to 200, 70 to 210, 70 to 220, 70 to 230, 70 to 240, 70 to 250, 70 to 260, 70 to 270, 70 to 280, 70 to 290, 70 to 300, 70 to 320, 70 to 340, 70 to 360, 70 to 380, 70 to 400, 70 to 420, 70 to 440, 70 to 460, 70 to 480, 70 to 500, 70 to 550, 70 to 600, 70 to 650, 70 to 700, 70 to 750, 70 to 800, 70 to 850, 70 to 900, 70 to 1000, 80 to 85, 80 to 90, 80 to 95, 80 to 100, 80 to 110, 80 to 120, 80 to 130, 80 to 140, 80 to 150, 80 to 160, 80 to 170, 80 to 180, 80 to 190, 80 to 200, 80 to 210, 80 to 220, 80 to 230, 80 to 240, 80 to 250, 80 to 260, 80 to 270, 80 to 280, 80 to 290, 80 to 300, 80 to 320, 80 to 340, 80 to 360, 80 to 380, 80 to 400, 80 to 420, 80 to 440, 80 to 460, 80 to 480, 80 to 500, 80 to 550, 80 to 600, 80 to 650, 80 to 700, 80 to 750, 80 to 800, 80 to 850, 80 to 900, 80 to 1000, 90 to 95, 90 to 100, 90 to 110, 90 to 120, 90 to 130, 90 to 140, 90 to 150, 90 to 160, 90 to 170, 90 to 180, 90 to 190, 90 to 200, 90 to 210, 90 to 220, 90 to 230, 90 to 240, 90 to 250, 90 to 260, 90 to 270, 90 to 280, 90 to 290, 90 to 300, 90 to 320, 90 to 340, 90 to 360, 90 to 380, 90 to 400, 90 to 420, 90 to 440, 90 to 460, 90 to 480, 90 to 500, 90 to 550, 90 to 600, 90 to 650, 90 to 700, 90 to 750, 90 to 800, 90 to 850, 90 to 900, 90 to 1000, 100 to 110, 100 to 120, 100 to 130, 100 to 140, 100 to 150, 100 to 160, 100 to 170, 100 to 180, 100 to 190, 100 to 200, 100 to 210, 100 to 220, 100 to 230, 100 to 240, 100 to 250, 100 to 260, 100 to 270, 100 to 280, 100 to 290, 100 to 300, 100 to 320, 100 to 340, 100 to 360, 100 to 380, 100 to 400, 100 to 420, 100 to 440, 100 to 460, 100 to 480, 100 to 500, 100 to 550, 100 to 600, 100 to 650, 100 to 700, 100 to 750, 100 to 800, 100 to 850, 100 to 900, 100 to 1000, 200 to 210, 200 to 220, 200 to 230, 200 to 240, 200 to 250, 200 to 260, 200 to 270, 200 to 280, 200 to 290, 200 to 300, 200 to 320, 200 to 340, 200 to 360, 200 to 380, 200 to 400, 200 to 420, 200 to 440, 200 to 460, 200 to 480, 200 to 500, 200 to 550, 200 to 600, 200 to 650, 200 to 700, 200 to 750, 200 to 800, 200 to 850, 200 to 900, 200 to 1000, 300 to 320, 300 to 340, 300 to 360, 300 to 380, 300 to 400, 300 to 420, 300 to 440, 300 to 460, 300 to 480, 300 to 500, 300 to 550, 300 to 600, 300 to 650, 300 to 700, 300 to 750, 300 to 800, 300 to 850, 300 to 900, 300 to 1000, 400 to 420, 400 to 440, 400 to 460, 400 to 480, 400 to 500, 400 to 550, 400 to 600, 400 to 650, 400 to 700, 400 to 750, 400 to 800, 400 to 850, 400 to 900, 400 to 1000, 500 to 550, 500 to 600, 500 to 650, 500 to 700, 500 to 750, 500 to 800, 500 to 850, 500 to 900, 500 to 1000, 600 to 650, 600 to 700, 600 to 750, 600 to 800, 600 to 850, 600 to 900, 600 to 1000, 700 to 750, 700 to 800, 700 to 850, 700 to 900, 700 to 1000, 800 to 850, 800 to 900, 800 to 1000, and 900 to 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a combination of product size or diameter and derivatization density described herein.

5 In some embodiments, the products have a mean diameter or size that is greater than 1 mm and less than 8 mm, greater than 1.5 mm and less than 8 mm, greater than 2 mm and less than 8 mm, greater than 2.5 mm and less than 8 mm, greater than 3 mm and less than 8 mm, greater than 3.5 mm and less than 8 mm, greater than 4 mm and less than 8 mm, greater than 4.5 mm and less than 8 mm, greater than 5 mm and less than 8 mm, greater than 5.5 mm and less than 8 mm, greater than 6 mm and less than 8 mm, greater than 6.5 mm and less than 8 mm, greater than 7 mm and less than 8 mm, or greater than 7.5 mm and less than 8 mm, and, independently, the concentration of surface modifications is at least, is less than, or is 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 10 greater than 70, 75, 80, 85, 90, 95, and 100 percent.

In some embodiments, the products have a mean diameter or size in a range of 1 mm to 8 mm, 1 mm to 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm, 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm, 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 20 2 mm to 5 mm, 2 mm to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5 mm to 6 mm, 2.5 mm to 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm, 4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5 mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 25 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm, and a concentration of surface modifications in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.2 to 0.5, 0.2 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2

to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70,
 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.5 to 1, 0.5 to 2, 0.5 to 3,
 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to
 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5
 5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70,
 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 1 to 2, 1 to 3, 1 to 4, 1 to 5,
 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to
 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to
 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 2 to 3, 2 to 4, 2 to
 10 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2
 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2
 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 3 to 4, 3 to 5, 3
 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to
 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to
 15 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 4 to 5, 4 to 6, 4 to
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 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65,
 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5
 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5
 20 to 25, 5 to 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5
 to 80, 5 to 85, 5 to 90, 5 to 95, 5 to 100, 6 to 7, 6 to 8, 6 to 9, 6 to 10, 6 to 11, 6 to 12, 6
 to 13, 6 to 14, 6 to 15, 6 to 16, 6 to 17, 6 to 18, 6 to 19, 6 to 20, 6 to 25, 6 to 30, 6 to 35, 6
 to 40, 6 to 45, 6 to 50, 6 to 55, 6 to 60, 6 to 65, 6 to 70, 6 to 75, 6 to 80, 6 to 85, 6 to 90, 6
 to 95, 6 to 100, 7 to 8, 7 to 9, 7 to 10, 7 to 11, 7 to 12, 7 to 13, 7 to 14, 7 to 15, 7 to 16, 7
 25 to 17, 7 to 18, 7 to 19, 7 to 20, 7 to 25, 7 to 30, 7 to 35, 7 to 40, 7 to 45, 7 to 50, 7 to 55, 7
 to 60, 7 to 65, 7 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100, 8 to 9, 8 to 10, 8
 to 11, 8 to 12, 8 to 13, 8 to 14, 8 to 15, 8 to 16, 8 to 17, 8 to 18, 8 to 19, 8 to 20, 8 to 25, 8
 to 30, 8 to 35, 8 to 40, 8 to 45, 8 to 50, 8 to 55, 8 to 60, 8 to 65, 8 to 70, 8 to 75, 8 to 80, 8
 to 85, 8 to 90, 8 to 95, 8 to 100, 9 to 10, 9 to 11, 9 to 12, 9 to 13, 9 to 14, 9 to 15, 9 to 16,
 30 9 to 17, 9 to 18, 9 to 19, 9 to 20, 9 to 25, 9 to 30, 9 to 35, 9 to 40, 9 to 45, 9 to 50, 9 to 55,
 9 to 60, 9 to 65, 9 to 70, 9 to 75, 9 to 80, 9 to 85, 9 to 90, 9 to 95, 9 to 100, 10 to 11, 10 to
 12, 10 to 13, 10 to 14, 10 to 15, 10 to 16, 10 to 17, 10 to 18, 10 to 19, 10 to 20, 10 to 25,
 10 to 30, 10 to 35, 10 to 40, 10 to 45, 10 to 50, 10 to 55, 10 to 60, 10 to 65, 10 to 70, 10
 to 75, 10 to 80, 10 to 85, 10 to 90, 10 to 95, 10 to 100, 20 to 25, 20 to 30, 20 to 35, 20 to

40, 20 to 45, 20 to 50, 20 to 55, 20 to 60, 20 to 65, 20 to 70, 20 to 75, 20 to 80, 20 to 85, 20 to 90, 20 to 95, 20 to 100, 30 to 35, 30 to 40, 30 to 45, 30 to 50, 30 to 55, 30 to 60, 30 to 65, 30 to 70, 30 to 75, 30 to 80, 30 to 85, 30 to 90, 30 to 95, 30 to 100, 40 to 45, 40 to 50, 40 to 55, 40 to 60, 40 to 65, 40 to 70, 40 to 75, 40 to 80, 40 to 85, 40 to 90, 40 to 95, 40 to 100, 50 to 55, 50 to 60, 50 to 65, 50 to 70, 50 to 75, 50 to 80, 50 to 85, 50 to 90, 50 to 95, 50 to 100, 60 to 65, 60 to 70, 60 to 75, 60 to 80, 60 to 85, 60 to 90, 60 to 95, 60 to 100, 70 to 75, 70 to 80, 70 to 85, 70 to 90, 70 to 95, 70 to 100, 80 to 85, 80 to 90, 80 to 95, 80 to 100, 90 to 95, 90 to 100 percent.

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a combination of product size or diameter and concentrations of surface modifications described herein.

In some embodiments, the density of the chemical derivatizations is at least, is less than, or is 0.1, 0.2, 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 550, 600, 650, 700, 750, 800, 850, 900, or 1000 chemical derivatizations per μm^2 on the surface or a surface of the products, in the interior of the products, or both, or the concentration of surface modifications is at least, is less than, or is 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 100 percent, and, independently, the products have pores in a size range of 0.1 μm to 10 μm , 0.1 μm to 9 μm , 0.1 μm to 8 μm , 0.1 μm to 7 μm , 0.1 μm to 6 μm , 0.1 μm to 5 μm , 0.1 μm to 4 μm , 0.1 μm to 3 μm , 0.1 μm to 2 μm , 0.15 μm to 10 μm , 0.15 μm to 9 μm , 0.15 μm to 8 μm , 0.15 μm to 7 μm , 0.15 μm to 6 μm , 0.15 μm to 5 μm , 0.15 μm to 4 μm , 0.15 μm to 3 μm , 0.15 μm to 2 μm , 0.2 μm to 10 μm , 0.2 μm to 9 μm , 0.2 μm to 8 μm , 0.2 μm to 7 μm , 0.2 μm to 6 μm , 0.2 μm to 5 μm , 0.2 μm to 4 μm , 0.2 μm to 3 μm , 0.25 μm to 10 μm , 0.25 μm to 9 μm , 0.25 μm to 8 μm , 0.25 μm to 7 μm , 0.25 μm to 6 μm , 0.25 μm to 5 μm , 0.25 μm to 4 μm , 0.25 μm to 3 μm , 0.3 μm to 10 μm , 0.3 μm to 9 μm , 0.3 μm to 8 μm , 0.3 μm to 7 μm , 0.3 μm to 6 μm , 0.3 μm to 5 μm , 0.3 μm to 4 μm , 0.35 μm to 10 μm , 0.35 μm to 9 μm , 0.35 μm to 8 μm , 0.35 μm to 7 μm , 0.35 μm to 6 μm , 0.35 μm to 5 μm , 0.35 μm to 4 μm , 0.4 μm to 10 μm , 0.4 μm to 9 μm , 0.4 μm to 8 μm , 0.4 μm to 7 μm , 0.4 μm to 6 μm , 0.4 μm to 5 μm , 0.45 μm to 10 μm , 0.45 μm to 9 μm , 0.45 μm to 8 μm , 0.45 μm to 7 μm , 0.45 μm to 6 μm , 0.45 μm to 5 μm , 0.5 μm to

10 μm , 0.5 μm to 9 μm , 0.5 μm to 8 μm , 0.5 μm to 7 μm , 0.5 μm to 6 μm , 0.55 μm to 10 μm , 0.55 μm to 9 μm , 0.55 μm to 8 μm , 0.55 μm to 7 μm , 0.55 μm to 6 μm , 0.6 μm to 10 μm , 0.6 μm to 9 μm , 0.6 μm to 8 μm , 0.6 μm to 7 μm , 0.65 μm to 10 μm , 0.65 μm to 9 μm , 0.65 μm to 8 μm , 0.65 μm to 7 μm , 0.7 μm to 10 μm , 0.7 μm to 9 μm , 0.7 μm to 8 μm , 0.75 μm to 10 μm , 0.75 μm to 9 μm , 0.75 μm to 8 μm , 0.8 μm to 10 μm , 0.8 μm to 9 μm , 0.85 μm to 10 μm , 0.85 μm to 9 μm , 0.9 μm to 10 μm , 0.95 μm to 10 μm , 1 μm to 10 μm , 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm .

25 In some embodiments, the density of the chemical derivatizations is in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.1 to 110, 0.1 to 120, 0.1 to 130, 0.1 to 140, 0.1 to 150, 0.1 to 160, 0.1 to 170, 0.1 to 180, 0.1 to 190, 0.1 to 200, 0.1 to 210, 0.1 to 220, 0.1 to 230, 0.1 to 240, 0.1 to 250, 0.1 to 260, 0.1 to 270, 0.1 to 280, 0.1 to 290, 0.1 to 300, 0.1 to 320, 0.1 to 340, 0.1 to 360, 0.1 to 380, 0.1 to 400, 0.1 to 420, 0.1 to 440, 0.1 to 460, 0.1 to 480, 0.1 to 500, 0.1 to 550, 0.1 to 600, 0.1 to 650, 0.1 to 700, 0.1 to 750, 0.1 to 800, 0.1

to 850, 0.1 to 900, 0.1 to 1000, 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80,

5 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.2 to 110, 0.2 to 120, 0.2 to 130, 0.2 to 140, 0.2 to 150, 0.2 to 160, 0.2 to 170, 0.2 to 180, 0.2 to 190, 0.2 to 200, 0.2 to 210, 0.2 to 220, 0.2 to 230, 0.2 to 240, 0.2 to 250, 0.2 to 260, 0.2 to 270, 0.2 to 280, 0.2 to 290, 0.2 to 300, 0.2 to 320, 0.2 to 340, 0.2 to 360, 0.2 to 380, 0.2 to 400, 0.2 to 420, 0.2 to 440, 0.2 to 460, 0.2 to 480, 0.2 to 500, 0.2 to 550, 0.2 to 600, 0.2 to 650, 0.2 to 700, 0.2 to 750, 0.2 to 800, 0.2 to 850, 0.2 to 900, 0.2 to 1000, 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4,

10 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 0.5 to 110, 0.5 to 120, 0.5 to 130, 0.5 to 140, 0.5 to 150, 0.5 to 160, 0.5 to 170, 0.5 to 180, 0.5 to 190, 0.5 to 200, 0.5 to 210, 0.5 to 220, 0.5 to 230, 0.5 to 240, 0.5 to 250, 0.5 to 260, 0.5 to 270, 0.5 to 280, 0.5 to 290, 0.5 to 300, 0.5 to 320, 0.5 to 340, 0.5 to 360, 0.5 to 380, 0.5 to 400, 0.5 to 420, 0.5 to 440, 0.5 to 460, 0.5 to 480, 0.5 to 500, 0.5 to 550, 0.5 to 600, 0.5 to 650, 0.5 to 700, 0.5 to 750, 0.5 to 800, 0.5 to 850, 0.5 to 900, 0.5 to 1000, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 1 to 110, 1 to 120, 1 to 130, 1 to 140, 1 to 150, 1 to 160, 1 to 170, 1 to 180, 1 to 190, 1 to 200, 1 to 210, 1 to 220, 1 to 230, 1 to 240, 1 to 250, 1 to 260, 1 to 270, 1 to 280, 1 to 290, 1 to 300, 1 to 320, 1 to 340, 1 to 360, 1 to 380, 1 to 400, 1 to 420, 1 to 440, 1 to 460, 1 to 480, 1 to 500,

25 1 to 550, 1 to 600, 1 to 650, 1 to 700, 1 to 750, 1 to 800, 1 to 850, 1 to 900, 1 to 1000, 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 2 to 110, 2 to 120, 2 to 130, 2 to 140, 2 to 150, 2 to 160, 2 to 170, 2 to 180, 2 to 190, 2 to 200, 2 to 210, 2 to 220, 2 to 230, 2 to 240, 2 to 250, 2 to 260, 2 to 270, 2 to 280, 2 to 290, 2 to 300, 2 to 320, 2 to 340, 2 to 360, 2 to 380, 2 to 400, 2 to 420, 2 to 440, 2 to 460, 2 to 480, 2 to 500, 2 to 550, 2 to 600, 2 to 650, 2 to 700, 2 to 750, 2 to 800, 2 to 850, 2 to 900, 2 to 1000, 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to

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14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to
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 5 290, 3 to 300, 3 to 320, 3 to 340, 3 to 360, 3 to 380, 3 to 400, 3 to 420, 3 to 440, 3 to 460,
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 20 to 150, 20 to 160, 20 to 170, 20 to 180, 20 to 190, 20 to 200, 20 to 210, 20 to 220, 20
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40 to 60, 40 to 65, 40 to 70, 40 to 75, 40 to 80, 40 to 85, 40 to 90, 40 to 95, 40 to 100, 40
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 190, 40 to 200, 40 to 210, 40 to 220, 40 to 230, 40 to 240, 40 to 250, 40 to 260, 40 to
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 15 850, 500 to 900, 500 to 1000, 600 to 650, 600 to 700, 600 to 750, 600 to 800, 600 to 850,
 600 to 900, 600 to 1000, 700 to 750, 700 to 800, 700 to 850, 700 to 900, 700 to 1000,
 800 to 850, 800 to 900, 800 to 1000, and 900 to 1000 chemical derivatizations per μm^2
 on the surface or a surface of the products, in the interior of the products, or both, and the
 products have pores in a size range of 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1
 20 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm ,
 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5
 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9
 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3
 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm ,
 25 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to
 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5
 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm
 to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4
 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm
 30 to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5
 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm
 to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm ,
 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to

8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm .

In some embodiments, the concentration of surface modifications in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5 to 25, 5 to 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5 to 80, 5 to 85, 5 to 90, 5 to 95, 5 to 100, 6 to 7, 6 to 8, 6 to 9, 6 to 10, 6 to 11, 6 to 12, 6 to 13, 6 to 14, 6 to 15, 6 to 16, 6 to 17, 6 to 18, 6 to 19, 6 to 20, 6 to 25, 6 to 30, 6 to 35, 6 to 40, 6 to 45, 6 to 50, 6 to 55, 6 to 60, 6 to 65, 6 to 70, 6 to 75, 6 to 80, 6 to 85, 6 to 90, 6 to 95, 6 to 100, 7 to 8, 7 to 9, 7 to 10, 7 to 11, 7 to 12, 7 to 13, 7 to 14, 7 to 15, 7 to 16, 7 to 17, 7 to 18, 7 to 19, 7 to 20, 7

to 25, 7 to 30, 7 to 35, 7 to 40, 7 to 45, 7 to 50, 7 to 55, 7 to 60, 7 to 65, 7 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100, 8 to 9, 8 to 10, 8 to 11, 8 to 12, 8 to 13, 8 to 14, 8 to 15, 8 to 16, 8 to 17, 8 to 18, 8 to 19, 8 to 20, 8 to 25, 8 to 30, 8 to 35, 8 to 40, 8 to 45, 8 to 50, 8 to 55, 8 to 60, 8 to 65, 8 to 70, 8 to 75, 8 to 80, 8 to 85, 8 to 90, 8 to 95, 8 to 100, 9 to 10, 9 to 11, 9 to 12, 9 to 13, 9 to 14, 9 to 15, 9 to 16, 9 to 17, 9 to 18, 9 to 19, 9 to 20, 9 to 25, 9 to 30, 9 to 35, 9 to 40, 9 to 45, 9 to 50, 9 to 55, 9 to 60, 9 to 65, 9 to 70, 9 to 75, 9 to 80, 9 to 85, 9 to 90, 9 to 95, 9 to 100, 10 to 11, 10 to 12, 10 to 13, 10 to 14, 10 to 15, 10 to 16, 10 to 17, 10 to 18, 10 to 19, 10 to 20, 10 to 25, 10 to 30, 10 to 35, 10 to 40, 10 to 45, 10 to 50, 10 to 55, 10 to 60, 10 to 65, 10 to 70, 10 to 75, 10 to 80, 10 to 85, 10 to 90, 10 to 95, 10 to 100, 20 to 25, 20 to 30, 20 to 35, 20 to 40, 20 to 45, 20 to 50, 20 to 55, 20 to 60, 20 to 65, 20 to 70, 20 to 75, 20 to 80, 20 to 85, 20 to 90, 20 to 95, 20 to 100, 30 to 35, 30 to 40, 30 to 45, 30 to 50, 30 to 55, 30 to 60, 30 to 65, 30 to 70, 30 to 75, 30 to 80, 30 to 85, 30 to 90, 30 to 95, 30 to 100, 40 to 45, 40 to 50, 40 to 55, 40 to 60, 40 to 65, 40 to 70, 40 to 75, 40 to 80, 40 to 85, 40 to 90, 40 to 95, 40 to 100, 50 to 55, 50 to 60, 50 to 65, 50 to 70, 50 to 75, 50 to 80, 50 to 85, 50 to 90, 50 to 95, 50 to 100, 60 to 65, 60 to 70, 60 to 75, 60 to 80, 60 to 85, 60 to 90, 60 to 95, 60 to 100, 70 to 75, 70 to 80, 70 to 85, 70 to 90, 70 to 95, 70 to 100, 80 to 85, 80 to 90, 80 to 95, 80 to 100, 90 to 95, 90 to 100 percent, and the products have pores in a size range of 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm .

In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a combination of pore size and derivatization density or concentration of surface modifications described herein.

- 5 In some embodiments, the products are in a size range of 1 mm to 8 mm, 1 mm to 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm, 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm, 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 2 mm to 5 mm, 2 mm to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5 mm to 6 mm, 2.5 mm to 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm, 4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5 mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm, have pores in a size range of 0.1 μm to 10 μm , 0.1 μm to 9 μm , 0.1 μm to 8 μm , 0.1 μm to 7 μm , 0.1 μm to 6 μm , 0.1 μm to 5 μm , 0.1 μm to 4 μm , 0.1 μm to 3 μm , 0.1 μm to 2 μm , 0.15 μm to 10 μm , 0.15 μm to 9 μm , 0.15 μm to 8 μm , 0.15 μm to 7 μm , 0.15 μm to 6 μm , 0.15 μm to 5 μm , 0.15 μm to 4 μm , 0.15 μm to 3 μm , 0.15 μm to 2 μm , 0.2 μm to 10 μm , 0.2 μm to 9 μm , 0.2 μm to 8 μm , 0.2 μm to 7 μm , 0.2 μm to 6 μm , 0.2 μm to 5 μm , 0.2 μm to 4 μm , 0.2 μm to 3 μm , 0.25 μm to 10 μm , 0.25 μm to 9 μm , 0.25 μm to 8 μm , 0.25 μm to 7 μm , 0.25 μm to 6 μm , 0.25 μm to 5 μm , 0.25 μm to 4 μm , 0.25 μm to 3 μm , 0.3 μm to 10 μm , 0.3 μm to 9 μm , 0.3 μm to 8 μm , 0.3 μm to 7 μm , 0.3 μm to 6 μm , 0.3 μm to 5 μm , 0.3 μm to 4 μm , 0.35 μm to 10 μm , 0.35 μm to 9 μm , 0.35 μm to 8 μm , 0.35 μm to 7 μm , 0.35 μm to 6 μm , 0.35 μm to 5 μm , 0.35 μm to 4 μm , 0.4 μm to 10 μm , 0.4 μm to 9 μm , 0.4 μm to 8 μm , 0.4 μm to 7 μm , 0.4 μm to 6 μm , 0.4 μm to 5 μm , 0.45 μm to 10 μm , 0.45 μm to 9 μm , 0.45 μm to 8 μm , 0.45 μm to 7 μm , 0.45 μm to 6 μm , 0.45 μm to 5 μm , 0.5 μm to 10 μm , 0.5 μm to 9 μm , 0.5 μm to 8 μm , 0.5 μm to 7 μm , 0.5 μm to 6 μm , 0.55 μm to 10 μm , 0.55 μm to 9 μm , 0.55 μm to 8 μm , 0.55 μm to 7 μm , 0.55 μm to 6 μm , 0.6 μm to 10 μm , 0.6 μm to 9 μm , 0.6 μm to 8 μm , 0.6 μm to 7 μm , 0.65 μm to 10 μm , 0.65 μm to 9 μm , 0.65 μm to 8 μm , 0.65 μm to 7 μm , 0.7 μm to 10 μm , 0.7 μm to 9 μm , 0.7 μm to 8 μm , 0.75 μm to 10 μm , 0.75 μm to 9 μm , 0.75 μm to 8 μm , 0.8 μm to 10 μm , 0.8 μm to 9 μm , 0.85 μm to 10 μm , 0.85 μm to 9 μm , 0.9 μm to 10 μm , 0.95 μm to 10 μm , 1 μm to 10 μm , 1 μm to

10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm
 to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8
 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm ,
 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6
 5 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5
 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm
 to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3
 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to
 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4
 10 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9
 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5
 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9
 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6
 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to
 15 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm ,
 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm
 to 10 μm , or 9.5 μm to 10 μm , and have a density of at least, of less than, or of 0.1, 0.2,
 0.5, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45,
 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190,
 20 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, 300, 320, 340, 360, 380, 400, 420, 440,
 460, 480, 500, 550, 600, 650, 700, 750, 800, 850, 900, or 1000 chemical derivatizations
 per μm^2 on its surface, interior or both, or have a concentration of surface modifications
 is at least, is less than, or is 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, 4, 5, 6, 7, 8, 9,
 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85,
 25 90, 95, or 100 percent.

In some embodiments, the products are in a size range of 1 mm to 8 mm, 1 mm to
 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm,
 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm,
 30 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 2 mm to 5 mm, 2 mm
 to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5 mm to 6 mm, 2.5 mm to
 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6
 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6
 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm,

4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5 mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm, have pores in a size range of 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm , and have a density in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.1 to 110, 0.1 to 120, 0.1 to 130, 0.1 to 140, 0.1 to 150, 0.1 to 160, 0.1 to 170, 0.1 to 180, 0.1 to 190, 0.1 to 200, 0.1 to 210, 0.1 to 220, 0.1 to 230, 0.1 to 240, 0.1 to 250, 0.1 to 260, 0.1 to 270, 0.1 to 280, 0.1 to 290, 0.1 to 300, 0.1 to 320, 0.1 to 340, 0.1 to 360, 0.1 to 380, 0.1 to 400, 0.1 to 420, 0.1 to 440, 0.1 to 460, 0.1 to 480, 0.1 to 500, 0.1 to 550, 0.1 to 600, 0.1 to 650, 0.1 to 700, 0.1 to 750, 0.1 to 800, 0.1 to 850, 0.1 to 900, 0.1 to 1000, 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.2 to 110,

0.2 to 120, 0.2 to 130, 0.2 to 140, 0.2 to 150, 0.2 to 160, 0.2 to 170, 0.2 to 180, 0.2 to 190, 0.2 to 200, 0.2 to 210, 0.2 to 220, 0.2 to 230, 0.2 to 240, 0.2 to 250, 0.2 to 260, 0.2 to 270, 0.2 to 280, 0.2 to 290, 0.2 to 300, 0.2 to 320, 0.2 to 340, 0.2 to 360, 0.2 to 380, 0.2 to 400, 0.2 to 420, 0.2 to 440, 0.2 to 460, 0.2 to 480, 0.2 to 500, 0.2 to 550, 0.2 to 600, 0.2 to 650, 0.2 to 700, 0.2 to 750, 0.2 to 800, 0.2 to 850, 0.2 to 900, 0.2 to 1000, 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 0.5 to 110, 0.5 to 120, 0.5 to 130, 0.5 to 140, 0.5 to 150, 0.5 to 160, 0.5 to 170, 0.5 to 180, 0.5 to 190, 0.5 to 200, 0.5 to 210, 0.5 to 220, 0.5 to 230, 0.5 to 240, 0.5 to 250, 0.5 to 260, 0.5 to 270, 0.5 to 280, 0.5 to 290, 0.5 to 300, 0.5 to 320, 0.5 to 340, 0.5 to 360, 0.5 to 380, 0.5 to 400, 0.5 to 420, 0.5 to 440, 0.5 to 460, 0.5 to 480, 0.5 to 500, 0.5 to 550, 0.5 to 600, 0.5 to 650, 0.5 to 700, 0.5 to 750, 0.5 to 800, 0.5 to 850, 0.5 to 900, 0.5 to 1000, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 1 to 110, 1 to 120, 1 to 130, 1 to 140, 1 to 150, 1 to 160, 1 to 170, 1 to 180, 1 to 190, 1 to 200, 1 to 210, 1 to 220, 1 to 230, 1 to 240, 1 to 250, 1 to 260, 1 to 270, 1 to 280, 1 to 290, 1 to 300, 1 to 320, 1 to 340, 1 to 360, 1 to 380, 1 to 400, 1 to 420, 1 to 440, 1 to 460, 1 to 480, 1 to 500, 1 to 550, 1 to 600, 1 to 650, 1 to 700, 1 to 750, 1 to 800, 1 to 850, 1 to 900, 1 to 1000, 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 2 to 110, 2 to 120, 2 to 130, 2 to 140, 2 to 150, 2 to 160, 2 to 170, 2 to 180, 2 to 190, 2 to 200, 2 to 210, 2 to 220, 2 to 230, 2 to 240, 2 to 250, 2 to 260, 2 to 270, 2 to 280, 2 to 290, 2 to 300, 2 to 320, 2 to 340, 2 to 360, 2 to 380, 2 to 400, 2 to 420, 2 to 440, 2 to 460, 2 to 480, 2 to 500, 2 to 550, 2 to 600, 2 to 650, 2 to 700, 2 to 750, 2 to 800, 2 to 850, 2 to 900, 2 to 1000, 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 3 to 110, 3 to 120, 3 to 130, 3 to 140, 3 to 150, 3 to 160, 3 to 170, 3 to 180, 3 to 190, 3 to 200, 3 to 210, 3 to 220, 3 to 230, 3 to 240, 3 to 250, 3 to 260, 3 to 270, 3 to 280, 3 to 290, 3 to 300, 3 to 320, 3 to 340, 3 to 360, 3 to 380, 3 to

400, 3 to 420, 3 to 440, 3 to 460, 3 to 480, 3 to 500, 3 to 550, 3 to 600, 3 to 650, 3 to 700,
 3 to 750, 3 to 800, 3 to 850, 3 to 900, 3 to 1000, 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to
 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to
 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to
 5 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 4 to 110, 4 to 120, 4 to 130, 4 to 140, 4 to 150, 4 to
 160, 4 to 170, 4 to 180, 4 to 190, 4 to 200, 4 to 210, 4 to 220, 4 to 230, 4 to 240, 4 to 250,
 4 to 260, 4 to 270, 4 to 280, 4 to 290, 4 to 300, 4 to 320, 4 to 340, 4 to 360, 4 to 380, 4 to
 400, 4 to 420, 4 to 440, 4 to 460, 4 to 480, 4 to 500, 4 to 550, 4 to 600, 4 to 650, 4 to 700,
 4 to 750, 4 to 800, 4 to 850, 4 to 900, 4 to 1000, 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to
 10 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5 to 16, 5 to 17, 5 to 18, 5 to 19, 5 to 20, 5 to 25, 5 to
 30, 5 to 35, 5 to 40, 5 to 45, 5 to 50, 5 to 55, 5 to 60, 5 to 65, 5 to 70, 5 to 75, 5 to 80, 5 to
 85, 5 to 90, 5 to 95, 5 to 100, 5 to 110, 5 to 120, 5 to 130, 5 to 140, 5 to 150, 5 to 160, 5
 to 170, 5 to 180, 5 to 190, 5 to 200, 5 to 210, 5 to 220, 5 to 230, 5 to 240, 5 to 250, 5 to
 260, 5 to 270, 5 to 280, 5 to 290, 5 to 300, 5 to 320, 5 to 340, 5 to 360, 5 to 380, 5 to 400,
 15 5 to 420, 5 to 440, 5 to 460, 5 to 480, 5 to 500, 5 to 550, 5 to 600, 5 to 650, 5 to 700, 5 to
 750, 5 to 800, 5 to 850, 5 to 900, 5 to 1000, 6 to 7, 6 to 8, 6 to 9, 6 to 10, 6 to 11, 6 to 12,
 6 to 13, 6 to 14, 6 to 15, 6 to 16, 6 to 17, 6 to 18, 6 to 19, 6 to 20, 6 to 25, 6 to 30, 6 to 35,
 6 to 40, 6 to 45, 6 to 50, 6 to 55, 6 to 60, 6 to 65, 6 to 70, 6 to 75, 6 to 80, 6 to 85, 6 to 90,
 6 to 95, 6 to 100, 6 to 110, 6 to 120, 6 to 130, 6 to 140, 6 to 150, 6 to 160, 6 to 170, 6 to
 20 180, 6 to 190, 6 to 200, 6 to 210, 6 to 220, 6 to 230, 6 to 240, 6 to 250, 6 to 260, 6 to 270,
 6 to 280, 6 to 290, 6 to 300, 6 to 320, 6 to 340, 6 to 360, 6 to 380, 6 to 400, 6 to 420, 6 to
 440, 6 to 460, 6 to 480, 6 to 500, 6 to 550, 6 to 600, 6 to 650, 6 to 700, 6 to 750, 6 to 800,
 6 to 850, 6 to 900, 6 to 1000, 7 to 8, 7 to 9, 7 to 10, 7 to 11, 7 to 12, 7 to 13, 7 to 14, 7 to
 15, 7 to 16, 7 to 17, 7 to 18, 7 to 19, 7 to 20, 7 to 25, 7 to 30, 7 to 35, 7 to 40, 7 to 45, 7 to
 25 50, 7 to 55, 7 to 60, 7 to 65, 7 to 70, 7 to 75, 7 to 80, 7 to 85, 7 to 90, 7 to 95, 7 to 100, 7
 to 110, 7 to 120, 7 to 130, 7 to 140, 7 to 150, 7 to 160, 7 to 170, 7 to 180, 7 to 190, 7 to
 200, 7 to 210, 7 to 220, 7 to 230, 7 to 240, 7 to 250, 7 to 260, 7 to 270, 7 to 280, 7 to 290,
 7 to 300, 7 to 320, 7 to 340, 7 to 360, 7 to 380, 7 to 400, 7 to 420, 7 to 440, 7 to 460, 7 to
 480, 7 to 500, 7 to 550, 7 to 600, 7 to 650, 7 to 700, 7 to 750, 7 to 800, 7 to 850, 7 to 900,
 30 7 to 1000, 8 to 9, 8 to 10, 8 to 11, 8 to 12, 8 to 13, 8 to 14, 8 to 15, 8 to 16, 8 to 17, 8 to
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In some embodiments, the products are in a size range of 1 mm to 8 mm, 1 mm to 6 mm, 1 mm to 5 mm, 1 mm to 4 mm, 1 mm to 3 mm, 1 mm to 2 mm, 1 mm to 1.5 mm, 1.5 mm to 8 mm, 1.5 mm to 6 mm, 1.5 mm to 5 mm, 1.5 mm to 4 mm, 1.5 mm to 3 mm, 1.5 mm to 2 mm, 2 mm to 8 mm, 2 mm to 7 mm, 2 mm to 6 mm, 2 mm to 5 mm, 2 mm to 4 mm, 2 mm to 3 mm, 2.5 mm to 8 mm, 2.5 mm to 7 mm, 2.5 mm to 6 mm, 2.5 mm to 5 mm, 2.5 mm to 4 mm, 2.5 mm to 3 mm, 3 mm to 8 mm, 3 mm to 7 mm, 3 mm to 6 mm, 3 mm to 5 mm, 3 mm to 4 mm, 3.5 mm to 8 mm, 3.5 mm to 7 mm, 3.5 mm to 6 mm, 3.5 mm to 5 mm, 3.5 mm to 4 mm, 4 mm to 8 mm, 4 mm to 7 mm, 4 mm to 6 mm, 4 mm to 5 mm, 4.5 mm to 8 mm, 4.5 mm to 7 mm, 4.5 mm to 6 mm, 4.5 mm to 5 mm, 5 mm to 8 mm, 5 mm to 7 mm, 5 mm to 6 mm, 5.5 mm to 8 mm, 5.5 mm to 7 mm, 5.5 mm to 6 mm, 6 mm to 8 mm, 6 mm to 7 mm, 6.5 mm to 8 mm, 6.5 mm to 7 mm, 7 mm to 8 mm, or 7.5 mm to 8 mm, have pores in a size range of 1 μm to 10 μm , 1 μm to 9 μm , 1 μm to 8 μm , 1 μm to 7 μm , 1 μm to 6 μm , 1 μm to 5 μm , 1 μm to 4 μm , 1 μm to 3 μm , 1 μm to 2 μm , 1.5 μm to 10 μm , 1.5 μm to 9 μm , 1.5 μm to 8 μm , 1.5 μm to 7 μm , 1.5 μm to 6 μm , 1.5 μm to 5 μm , 1.5 μm to 4 μm , 1.5 μm to 3 μm , 1.5 μm to 2 μm , 2 μm to 10 μm , 2 μm to 9 μm , 2 μm to 8 μm , 2 μm to 7 μm , 2 μm to 6 μm , 2 μm to 5 μm , 2 μm to 4 μm , 2 μm to 3 μm , 2.5 μm to 10 μm , 2.5 μm to 9 μm , 2.5 μm to 8 μm , 2.5 μm to 7 μm , 2.5 μm to 6 μm , 2.5 μm to 5 μm , 2.5 μm to 4 μm , 2.5 μm to 3 μm , 3 μm to 10 μm , 3 μm to 9 μm , 3 μm to 8 μm , 3 μm to 7 μm , 3 μm to 6 μm , 3 μm to 5 μm , 3 μm to 4 μm , 3.5 μm to 10 μm , 3.5 μm to 9 μm , 3.5 μm to 8 μm , 3.5 μm to 7 μm , 3.5 μm to 6 μm , 3.5 μm

to 5 μm , 3.5 μm to 4 μm , 4 μm to 10 μm , 4 μm to 9 μm , 4 μm to 8 μm , 4 μm to 7 μm , 4 μm to 6 μm , 4 μm to 5 μm , 4.5 μm to 10 μm , 4.5 μm to 9 μm , 4.5 μm to 8 μm , 4.5 μm to 7 μm , 4.5 μm to 6 μm , 4.5 μm to 5 μm , 5 μm to 10 μm , 5 μm to 9 μm , 5 μm to 8 μm , 5 μm to 7 μm , 5 μm to 6 μm , 5.5 μm to 10 μm , 5.5 μm to 9 μm , 5.5 μm to 8 μm , 5.5 μm to 7 μm , 5.5 μm to 6 μm , 6 μm to 10 μm , 6 μm to 9 μm , 6 μm to 8 μm , 6 μm to 7 μm , 6.5 μm to 10 μm , 6.5 μm to 9 μm , 6.5 μm to 8 μm , 6.5 μm to 7 μm , 7 μm to 10 μm , 7 μm to 9 μm , 7 μm to 8 μm , 7.5 μm to 10 μm , 7.5 μm to 9 μm , 7.5 μm to 8 μm , 8 μm to 10 μm , 8 μm to 9 μm , 8.5 μm to 10 μm , 8.5 μm to 9 μm , 9 μm to 10 μm , or 9.5 μm to 10 μm , and have a concentration of surface modifications in the range of 0.1 to 0.2, 0.1 to 0.5, 0.1 to 1, 0.1 to 2, 0.1 to 3, 0.1 to 4, 0.1 to 5, 0.1 to 6, 0.1 to 7, 0.1 to 8, 0.1 to 9, 0.1 to 10, 0.1 to 11, 0.1 to 12, 0.1 to 13, 0.1 to 14, 0.1 to 15, 0.1 to 16, 0.1 to 17, 0.1 to 18, 0.1 to 19, 0.1 to 20, 0.1 to 25, 0.1 to 30, 0.1 to 35, 0.1 to 40, 0.1 to 45, 0.1 to 50, 0.1 to 55, 0.1 to 60, 0.1 to 65, 0.1 to 70, 0.1 to 75, 0.1 to 80, 0.1 to 85, 0.1 to 90, 0.1 to 95, 0.1 to 100, 0.2 to 0.5, 0.0 to 1, 0.2 to 2, 0.2 to 3, 0.2 to 4, 0.2 to 5, 0.2 to 6, 0.2 to 7, 0.2 to 8, 0.2 to 9, 0.2 to 10, 0.2 to 11, 0.2 to 12, 0.2 to 13, 0.2 to 14, 0.2 to 15, 0.2 to 16, 0.2 to 17, 0.2 to 18, 0.2 to 19, 0.2 to 20, 0.2 to 25, 0.2 to 30, 0.2 to 35, 0.2 to 40, 0.2 to 45, 0.2 to 50, 0.2 to 55, 0.2 to 60, 0.2 to 65, 0.2 to 70, 0.2 to 75, 0.2 to 80, 0.2 to 85, 0.2 to 90, 0.2 to 95, 0.2 to 100, 0.5 to 1, 0.5 to 2, 0.5 to 3, 0.5 to 4, 0.5 to 5, 0.5 to 6, 0.5 to 7, 0.5 to 8, 0.5 to 9, 0.5 to 10, 0.5 to 11, 0.5 to 12, 0.5 to 13, 0.5 to 14, 0.5 to 15, 0.5 to 16, 0.5 to 17, 0.5 to 18, 0.5 to 19, 0.5 to 20, 0.5 to 25, 0.5 to 30, 0.5 to 35, 0.5 to 40, 0.5 to 45, 0.5 to 50, 0.5 to 55, 0.5 to 60, 0.5 to 65, 0.5 to 70, 0.5 to 75, 0.5 to 80, 0.5 to 85, 0.5 to 90, 0.5 to 95, 0.5 to 100, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 7, 1 to 8, 1 to 9, 1 to 10, 1 to 11, 1 to 12, 1 to 13, 1 to 14, 1 to 15, 1 to 16, 1 to 17, 1 to 18, 1 to 19, 1 to 20, 1 to 25, 1 to 30, 1 to 35, 1 to 40, 1 to 45, 1 to 50, 1 to 55, 1 to 60, 1 to 65, 1 to 70, 1 to 75, 1 to 80, 1 to 85, 1 to 90, 1 to 95, 1 to 100, 2 to 3, 2 to 4, 2 to 5, 2 to 6, 2 to 7, 2 to 8, 2 to 9, 2 to 10, 2 to 11, 2 to 12, 2 to 13, 2 to 14, 2 to 15, 2 to 16, 2 to 17, 2 to 18, 2 to 19, 2 to 20, 2 to 25, 2 to 30, 2 to 35, 2 to 40, 2 to 45, 2 to 50, 2 to 55, 2 to 60, 2 to 65, 2 to 70, 2 to 75, 2 to 80, 2 to 85, 2 to 90, 2 to 95, 2 to 100, 3 to 4, 3 to 5, 3 to 6, 3 to 7, 3 to 8, 3 to 9, 3 to 10, 3 to 11, 3 to 12, 3 to 13, 3 to 14, 3 to 15, 3 to 16, 3 to 17, 3 to 18, 3 to 19, 3 to 20, 3 to 25, 3 to 30, 3 to 35, 3 to 40, 3 to 45, 3 to 50, 3 to 55, 3 to 60, 3 to 65, 3 to 70, 3 to 75, 3 to 80, 3 to 85, 3 to 90, 3 to 95, 3 to 100, 4 to 5, 4 to 6, 4 to 7, 4 to 8, 4 to 9, 4 to 10, 4 to 11, 4 to 12, 4 to 13, 4 to 14, 4 to 15, 4 to 16, 4 to 17, 4 to 18, 4 to 19, 4 to 20, 4 to 25, 4 to 30, 4 to 35, 4 to 40, 4 to 45, 4 to 50, 4 to 55, 4 to 60, 4 to 65, 4 to 70, 4 to 75, 4 to 80, 4 to 85, 4 to 90, 4 to 95, 4 to 100, 5 to 6, 5 to 7, 5 to 8, 5 to 9, 5 to 10, 5 to 11, 5 to 12, 5 to 13, 5 to 14, 5 to 15, 5

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In some embodiments, the product is provided as a preparation and at least 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, 70%, 75%, 80%, 85%, 90%, 95% or 100% of the products in the preparation have a combination of product size or diameter, pore size, and derivatization density or concentration of surface modifications described herein.

C. Properties of Surface-modified Products

In preferred embodiments, the surface modified product shows an improved beneficial effect. In further embodiments, the improved beneficial effect involves enhanced biocompatibility such that the fluorescence response normalized to a corresponding unmodified product measured using the *in vivo* biocompatibility assay described herein is less than 100%, 95%, 90%, 85%, 80%, 75%, 70%, 65%, 60%, 55%, 50%, 45%, or 40%. In preferred embodiments, the surface modified product induces a

lower foreign body response than the corresponding unmodified product. This is indicated by fluorescence response normalized to unmodified surface of less than 100%. In some embodiments, the surface modified product is biocompatible such that the fluorescence response normalized a corresponding unmodified product measured using the *in vivo* biocompatibility assay described herein is less than 75%, more preferably less than 65%, and most preferably less than 50%.

A surface of a product adapted for use in a medical environment can be capable of sterilization using autoclaving, biocide exposure, irradiation, or gassing techniques, like ethylene oxide exposure. Surfaces found in medical environments include the inner and outer aspects of various instruments and devices, whether disposable or intended for repeated uses.

D. Therapeutic Agents Included in Products

The disclosed surface modified products can include one or more therapeutic agents. Therapeutic agents are any compound, composition, conjugate, or construct that can be used to treat a disease, disorder, condition, symptom, etc. Examples of therapeutic agents include cells, tissues, cell products, tissue products, proteins, antibodies, vaccines, vaccine components, antigens, epitopes, drugs, salts, nutrients, buffers, acids, and bases. In some embodiments, the therapeutic agent can be a biological material.

In some embodiments, the product can include a cell or tissue, e.g., a living cell or tissue, which in some embodiments is encapsulated in, or coated with, a polymer. In such embodiments, the surface or a surface of the polymer encapsulation or coating is modified with moieties or compounds disclosed herein. In some embodiments, the cell can include an exogenous nucleic acid that encodes a therapeutic or diagnostic polypeptide. In some embodiments the cell or engineered cell is autologous, allogenic, or xenogeneic.

In some embodiments, the cell is a genetically engineered cell that secretes a therapeutic agent, such as a protein or hormone for treating a disease or other condition. In some embodiments, the cell is a genetically engineered cell that secretes a diagnostic agent. In some embodiments, the cell is a stem cell, e.g., an embryonic stem cell, mesenchymal stem cell, hepatic stem cell, or bone marrow stem cell.

1. Biological Materials

Biological material for inclusion in the disclosed products can be any biological substance. For example, the biological material can be tissue, cells, biological micromolecules, or biological macromolecules. Examples of biological macromolecules

include nucleotides, amino acids, cofactors, and hormones. Examples of biological macromolecules include nucleic acids, polypeptides, proteins, and polysaccharides. Examples of proteins include enzymes, receptors, secretory proteins, structural proteins, signaling proteins, hormones, and ligands. Any class, type, form, or particular biological material can be used together with any other classes, types, forms, or particular biological materials.

a. Cells

The cell type chosen for inclusion in the disclosed products depends on the desired therapeutic effect. The cells may be from the patient (autologous cells), from another donor of the same species (allogeneic cells), or from another species (xenogeneic). Xenogeneic cells are easily accessible, but the potential for rejection and the danger of possible transmission of viruses to the patient restricts their clinical application. Any of these types of cells can be from natural sources, stem cells, derived cells, or genetically engineered cell.

In some embodiments, the cells secrete a therapeutically effective substance, such as a protein or nucleic acid. In some embodiments, the cells produce a metabolic product. In some embodiments, the cells metabolize toxic substances. In some embodiments, the cells form structural tissues, such as skin, bone, cartilage, blood vessels, or muscle. In some embodiments, the cells are natural, such as islet cells that naturally secrete insulin, or hepatocytes that naturally detoxify. In some embodiments, the cells are genetically engineered to express a heterologous protein or nucleic acid and/or overexpress an endogenous protein or nucleic acid. In some embodiments, the cells are genetically engineered to produce a new or different product, which can be an expression product of the engineered gene(s) or another product, such as a metabolite, produced because of the engineered gene(s).

Types of cells for inclusion in the disclosed products include cells from natural sources, such as cells from xenotissue, cells from a cadaver, and primary cells; stem cells, such as embryonic stem cells, mesenchymal stem cells, and induced pluripotent stem cells; derived cells, such as cells derived from stem cells, cells from a cell line, reprogrammed cells, reprogrammed stem cells, and cells derived from reprogrammed stem cells; and genetically engineered cells, such as cells genetically engineered to express a protein or nucleic acid, cells genetically engineered to produce a metabolic product, and cells genetically engineered to metabolize toxic substances.

Types of cells for inclusion in the disclosed products include liver cells (e.g., hepatoblasts liver stellate cells, biliary cells, or hepatocytes), insulin producing cells (e.g., pancreatic islet cells, isolated pancreatic beta cells, or insulinoma cells), kidney cells, epidermal cells, epithelial cells, neural cells, including neurons and glial cells (e.g., astrocytes), ganglion cells, retinal epithelial cells, adrenal medulla cells, lung cells, cardiac muscle cells, osteoblast cells, osteoclast cells, bone marrow cells, spleen cells, thymus cells, glandular cells, blood cells (e.g., T cells, B cells, macrophage lineage cells, lymphocytes, or monocytes), endocrine hormone-producing cells (e.g., parathyroid, thyroid, or adrenal cells), cells of intestinal origin and other cells acting primarily to synthesize and secrete or to metabolize materials, endothelial cells (e.g., capillary endothelial cells), fibroblasts (e.g., dermal fibroblasts), myogenic cells, keratinocytes, smooth muscle cells, progenitor cells (e.g., bone marrow progenitor cells, adipose progenitor cells, hepatic precursor cells, endothelial progenitor cells, peripheral blood progenitor cells, or progenitor cells from muscle, skin) marrow stromal cells cell lines (e.g., CHO cells, MDCK cells and PC12 cells).

A preferred cell type is a pancreatic islet cell or other insulin-producing cell. Hormone-producing cells can produce one or more hormones, such as insulin, parathyroid hormone, anti-diuretic hormone, oxytocin, growth hormone, prolactin, thyroid stimulating hormone, adrenocorticotrophic hormone, follicle-stimulating hormone, luteinizing hormone, thyroxine, calcitonin, aldosterone, cortisol, epinephrine, glucagon, estrogen, progesterone, and testosterone. Genetically engineered cells are also suitable for inclusion in the disclosed products. In some embodiments, the cells are engineered to produce one or more hormones, such as insulin, parathyroid hormone, anti-diuretic hormone, oxytocin, growth hormone, prolactin, thyroid stimulating hormone, adrenocorticotrophic hormone, follicle-stimulating hormone, luteinizing hormone, thyroxine, calcitonin, aldosterone, cortisol, epinephrine, glucagon, estrogen, progesterone, and testosterone. In some embodiments, the cells are engineered to secrete blood clotting factors (e.g., for hemophilia treatment) or to secrete growth hormones. In some embodiments, the cells are contained in natural or bioengineered tissue. For example, the cells for inclusion in the disclosed products are in some embodiments a bioartificial renal glomerulus. In some embodiments, the cells are suitable for transplantation into the central nervous system for treatment of neurodegenerative disease.

Cells can be obtained directly from a donor, from cell culture of cells from a donor, or from established cell culture lines. In the preferred embodiments, cells are obtained directly from a donor, washed and implanted directly in combination with the polymeric material. The cells are cultured using techniques known to those skilled in the art of tissue culture.

Cell viability can be assessed using standard techniques, such as histology and fluorescent microscopy. The function of the implanted cells can be determined using a combination of these techniques and functional assays. For example, in the case of hepatocytes, *in vivo* liver function studies can be performed by placing a cannula into the recipient's common bile duct. Bile can then be collected in increments. Bile pigments can be analyzed by high pressure liquid chromatography looking for underivatized tetrapyrroles or by thin layer chromatography after being converted to azodipyrroles by reaction with diazotized azodipyrroles ethylanthranilate either with or without treatment with P-glucuronidase. Diconjugated and monoconjugated bilirubin can also be determined by thin layer chromatography after alkalinemethanolysis of conjugated bile pigments. In general, as the number of functioning transplanted hepatocytes increases, the levels of conjugated bilirubin will increase. Simple liver function tests can also be done on blood samples, such as albumin production. Analogous organ function studies can be conducted using techniques known to those skilled in the art, as required to determine the extent of cell function after implantation. For example, pancreatic islet cells and other insulin-producing cells can be implanted to achieve glucose regulation by appropriate secretion of insulin. Other endocrine tissues and cells can also be implanted.

The site, or sites, where cells are to be implanted is determined based on individual need, as is the requisite number of cells. For cells replacing or supplementing organ or gland function (for example, hepatocytes or islet cells), the mixture can be injected into the mesentery, subcutaneous tissue, retroperitoneum, properitoneal space, and intramuscular space.

The amount and density of cells included in the disclosed products will vary depending on the choice of cell and site of implantation. In some embodiments, the single cells are present in the product at a concentration of 0.1×10^6 to 4×10^6 cells/ml, preferred 0.5×10^6 to 2×10^6 cells/ml. In other embodiments, the cells are present as cell aggregates. For example, islet cell aggregates (or whole islets) preferably contain about 1500-2000 cells for each aggregate of 150 μ m diameter, which is defined as one islet equivalent (IE). Therefore, in some embodiments, islet cells are present at a

concentration of 100-10000 IE/ml, preferably 200-3,000 IE/ml, more preferably 500-1500 IE/ml.

i. Islet Cells and Other Insulin-Producing Cells

In preferred embodiments, the disclosed compositions contain islet cells or other
5 insulin-producing cells. Methods of isolating pancreatic islet cells are known in the art. Field et al., *Transplantation* 61:1554 (1996); Linetsky et al., *Diabetes* 46:1120 (1997). Fresh pancreatic tissue can be divided by mincing, teasing, comminution and/or collagenase digestion. The islets can then be isolated from contaminating cells and materials by washing, filtering, centrifuging or picking procedures. Methods and
10 apparatus for isolating and purifying islet cells are described in U.S. Patent Nos. 5,447,863 to Langley, 5,322,790 to Scharp et al., 5,273,904 to Langley, and 4,868,121 to Scharp et al. The isolated pancreatic cells may optionally be cultured prior to inclusion in the product using any suitable method of culturing islet cells as is known in the art. See e.g., U.S. Patent No. 5,821,121 to Brothers. Isolated cells may be cultured in a medium
15 under conditions that helps to eliminate antigenic components. Insulin-producing cells can also be derived from stem cells and cell lines and can be cells genetically engineered to produce insulin.

2. Genetically Engineered Cells

In some embodiments, the disclosed compositions contain cells genetically
20 engineered to produce a protein or nucleic acid (e.g., a therapeutic protein or nucleic acid). In these embodiments, the cell can be, for example, a stem cell (e.g., pluripotent), a progenitor cell (e.g., multipotent or oligopotent), or a terminally differentiated cell (i.e., unipotent). Any of the disclosed cell types can be genetically engineered. The cell can be engineered, for example, to contain a nucleic acid encoding, for example, a
25 polynucleotide such as miRNA or RNAi or a polynucleotide encoding a protein. The nucleic acid can be, for example, integrated into the cells genomic DNA for stable expression or can be, for example, in an expression vector (e.g., plasmid DNA). The polynucleotide or protein can be selected based on the disease to be treated (or effect to be achieved) and the site of transplantation or implantation. In some embodiments, the
30 polynucleotide or protein is anti-neoplastic. In other embodiments, the polynucleotide or protein is a hormone, growth factor, or enzyme.

Therapeutic agents for secretion by genetically engineered cells include, for example, thyroid stimulating hormone; beneficial lipoproteins such as ApoI; prostacyclin and other vasoactive substances, anti-oxidants and free radical scavengers;

soluble cytokine receptors, for example soluble transforming growth factor (TGF) receptor, or cytokine receptor antagonists, for example IL1ra; soluble adhesion molecules, for example ICAM-1; soluble receptors for viruses, e.g. CD4, CXCR4, CCR5 for HIV; cytokines; elastase inhibitors; bone morphogenetic proteins (BMP) and BMP receptors 1 and 2; endoglin; serotonin receptors; tissue inhibiting metalloproteinases; potassium channels or potassium channel modulators; anti-inflammatory factors; angiogenic factors including vascular endothelial growth factor (VEGF), transforming growth factor (TGF), hepatic growth factor, and hypoxia inducible factor (HIF); polypeptides with neurotrophic and/or anti-angiogenic activity including ciliary neurotrophic factor (CNTF), glial-derived neurotrophic factor (GDNF), nerve growth factor (NGF), brain-derived neurotrophic factor (BDNF), neurotrophin-3, nurturin, fibroblast growth factors (FGFs), endostatin, ATF, fragments of thrombospondin, variants thereof and the like. More preferred polypeptides are FGFs, such as acidic FGF (aFGF), basic FGF (bFGF), FGF-1 and FGF-2 and endostatin.

15 In some embodiments, the active agent is a protein or peptide. Examples of protein active agents include, but are not limited to, cytokines and their receptors, as well as chimeric proteins including cytokines or their receptors, including, for example tumor necrosis factor alpha and beta, their receptors and their derivatives; renin; lipoproteins; colchicine; prolactin; corticotrophin; vasopressin; somatostatin; lyppressin; pancreozymin; leuprolide; alpha-1-antitrypsin; clotting factors such as factor VIIIC, factor IX, tissue factor, and von Willebrands factor; anti-clotting factors such as Protein C; atrial natriuretic factor; lung surfactant; a plasminogen activator other than a tissue-type plasminogen activator (t-PA), for example a urokinase; bombesin; thrombin; hemopoietic growth factor; enkephalinase; RANTES (regulated on activation normally T-cell expressed and secreted); human macrophage inflammatory protein (MIP-1-alpha); 25 a serum albumin such as human serum albumin; mullerian-inhibiting substance; relaxin A-chain; relaxin B-chain; prorelaxin; mouse gonadotropin-associated peptide; chorionic gonadotropin; a microbial protein, such as beta-lactamase; DNase; inhibin; activin; receptors for hormones or growth factors; integrin; protein A or D; rheumatoid factors; platelet-derived growth factor (PDGF); epidermal growth factor (EGF); transforming growth factor (TGF) such as TGF- α and TGF- β , including TGF- β 1, TGF- β 2, TGF- β 3, TGF- β 4, or TGF- β 5; insulin-like growth factor-I and -II (IGF-I and IGF-II); des(1-3)-IGF-I (brain IGF-I), insulin-like growth factor binding proteins; CD proteins such as CD-3, CD-4, CD-8, and CD-19; erythropoietin; osteoinductive factors; immunotoxins; an

interferon such as interferon-alpha (e.g., interferon.alpha.2A), -beta, -gamma, -lambda and consensus interferon; colony stimulating factors (CSFs), e.g., M-CSF, GM-CSF, and G-CSF; interleukins (ILs), e.g., IL-1 to IL-10; superoxide dismutase; T-cell receptors; surface membrane proteins; decay accelerating factor; transport proteins; homing
5 receptors; addressins; fertility inhibitors such as the prostaglandins; fertility promoters; regulatory proteins; antibodies (including fragments thereof) and chimeric proteins, such as immunoadhesins; precursors, derivatives, prodrugs and analogues of these compounds, and pharmaceutically acceptable salts of these compounds, or their precursors, derivatives, prodrugs and analogues. Suitable proteins or peptides may be
10 native or recombinant and include, e.g., fusion proteins.

Examples of protein active agents also include CCL1, CCL2 (MCP-1), CCL3 (MIP-1 α), CCL4 (MIP-1 β), CCL5 (RANTES), CCL6, CCL7, CCL8, CCL9 (CCL10), CCL11, CCL12, CCL13, CCL14, CCL15, CCL16, CCL17, CCL18, CCL19, CCL20, CCL21, CCL22, CCL23, CCL24, CCL25, CCL26, CCL27, CCL28, CXCL1 (KC),
15 CXCL2 (SDF1a), CXCL3, CXCL4, CXCL5, CXCL6, CXCL7, CXCL8 (IL8), CXCL9, CXCL10, CXCL11, CXCL12, CXCL13, CXCL14, CXCL15, CXCL16, CXCL17, CX3CL1, XCL1, XCL2, TNFA, TNFB (LTA), TNFC (LTB), TNFSF4, TNFSF5 (CD40LG), TNFSF6, TNFSF7, TNFSF8, TNFSF9, TNFSF10, TNFSF11, TNFSF13B, EDA, IL2, IL15, IL4, IL13, IL7, IL9, IL21, IL3, IL5, IL6, IL11, IL27, IL30, IL31, OSM,
20 LIF, CNTF, CTF1, IL12a, IL12b, IL23, IL27, IL35, IL14, IL16, IL32, IL34, IL10, IL22, IL19, IL20, IL24, IL26, IL29, IFNL1, IFNL2, IFNL3, IL28, IFNA1, IFNA2, IFNA4, IFNA5, IFNA6, IFNA7, IFNA8, IFNA10, IFNA13, IFNA14, IFNA16, IFNA17, IFNA21, IFNB1, IFNK, IFNW1, IFNG, IL1A (IL1F1), IL1B (IL1F2), IL1Ra (IL1F3), IL1F5 (IL36RN), IL1F6 (IL36A), IL1F7 (IL37), IL1F8 (IL36B), IL1F9 (IL36G), IL1F10
25 (IL38), IL33 (IL1F11), IL18 (IL1G), IL17, KITLG, IL25 (IL17E), CSF1 (M-CSF), CSF2 (GM-CSF), CSF3 (G-CSF), SPP1, TGFB1, TGFB2, TGFB3, CCL3L1, CCL3L2, CCL3L3, CCL4L1, CCL4L2, IL17B, IL17C, IL17D, IL17F, AIMP1 (SCYE1), MIF, Areg, BC096441, Bmp1, Bmp10, Bmp15, Bmp2, Bmp3, Bmp4, Bmp5, Bmp6, Bmp7, Bmp8a, Bmp8b, C1qtnf4, Ccl21a, Ccl27a, Cd70, Cer1, Cklf, Clcf1, Cmtm2a, Cmtm2b,
30 Cmtm3, Cmtm4, Cmtm5, Cmtm6, Cmtm7, Cmtm8, Crlf1, Ctf2, Ebi3, Edn1, Fam3b, FasL, Fgf2, Flt3l, Gdf10, Gdf11, Gdf15, Gdf2, Gdf3, Gdf5, Gdf6, Gdf7, Gdf9, Gm12597, Gm13271, Gm13275, Gm13276, Gm13280, Gm13283, Gm2564, Gpi1, Grem1, Grem2, Grn, Hmgb1, Ifna11, Ifna12, Ifna9, Ifnab, Ifne, Il17a, Il23a, Il25, Il31, Iltifb, Inhba, Lefty1, Lefty2, Mstn, Nampt, Ndp, Nodal, Pf4, Pglyrp1, Prl7d1, Scg2, Scgb3a1, Slurp1,

Spp1, Thpo, Tnfsf10, Tnfsf11, Tnfsf12, Tnfsf13, Tnfsf13b, Tnfsf14, Tnfsf15, Tnfsf18, Tnfsf4, Tnfsf8, Tnfsf9, Tslp, Vegfa, Wnt1, Wnt2, Wnt5a, Wnt7a, Xcl1, Epinephrine, Melatonin, Triiodothyronine, Thyroxine, Prostaglandins, Leukotrienes, Prostacyclin, Thromboxane, Islet Amyloid Polypeptide, Müllerian inhibiting factor or hormone,

5 Adiponectin, Corticotropin, Angiotensin, vasopressin, arginine vasopressin, atriopeptin, Brain natriuretic peptide, Calcitonin, Cholecystokinin, Cortistatin, Enkephalin, Endothelin, Erythropoietin, Follicle-stimulating hormone, Galanin, Gastric inhibitory polypeptide, Gastrin, Ghrelin, Glucagon, Glucagon-like peptide-1, Gonadotropin-releasing hormone, Growth hormone-releasing hormone, Hepcidin, Human chorionic

10 gonadotropin, Human placental lactogen, Growth hormone, Inhibin, Insulin, Somatomedin, Leptin, Lipotropin, Luteinizing hormone, Melanocyte stimulating hormone, Motilin, Orexin, Oxytocin, Pancreatic polypeptide, Parathyroid hormone, Pituitary adenylate cyclase-activating peptide, Prolactin, Prolactin releasing hormone, Relaxin, Renin, Secretin, Somatostatin, Thrombopoietin, Thyrotropin, Thyrotropin-

15 releasing hormone, Vasoactive intestinal peptide, Androgen, Androgen, acid maltase (alpha-glucosidase), glycogen phosphorylase, glycogen debrancher enzyme, Phosphofructokinase, Phosphoglycerate kinase, Phosphoglycerate mutase, Lactate dehydrogenase, Carnitine palmytil transferase, Carnitine, and Myoadenylate deaminase.

b. Hormones

20 Hormones to be included in the disclosed products or, most preferably, produced from cells included in the disclosed products can be any hormone of interest.

Examples of endocrine hormones include Anti-diuretic Hormone (ADH), which is produced by the posterior pituitary, targets the kidneys, and affects water balance and blood pressure; Oxytocin, which is produced by the posterior pituitary, targets the uterus,

25 breasts, and stimulates uterine contractions and milk secretion; Growth Hormone (GH), which is produced by the anterior pituitary, targets the body cells, bones, muscles, and affects growth and development; Prolactin, which is produced by the anterior pituitary, targets the breasts, and maintains milk secretions; Growth Hormone-Releasing Hormone (GHRH), which is a releasing hormone of GH and is produced in the arcuate nucleus of

30 the hypothalamus; Thyroid Stimulating Hormone (TSH), which is produced by the anterior pituitary, targets the thyroid, and regulates thyroid hormones; Thyrotropin-Release Hormone (TRH), which is produced by the hypothalamus and stimulates the release of TSH and prolactin from the anterior pituitary; Adrenocorticotrophic Hormone (ACTH), which is produced by the anterior pituitary, targets the adrenal cortex, and

regulates adrenal cortex hormones; Follicle-Stimulating Hormone (FSH), which is produced by the anterior pituitary, targets the ovaries/testes, and stimulates egg and sperm production; Lutenizing Hormone (LH), which is produced by the anterior pituitary, targets the ovaries/testes, and stimulates ovulation and sex hormone release;

5 Luteinizing Hormone-Releasing Hormone (LHRH), also known as Gonadotropin-Releasing Hormone (GnRH), which is synthesized and released from GnRH neurons within the hypothalamus and is a trophic peptide hormone responsible for the release of FSH and LH; Thyroxine, which is produced by the thyroid, targets the body cells, and regulates metabolism; Calcitonin, which is produced by the thyroid, targets the adrenal

10 cortex, and lowers blood calcium; Parathyroid Hormone, which is produced by the parathyroid, targets the bone matrix, and raises blood calcium; Aldosterone, which is produced by the adrenal cortex, targets the kidney, and regulates water balance; Cortisol, which is produced by the adrenal cortex, targets the body cells, and weakens immune system and stress responses; Epinephrine, which is produced by the adrenal medulla,

15 targets the heart, lungs, liver, and body cells, and affects primary "fight or flight" responses; Glucagon, which is produced by the pancreas, targets the liver body, and raises blood glucose level; Insulin, which is produced by the pancreas, targets body cells, and lowers blood glucose level; Estrogen, which is produced by the ovaries, targets the reproductive system, and affects puberty, menstrual, and development of gonads;

20 Progesterone, which is produced by the ovaries, targets the reproductive system, and affects puberty, menstrual cycle, and development of gonads; and Testosterone, which is produced by the adrenal gland, testes, targets the reproductive system, and affects puberty, development of gonads, and sperm.

In some embodiments, the protein is a growth hormone, such as human growth

25 hormone (hGH), recombinant human growth hormone (rhGH), bovine growth hormone, methionine-human growth hormone, des-phenylalanine human growth hormone, and porcine growth hormone; insulin, insulin A-chain, insulin B-chain, and proinsulin; or a growth factor, such as vascular endothelial growth factor (VEGF), nerve growth factor (NGF), platelet-derived growth factor (PDGF), fibroblast growth factor (FGF),

30 epidermal growth factor (EGF), transforming growth factor (TGF), and insulin-like growth factor-I and -II (IGF-I and IGF-II).

c. Vaccines

The disclosed products and materials can also be used to provide vaccine components. For example, cells expressing vaccine antigens can be included in the

product or material. A vaccine is a biological preparation that provides active acquired immunity to a particular disease. A vaccine typically contains the same antigens (or parts of antigens) from a microorganism that causes disease. For example, measles vaccine contains measles virus. However, the antigens in vaccines are either killed, or weakened to the point that they do not cause disease but they are strong enough to stimulate the body's immune system so that the immune system can readily recognize and kill any of microorganisms that it later encounters (immunity).

An antigen can include any protein or peptide that is foreign to the subject organism. Preferred antigens can be presented at the surface of antigen presenting cells (APC) of a subject for surveillance by immune effector cells, such as leucocytes expressing the CD4 receptor (CD4 T cells) and Natural Killer (NK) cells. Typically, the antigen is of viral, bacterial, protozoan, fungal, or animal origin. In some embodiments the antigen is a cancer antigen. Cancer antigens can be antigens expressed only on tumor cells and/or required for tumor cell survival.

Certain antigens are recognized by those skilled in the art as immuno-stimulatory (*i.e.*, stimulate effective immune recognition) and provide effective immunity to the organism or molecule from which they derive. Antigens can be peptides, proteins, polysaccharides, saccharides, lipids, nucleic acids, or combinations thereof. The antigen can be derived from a virus, bacterium, parasite, plant, protozoan, fungus, tissue or transformed cell such as a cancer or leukemic cell and can be a whole cell or immunogenic component thereof, *e.g.*, cell wall components or molecular components thereof. Suitable antigens are known in the art and are available from commercial government and scientific sources. The antigens may be purified or partially purified polypeptides derived from tumors or viral or bacterial sources. The antigens can be recombinant polypeptides produced by expressing DNA encoding the polypeptide antigen in a heterologous expression system. The antigens can be DNA encoding all or part of an antigenic protein. Antigens may be provided as single antigens or may be provided in combination. Antigens may also be provided as complex mixtures of polypeptides or nucleic acids.

Viral Antigens

A viral antigen can be isolated from any virus including, but not limited to, a virus from any of the following viral families: *Arenaviridae*, *Arterivirus*, *Astroviridae*, *Baculoviridae*, *Badnavirus*, *Barnaviridae*, *Birnaviridae*, *Bromoviridae*, *Bunyaviridae*, *Caliciviridae*, *Capillovirus*, *Carlavirus*, *Caulimovirus*, *Circoviridae*, *Closterovirus*,

Comoviridae, *Coronaviridae* (e.g., *Coronavirus*, such as severe acute respiratory syndrome (SARS) virus), *Corticoviridae*, *Cystoviridae*, *Deltavirus*, *Dianthovirus*, *Enamovirus*, *Filoviridae* (e.g., Marburg virus and Ebola virus (e.g., Zaire, Reston, Ivory Coast, or Sudan strain)), *Flaviviridae*, (e.g., Hepatitis C virus, Dengue virus 1, Dengue virus 2, Dengue virus 3, and Dengue virus 4), *Hepadnaviridae*, *Herpesviridae* (e.g., Human herpesvirus 1, 3, 4, 5, and 6, and Cytomegalovirus), *Hypoviridae*, *Iridoviridae*, *Leviviridae*, *Lipothrixviridae*, *Microviridae*, *Orthomyxoviridae* (e.g., Influenzavirus A and B and C), *Papovaviridae*, *Paramyxoviridae* (e.g., measles, mumps, and human respiratory syncytial virus), *Parvoviridae*, *Picornaviridae* (e.g., poliovirus, rhinovirus, hepatovirus, and aphthovirus), *Poxviridae* (e.g., vaccinia and smallpox virus), *Reoviridae* (e.g., rotavirus), *Retroviridae* (e.g., lentivirus, such as human immunodeficiency virus (HIV) 1 and HIV 2), *Rhabdoviridae* (for example, rabies virus, measles virus, respiratory syncytial virus, etc.), *Togaviridae* (for example, rubella virus, dengue virus, etc.), and *Totiviridae*. Suitable viral antigens also include all or part of Dengue protein M, Dengue protein E, Dengue D1NS1, Dengue D1NS2, and Dengue D1NS3. Viral antigens may be derived from a particular strain such as a papilloma virus, a herpes virus, *i.e.* herpes simplex 1 and 2; a hepatitis virus, for example, hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), the delta hepatitis D virus (HDV), hepatitis E virus (HEV) and hepatitis G virus (HGV), the tick-borne encephalitis viruses; parainfluenza, varicella-zoster, cytomegalovirus, Epstein-Barr, rotavirus, rhinovirus, adenovirus, coxsackieviruses, equine encephalitis, Japanese encephalitis, yellow fever, Rift Valley fever, and lymphocytic choriomeningitis.

Bacterial Antigens

Bacterial antigens can originate from any bacteria including, but not limited to, *Actinomyces*, *Anabaena*, *Bacillus*, *Bacteroides*, *Bdellovibrio*, *Bordetella*, *Borrelia*, *Campylobacter*, *Caulobacter*, *Chlamydia*, *Chlorobium*, *Chromatium*, *Clostridium*, *Corynebacterium*, *Cytophaga*, *Deinococcus*, *Escherichia*, *Francisella*, *Halobacterium*, *Heliobacter*, *Haemophilus*, *Hemophilus influenza type B (HIB)*, *Hyphomicrobium*, *Legionella*, *Leptspirosis*, *Listeria*, *Meningococcus A, B and C*, *Methanobacterium*, *Micrococcus*, *Myobacterium*, *Mycoplasma*, *Myxococcus*, *Neisseria*, *Nitrobacter*, *Oscillatoria*, *Prochloron*, *Proteus*, *Pseudomonas*, *Phodospirillum*, *Rickettsia*, *Salmonella*, *Shigella*, *Spirillum*, *Spirochaeta*, *Staphylococcus*, *Streptococcus*, *Streptomyces*, *Sulfolobus*, *Thermoplasma*, *Thiobacillus*, and *Treponema*, *Vibrio*, and *Yersinia*.

Parasite Antigens

Parasite antigens can be obtained from parasites such as, but not limited to, an antigen derived from *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Candida albicans*, *Candida tropicalis*, *Nocardia asteroides*, *Rickettsia rickettsii*, *Rickettsia typhi*,
5 *Mycoplasma pneumoniae*, *Chlamydial psittaci*, *Chlamydial trachomatis*, *Plasmodium falciparum*, *Trypanosoma brucei*, *Entamoeba histolytica*, *Toxoplasma gondii*, *Trichomonas vaginalis* and *Schistosoma mansoni*. These include Sporozoan antigens, Plasmodian antigens, such as all or part of a Circumsporozoite protein, a Sporozoite surface protein, a liver stage antigen, an apical membrane associated protein, or a
10 Merozoite surface protein.

Allergens and Environmental antigens

The antigen can be an allergen or environmental antigen, such as, but not limited to, an antigen derived from naturally occurring allergens such as pollen allergens (tree-, herb, weed-, and grass pollen allergens), insect allergens (inhalant, saliva and venom
15 allergens), animal hair and dandruff allergens, and food allergens. Important pollen allergens from trees, grasses and herbs originate from the taxonomic orders of *Fagales*, *Oleales*, *Pinales* and *platanaceae* including i.a. birch (*Betula*), alder (*Alnus*), hazel (*Corylus*), hornbeam (*Carpinus*) and olive (*Olea*), cedar (*Cryptomeria* and *Juniperus*), Plane tree (*Platanus*), the order of Poales including i.e. grasses of the genera *Lolium*,
20 *Phleum*, *Poa*, *Cynodon*, *Dactylis*, *Holcus*, *Phalaris*, *Secale*, and *Sorghum*, the orders of *Asterales* and *Urticales* including i.a. herbs of the genera *Ambrosia*, *Artemisia*, and *Parietaria*. Other allergen antigens that may be used include allergens from house dust mites of the genus *Dermatophagoides* and *Euroglyphus*, storage mite e.g. *Lepidoglyphys*, *Glycyphagus* and *Tyrophagus*, those from cockroaches, midges and fleas e.g. *Blatella*,
25 *Periplaneta*, *Chironomus* and *Ctenocephalides*, those from mammals such as cat, dog and horse, birds, venom allergens including such originating from stinging or biting insects such as those from the taxonomic order of *Hymenoptera* including bees (superfamily *Apidae*), wasps (superfamily *Vespidea*), and ants (superfamily *Formicoidae*). Still other allergen antigens that may be used include inhalation allergens
30 from fungi such as from the genera *Alternaria* and *Cladosporium*.

Tumor Antigens

The antigen can be a tumor antigen, including a tumor-associated or tumor-specific antigen, such as, but not limited to, alpha-actinin-4, Bcr-Abl fusion protein, Casp-8, beta-catenin, cdc27, cdk4, cdkn2a, coa-1, dek-can fusion protein, EF2, ETV6-

AML1 fusion protein, LDLR-fucosyltransferaseAS fusion protein, HLA-A2, HLA-A11,
 hsp70-2, KIAA0205, Mart2, Mum-1, 2, and 3, neo-PAP, myosin class I, OS-9, pml-
 RARa fusion protein, PTPRK, K-ras, N-ras, Triosephosphate isomeras, Bage-1, Gage
 3,4,5,6,7, GnTV, Herv-K-mel, Lage-1, Mage-A1,2,3,4,6,10,12, Mage-C2, NA-88, NY-
 5 Eso-1/Lage-2, SP17, SSX-2, and TRP2-Int2, MelanA (MART-I), gp100 (Pmel 17),
 tyrosinase, TRP-1, TRP-2, MAGE-1, MAGE-3, BAGE, GAGE-1, GAGE-2, p15(58),
 CEA, RAGE, NY-ESO (LAGE), SCP-1, Hom/Mel-40, PRAME, p53, H-Ras, HER-
 2/neu, BCR-ABL, E2A-PRL, H4-RET, IGH-IGK, MYL-RAR, Epstein Barr virus
 antigens, EBNA, human papillomavirus (HPV) antigens E6 and E7, TSP-180, MAGE-4,
 10 MAGE-5, MAGE-6, p185erbB2, p180erbB-3, c-met, nm-23H1, PSA, TAG-72-4, CA
 19-9, CA 72-4, CAM 17.1, NuMa, K-ras, b-Catenin, CDK4, Mum-1, p16, TAGE,
 PSMA, PSCA, CT7, telomerase, 43-9F, 5T4, 791Tgp72, a-fetoprotein, 13HCG,
 BCA225, BTAA, CA 125, CA 15-3 (CA 27.29\BCAA), CA 195, CA 242, CA-50,
 CAM43, CD68\KP1, CO-029, FGF-5, G250, Ga733 (EpCAM), HTgp-175, M344, MA-
 15 50, MG7-Ag, MOV18, NB\70K, NY-CO-1, RCAS1, SDCCAG16, TA-90 (Mac-2
 binding protein\cyclophilin C-associated protein), TAAL6, TAG72, TLP, and TPS.

d. Antibodies

The disclosed products and materials can also be used to provide antibodies. For example, cells expressing antibodies can be included in the product or material.

20 Antibodies that function by binding directly to one or more epitopes, other ligands or
 accessory molecules at the surface of eukaryote cells, are described. Typically, the
 antibody or antigen binding fragment thereof has affinity for a receptor at the surface of a
 specific cell type, such as a receptor expressed at the surface of macrophage cells.

25 In some embodiments, the antibody or antigen binding fragment binds
 specifically to an epitope. The epitope can be a linear epitope. The epitope can be
 specific to one cell type or can be expressed by multiple different cell types. In other
 embodiments, the antibody or antigen binding fragment thereof can bind a
 conformational epitope that includes a 3-D surface feature, shape, or tertiary structure at
 the surface of the target cell.

30 In some embodiments, the antibody or antigen binding fragment that binds
 specifically to an epitope on the target cell can only bind if the protein epitope is not
 bound by a ligand or small molecule.

Various types of antibodies and antibody fragments can be used in the described compositions and methods, including whole immunoglobulin of any class, fragments

thereof, and synthetic proteins containing at least the antigen binding variable domain of an antibody. The antibody can be an IgG antibody, such as IgG₁, IgG₂, IgG₃, or IgG₄. An antibody can be in the form of an antigen binding fragment including a Fab fragment, F(ab')₂ fragment, a single chain variable region, and the like. Antibodies can be

5 polyclonal or monoclonal (mAb). Monoclonal antibodies include “chimeric” antibodies in which a portion of the heavy and/or light chain is identical with or homologous to corresponding sequences in antibodies derived from a particular species or belonging to a particular antibody class or subclass, while the remainder of the chain(s) is identical with or homologous to corresponding sequences in antibodies derived from another

10 species or belonging to another antibody class or subclass, as well as fragments of such antibodies, so long as they specifically bind the target antigen and/or exhibit the desired biological activity (U.S. Patent No. 4,816,567; and Morrison, et al., *Proc. Natl. Acad. Sci. USA*, 81: 6851-6855 (1984)). The described antibodies can also be modified by recombinant means, for example by deletions, additions or substitutions of amino acids,

15 to increase efficacy of the antibody in mediating the desired function. Substitutions can be conservative substitutions. For example, at least one amino acid in the constant region of the antibody can be replaced with a different residue (see, *e.g.*, U.S. Patent No. 5,624,821; U.S. Patent No. 6,194,551; WO 9958572; and Angal, et al., *Mol. Immunol.* 30:105-08 (1993)). In some cases changes are made to reduce undesired activities, *e.g.*,

20 complement-dependent cytotoxicity. The antibody can be a bi-specific antibody having binding specificities for at least two different antigenic epitopes. In one embodiment, the epitopes are from the same antigen. In another embodiment, the epitopes are from two different antigens. Bi-specific antibodies can include bi-specific antibody fragments (see, *e.g.*, Hollinger, et al., *Proc. Natl. Acad. Sci. U.S.A.*, 90:6444-48 (1993); Gruber, et al., *J.*

25 *Immunol.*, 152:5368 (1994)).

Antibodies can be generated by any means known in the art. Exemplary descriptions means for antibody generation and production include Delves, *Antibody Production: Essential Techniques* (Wiley, 1997); Shephard, *et al.*, *Monoclonal Antibodies* (Oxford University Press, 2000); Goding, *Monoclonal Antibodies: Principles*

30 *And Practice* (Academic Press, 1993); and *Current Protocols In Immunology* (John Wiley & Sons, most recent edition). Fragments of intact Ig molecules can be generated using methods well known in the art, including enzymatic digestion and recombinant means.

V. Methods of Making

The surfaces of the products described herein, can be modified using procedures known in the art.

For example, stainless steel and glass can be derivatized using the following procedure. Material to be derivatized is stirred in piranha solution for 1h at room temperature. The material is washed by ultra-sonication in water, then ethanol, then acetone for 10 min each and then dried by blowing nitrogen over them. Immediate after drying the material is stirred in a 10% (v/v) silane/toluene solution for 48h at 55°C. The material is cleaned by ultra-sonication in Toluene and Dichloromethane for 5 min each. The material is dried under Argon and cured in an oven at 70°C for 3h to prevent air oxidation.

The material is stirred in water and succinic acid, 2-chloro-4,6-dimethoxy-1,3,5-triazine (CDMT) and N-methylmorpholine (NMM) were added. The suspension was stirred at 55°C overnight. The material is washed with water, methanol, and acetone to remove unreacted components.

The material is stirred in a water/acetonitrile solution and E9, CDMT, and NMM was added. The material is stirred overnight at 55°C. The material is washed with water, methanol, and acetone.

Polystyrene-COOH, PMMA-COOH and other similar materials can be derivatized by the following procedure. To PS/PMMA material in water/acetonitrile (3:2), E9 NMM and a spatula tip of CDMT is added. The solution is overhead stirred at 50°C overnight. The material is washed three times with methanol and then three times with ethanol. The material is dried under reduced pressure.

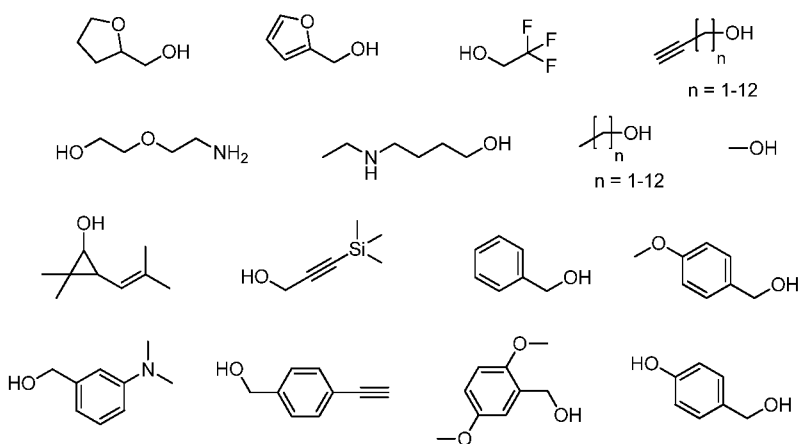
Plastics, ceramics, and metals can be derivatized by treating with plasma. Materials are plasma treated for 1min on each side and immediately dropped into a 0.2mol solution of E9 in 5% DMSO in toluene. The reaction is stirred for 90min and the materials are washed three times in methanol and three times in ethanol. The materials are dried under high vacuum overnight.

A. Compounds Used to Modify Surfaces

Compounds that can be used to modify the surfaces of the products include all of the compounds disclosed herein. Useful compounds include, but are not limited to, alcohols, thiols, amines, and combinations thereof.

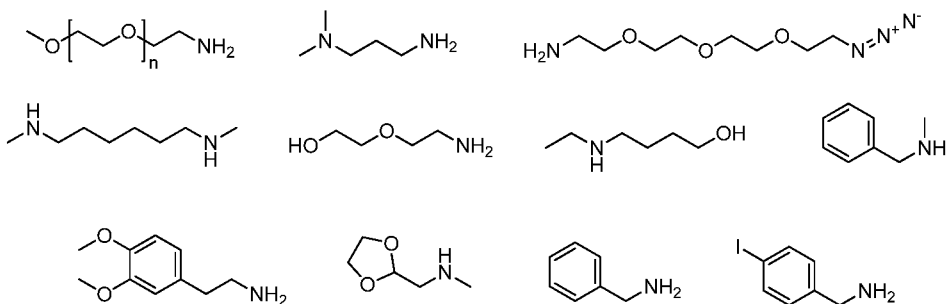
a. Alcohols

Preferred alcohols for use as reagents in esterification include those shown below.



b. Amines

Preferred amines that can be used to modify the surfaces of the products include, but are not limited to,



5

c. Thiols

Preferred thiols that can be used to modify the surfaces of the products include, but are not limited to,

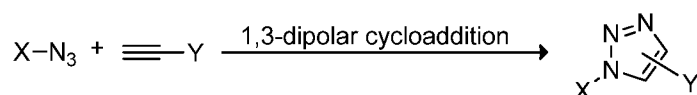
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d. Derivatization via click chemistry

In some embodiments, the surfaces of the products are covalently modified initially to introduce a functional group which can be further reacted via click chemistry.

In preferred embodiments, the alcohols, amines or thiols are used to introduce a functional group which can further reacted using a 1,3-dipolar cycloaddition reaction (i.e., a Huisgen cycloaddition reaction). In a 1,3-dipolar cycloaddition reaction, a first molecule containing an azide moiety is reacted with a second molecule containing a terminal or internal alkyne. As shown below, the azide and the alkyne groups undergo an intramolecular 1,3-dipolar cycloaddition reaction, coupling the two molecules together and forming a 1,2,3-triazole ring.

15



The regiochemistry of 1,3-dipolar cycloadditions reaction can be controlled by addition of a copper(I) catalyst (formed *in situ* by the reduction of CuSO₄ with sodium ascorbate) or a ruthenium catalyst (such as Cp^{*}RuCl(PPh₃)₂, Cp^{*}Ru(COD), or Cp^{*}[RuCl₄]). For example, using a copper catalyst, azides and terminal alkynes can be reacted to exclusively afford the 1,4-regioisomers of 1,2,3-triazoles. Similarly, in the presence of a suitable ruthenium catalyst, azides can be reacted with internal or terminal alkynes to form exclusively the 1,5-regioisomers of 1,2,3-triazoles.

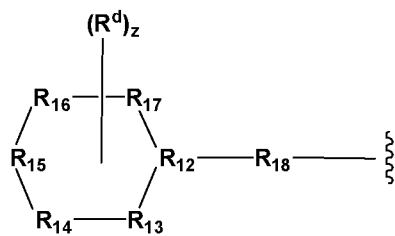
In some embodiments, the alcohol, amine or thiol containing an alkyne moiety is used to modify the surface initially. In these embodiments, the alkyne moiety present on the surface can be further reacted with a second molecule containing an azide functional group. Upon reaction, the azide and the alkyne groups undergo an intramolecular 1,3-dipolar cycloaddition reaction forming a 1,2,3-triazole ring, coupling the second molecule to the covalently modified surface.

Examples of the alkyne-containing alcohol, amine or thiol reactant include X_a-R_z-C≡C-R_x; wherein X_a is -OH, -SH or -NH₂; wherein R_z is U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃); and wherein R_x is hydrogen, U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

In some embodiments,

(1) R_z is

(A)



Formula VI

wherein z is an integer from 1-11; wherein R^d is independently U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃

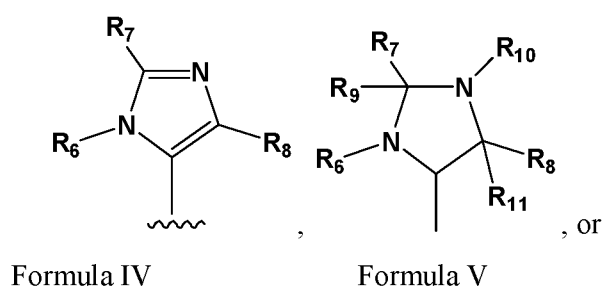
(preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring; wherein one instance of R^d is or contains X_a ; wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are independently C, O, N, S, S(O), or S(O)₂, wherein the
 5 bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and wherein R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O,
 10 =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$);

wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency;

15 **(B)** $-(CH_2)_s-R_{34}$, wherein s is an integer from 0 to 20; wherein R_{34} is $-X_a$, -O- R_{35} , -S- R_{35} , $-(CH_2)_r-R_{35}$, -CO- R_{35} , or -CHR₃₆ R_{37} , wherein r is an integer from 0 to 19; wherein R_{35} is $-X_a$, $-(CH_2)_u-R_{38}$, wherein u is an integer from 0 to 18; wherein R_{36} is $-(CH_2)_t-R_{38}$, R_{37} is $-(CH_2)_v-R_{38}$, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R_{38} is $-X_a$, methyl, -OH, -SH, or -COOH; R_x is hydrogen
 20 or $-(CH_2)_s-R_{34}$, wherein s is an integer from 0 to 20; wherein R_{26} is -O- R_{35} , -S- R_{35} , $-(CH_2)_r-R_{35}$, -CO- R_{35} , or -CHR₃₅ R_{36} , wherein r is an integer from 0 to 19; wherein R_{35} is $-(CH_2)_u-R_{38}$, wherein u is an integer from 0 to 18; wherein R_{36} is $-(CH_2)_t-R_{38}$, R_{37} is $-(CH_2)_v-R_{38}$, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R_{38} is methyl, -OH, -SH, or -COOH; wherein R_z and R_x are not both hydrogen;
 25 and wherein R_x can be hydrogen.

In some embodiments, R_z and R_x are independently

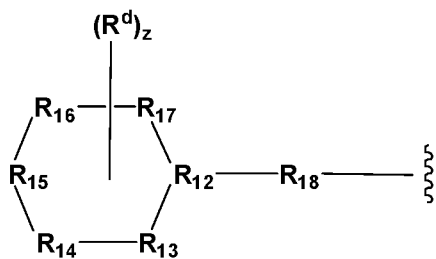
(C)



wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and wherein one instance of R_6 , R_7 , R_8 , R_9 , R_{10} , or R_{11} is or contains X_a ;

5 (2) and R_x is hydrogen,

(A)



Formula VI

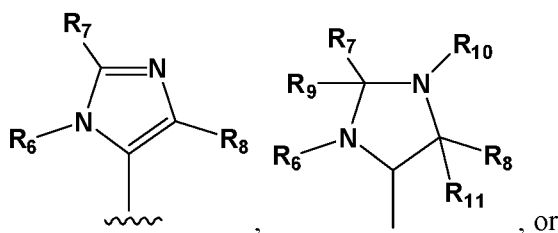
wherein z is an integer from 0-11; wherein R^d is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring; wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are
 10 + Q_3 , $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring; wherein R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} are
 15 independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and wherein R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency; and wherein R_{18} is independently $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R_{19} is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R_{20} is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$);

wherein R_6 , R_9 , R_{10} , and R_{11} are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency;

25 (B) $-(CH_2)_s-R_{34}$, wherein s is an integer from 0 to 20; wherein R_{34} is -O- R_{35} , -S- R_{35} , $-(CH_2)_r-R_{35}$, -CO- R_{35} , or -CHR₃₆ R_{37} , wherein r is an integer from 0 to 19; wherein R_{35} is $-(CH_2)_u-R_{38}$, wherein u is an integer from 0 to 18; wherein R_{28} is $-(CH_2)_t-R_{38}$, R_{37} is $-(CH_2)_v-R_{38}$, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R_{38} is methyl, -OH, -SH, or -COOH; wherein R_z and R_x are not both

hydrogen; and wherein R_x can be hydrogen; and R_x is hydrogen or $-(CH_2)_s-R_{34}$, wherein s is an integer from 0 to 20; wherein R_{34} is $-O-R_{35}$, $-S-R_{35}$, $-(CH_2)_t-R_{35}$, $-CO-R_{35}$, or $-CHR_{36}R_{37}$, wherein r is an integer from 0 to 19; wherein R_{35} is $-(CH_2)_u-R_{38}$, wherein u is an integer from 0 to 18; wherein R_{36} is $-(CH_2)_t-R_{38}$, R_{37} is $-(CH_2)_v-R_{38}$, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R_{38} is methyl, $-OH$, $-SH$, or $-COOH$; wherein R_z and R_x are not both hydrogen; and wherein R_x can be hydrogen;

(C)



Formula IV

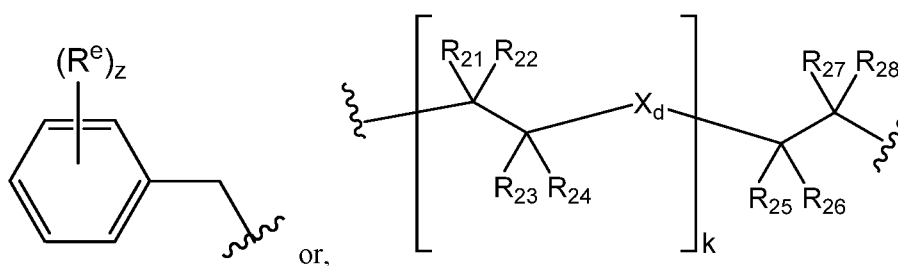
Formula V

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

Examples of the azide-containing second molecule include R_w-N_3 , wherein R_w is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

In some embodiments, R_w is

(A)



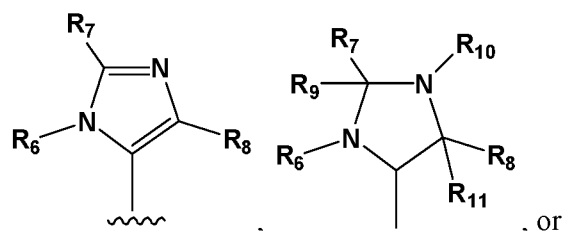
Formula VII

Formula XI

wherein n are independently an integer from 1 to 30; wherein z is an integer from 0-4; wherein X_d are independently O or S ; wherein R^e is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted

carbocyclic, or heterocyclic ring; and wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$);

(B)



Formula IV

Formula V

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

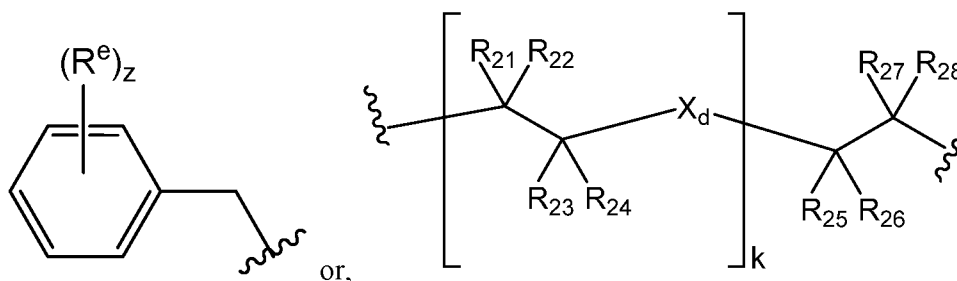
- 10 In alternative embodiments, an alcohol, amine or thiol, containing an azide moiety is used to modify the surface. In these embodiments, the azide moiety present on the covalently modified surface can be further reacted with a second molecule containing a terminal or internal alkyne. Upon reaction, the azide and the alkyne groups undergo an intramolecular 1,3-dipolar cycloaddition reaction forming a 1,2,3-triazole ring, coupling
- 15 the second molecule to the covalent modification.

Examples of the azide-containing amidation/esterification reactant include $X_c-R_w-N_3$, where X_c is $-OH$, $-SH$ or $-NH_2$ and R_w is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

- 20 In some embodiments, X_c is not $-NH_2$ and R_w is not $-CH_2-Ar-$ or $-CH_2-CH_2-(O-CH_2-CH_2)_3-$.

In some embodiments, R_w is

(A)



5

Formula VII

Formula XI

wherein n are independently an integer from 1 to 30; wherein z is an integer from 0-4; wherein X_d are independently O or S; wherein R^e is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$

10

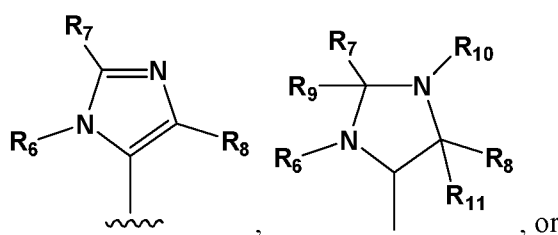
(preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted

carbocyclic, or heterocyclic ring; and wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$);

15

and wherein one instance of R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , or R_{28} is or contains X_c ;

(B)



Formula IV

Formula V

20

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and wherein one instance of R_6 , R_7 , R_8 , R_9 , R_{10} , or R_{11} is or contains X_c .

Examples of the alkyne-containing second molecule include $R_z-C\equiv C-R_x$, wherein

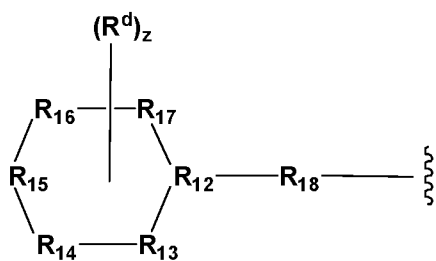
25

R_z and R_x are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, U_1

+ Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₂ + Q₃).

In some embodiments, R_z and R_x are independently

(A)



Formula VI

wherein z is an integer from 1-11; wherein R^d is independently U₂, U₂ + Q₁, U₂ + Q₂, U₂ + Q₃, U₂ + Q₁ + Q₂, U₂ + Q₁ + Q₃, U₂ + Q₂ + Q₃, U₂ + Q₁ + Q₂ + Q₃, U₃, U₃ + Q₁, U₃ + Q₂, U₃ + Q₃, U₃ + Q₁ + Q₂, U₃ + Q₁ + Q₃, U₃ + Q₂ + Q₃, or U₃ + Q₁ + Q₂ + Q₃

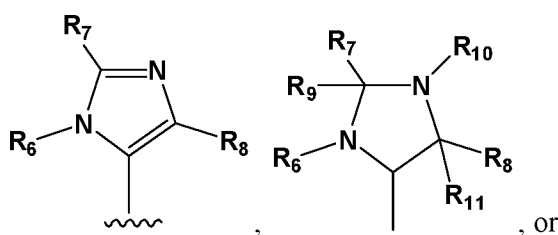
- 10 (preferably, in these embodiments, U₃ + Q₁ + Q₃); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic or heterocyclic ring; wherein one instance of R^d is or contains X_a; wherein R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently C, O, N, S, S(O), or S(O)₂, wherein the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and
- 15 wherein R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency; and wherein R₁₈ is independently -(CR₁₉R₁₉)_p- or -(CR₁₉R₁₉)_p-X_b-(CR₁₉R₁₉)_q-, wherein p and q are independently integers from 0 to 5, wherein X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, wherein each R₁₉ is, as valency permits, independently absent, hydrogen, =O, =S, -OH, -SH, or -NR₂₀, wherein R₂₀ is U₁, U₁ + Q₁, U₁ + Q₂, U₁ + Q₃, U₁ + Q₁ + Q₂, U₁ + Q₁ + Q₃, U₁ + Q₂ + Q₃, or U₁ + Q₁ + Q₂ + Q₃ (preferably, in these embodiments, U₁ + Q₁ + Q₃);
- 20

wherein R₆, R₉, R₁₀, and R₁₁ are independently present or absent according to valency, and wherein the ring bonds are double or single according to valency;

- (B) -(CH₂)_s-R₃₄, wherein s is an integer from 0 to 20; wherein R₃₄ is -O-R₃₅, -S-R₃₅, -(CH₂)_r-R₃₅, -CO-R₃₅, or -CHR₃₆R₃₇, wherein r is an integer from 0 to 19; wherein R₃₅ is -(CH₂)_u-R₃₈, wherein u is an integer from 0 to 18; wherein R₂₈ is -(CH₂)_t-R₃₈, R₃₇ is -(CH₂)_v-R₃₈, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R₃₈ is methyl, -OH, -SH, or -COOH; wherein R_z and R_x are not both hydrogen; and wherein R_x can be hydrogen; and R_x is hydrogen or -(CH₂)_s-R₃₄, wherein
- 25

s is an integer from 0 to 20; wherein R_{34} is $-O-R_{35}$, $-S-R_{35}$, $-(CH_2)_r-R_{35}$, $-CO-R_{35}$, or $-CHR_{36}R_{37}$, wherein r is an integer from 0 to 19; wherein R_{35} is $-(CH_2)_u-R_{38}$, wherein u is an integer from 0 to 18; wherein R_{36} is $-(CH_2)_t-R_{38}$, R_{37} is $-(CH_2)_v-R_{38}$, and t and v are integers from 0 to 18, wherein t and v together total 0 to 18; wherein R_{38} is methyl, $-OH$, $-SH$, or $-COOH$; wherein R_z and R_x are not both hydrogen; and wherein R_x can be hydrogen;

(C)



Formula IV

Formula V

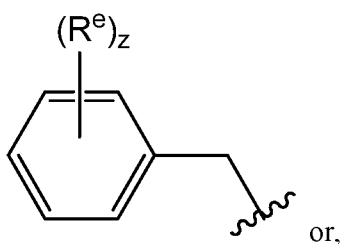
wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$).

In some embodiments, the azide moiety can be added to a covalently modified surface that has a compound containing a leaving group, such as I, Br, OTs, OMs. In some embodiments, the alcohol, amine or thiol containing the leaving group used to covalently modify the surface. Examples of the leaving group-containing alcohol, amine or thiol reactant include X_c-R_w-L , where X_c is $-OH$ or $-NH_2$, L is the leaving group, and R_w is U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$).

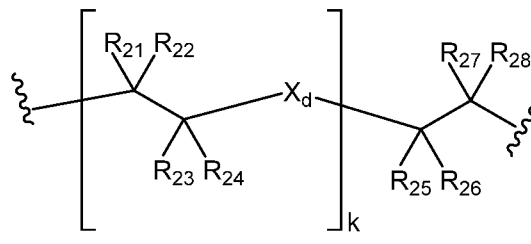
In some embodiments, X_c is not $-NH_2$ and R_w is not $-CH_2-Ar-$ or $-CH_2-CH_2-(O-CH_2-CH_2)_3-$.

In some embodiments, R_w is

(A)



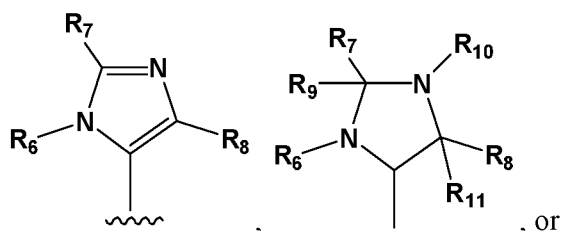
Formula VII



Formula XI

wherein n are independently an integer from 1 to 30; wherein z is an integer from 0-4; wherein X_d are independently O or S; wherein R^e is independently U_2 , $U_2 + Q_1$, $U_2 + Q_2$, $U_2 + Q_3$, $U_2 + Q_1 + Q_2$, $U_2 + Q_1 + Q_3$, $U_2 + Q_2 + Q_3$, $U_2 + Q_1 + Q_2 + Q_3$, U_3 , $U_3 + Q_1$, $U_3 + Q_2$, $U_3 + Q_3$, $U_3 + Q_1 + Q_2$, $U_3 + Q_1 + Q_3$, $U_3 + Q_2 + Q_3$, or $U_3 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_3 + Q_1 + Q_3$); or together with the carbon atom to which they are attached, form a 3- to 8-membered unsubstituted or substituted carbocyclic, or heterocyclic ring; and wherein R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , R_{28} are independently hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_2 + Q_3$); and wherein one instance of R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , or R_{28} is or contains X_c ;

(B)



Formula IV

Formula V

wherein R_6 , R_7 , R_8 , R_9 , R_{10} , and R_{11} are, independently, hydrogen, U_1 , $U_1 + Q_1$, $U_1 + Q_2$, $U_1 + Q_3$, $U_1 + Q_1 + Q_2$, $U_1 + Q_1 + Q_3$, $U_1 + Q_2 + Q_3$, or $U_1 + Q_1 + Q_2 + Q_3$ (preferably, in these embodiments, $U_1 + Q_1 + Q_3$); and wherein one instance of R_6 , R_7 , R_8 , R_9 , R_{10} , or R_{11} is or contains X_c .

In some embodiments, X_c is not $-NH_2$ and R_w is not $-CH_2-Ar-$ or $-CH_2-CH_2-(O-CH_2-CH_2)_3-$.

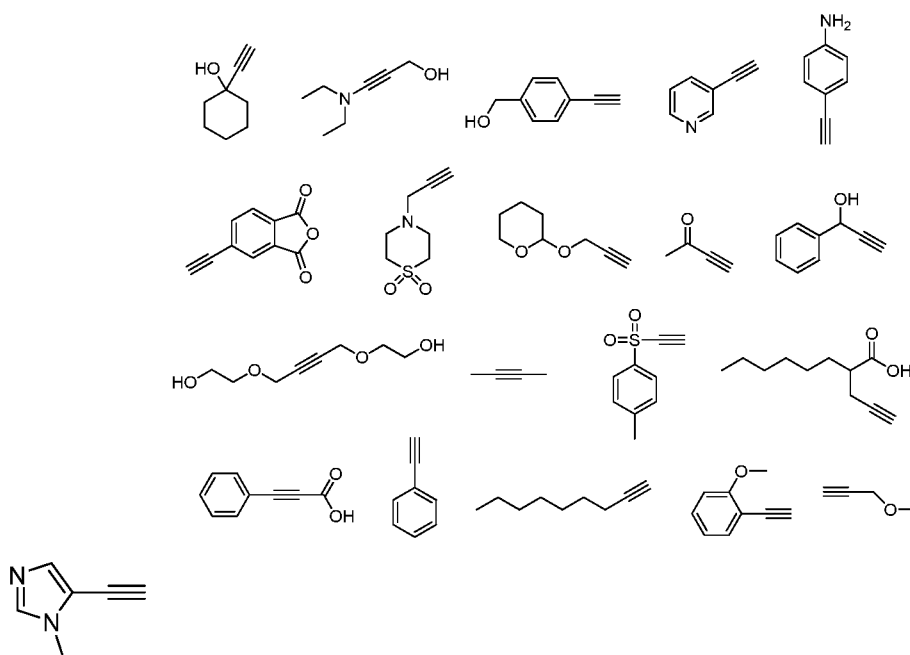
In preferred embodiments, an amine containing an azide moiety is used to covalently modify the surface initially. Subsequently, the azide moiety present on the covalently modified surface is reacted with a second molecule containing a terminal or internal alkyne, forming a 1,2,3-triazole ring and coupling the second molecule to the covalent modification.

Different strategies can be employed to prepare covalently modified surfaces containing an azide moiety. For example, the surface can be modified by reaction with an amine substituted with an azide moiety (for example, 11-Azido-3,6,9-trioxaundecan-1-amine) in a single synthetic step. Alternatively, the surface can be amidated by reaction with an amine substituted with any moiety which can be readily transformed into an azide. For example, the surface can be amidated by reaction with 4-iodobenzylamine.

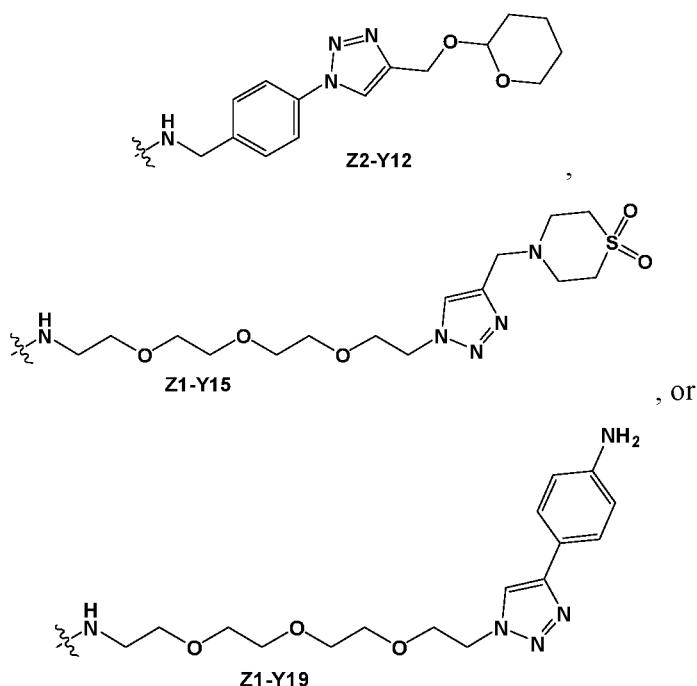
The iodine moiety can then be readily converted to the azide, for example by treatment with sodium azide.

Subsequently, the azide-functionalized surfaces can be reacted with a molecule containing an alkyne functionality in the presence of a copper(I) catalyst (formed *in situ* by the reduction of CuSO₄ with sodium ascorbate).

Preferred alkynes for use as reagents in 1,3-dipolarcycloaddition reactions include those shown below.



Preferred compounds for modifying products include compounds having the structure:



The terminal amine can differ in other preferred compounds depending on the attachment chemistry that is used.

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B. Chemical Modification of Products and Surfaces

Methods for attaching compounds to materials and surfaces are well established. For example, compounds can be attached to aminated surfaces, carboxylated surfaces or hydroxylated surfaces using standard immobilization chemistries. As another example, products and surfaces can be modified via a variety of methods to possess functional groups designed to covalently attach compounds. Examples of attachment groups include thiol, silane, carboxylate, methyl acrylate, phosphonate, nitrile, isonitrile, hydroxamate, acid chloride, anhydride, sulfonyl, phosphoryl, hydroxyl, amino acid, cyanogen bromide, succinimide, aldehydes (such as glutaraldehyde), tosyl chloride, photocrosslinkable agents, epoxides and maleimides. In some preferred embodiments, the attachment group is a thiol. In some embodiments, the attachment group contains a single functionality therein that can attach to the surface, for example, an amine or dimethyl-methoxysilane moiety. Any art recognized attachment group can be used to anchor a compound can be used to chemically modify products. For example, organosilanes, carboxylic acids, sulfur-containing anchor groups, may be used as attachments. Products and surfaces of

products formed from metals such as gold, silver, copper, cadmium, zinc, palladium, platinum, mercury, lead, iron, chromium, manganese, tungsten, and alloys of these can be patterned, for example, by forming thiol, sulfide, and disulfide bonds with compounds having sulfur-containing attachment groups. In addition, compounds be attached to
5 aluminum via a phosphonic acid (PO_3^{2-}) anchor group. Nitriles and isonitriles, for example, can be used to attach compounds to platinum and palladium, and copper and aluminum can be chemically modified via a hydroxamic acid or hydroxamic acid-containing attachment group. Other functional groups suitable for attachment include, but are not limited to, acid chlorides, anhydrides, sulfonyl groups, phosphoryl and
10 phosphonic groups, hydroxyl groups, and amino acid groups.

Free amine groups of compounds can also be attached to products and surfaces containing reactive amine groups via homobifunctional linkers. Linkers such as dithiobis(succinimidylpropionate) (DSP, 8-atom spacer), disuccinimidyl suberate (DSS, 8-atom spacer), glutaraldehyde (4-atom spacer), Bis[2-
15 (succinimidylloxycarbonyloxy)ethyl]sulfone (BSOCOES, 9-atom spacer), all requiring high pH, can be used for this purpose. Examples of homobifunctional sulfhydryl-reactive linkers include, but are not limited to, 1,4-Di-[3'-2'-pyridyldithio]propion-amido]butane (DPDPB, 16-atom spacer) and Bismaleimidohehexane (BMH, 14-atom spacer). For example, these homobifunctional linkers are first reacted with a thiolated
20 surface in aqueous solution (for example PBS, pH 7.4), and then in a second step, the thiolated antibody or protein is joined by the link. Homo- and heteromultifunctional linkers can also be used.

Compounds can be directly attached to thiol, amine, or carboxylic acid functional groups on products or surfaces or, conversely, compounds with thiol, amine, or carboxylic
25 acid functional groups can be attached to products or surfaces via these functional groups.

Amino groups can be added to the products and surfaces to, for example, increase the density of compounds on the products and surfaces.

Compounds can be attached to products and surfaces by several different
30 mechanisms. Products and surfaces can be modified via a variety of methods to possess functional groups designed to covalently attach compounds.

Passive adsorption consists of primarily hydrophobic interactions or hydrophobic/ionic interactions between the biomolecules and the surface. Typical nomenclature for passive binding surfaces includes medium binding for hydrophobic

surfaces and high binding for surfaces that are modified to have a small number of ionic carboxyl groups resulting in a slightly ionic, hydrophobic surface.

Covalent immobilization to products and surfaces can be accomplished through several means. On surfaces that are aminated or carboxylated, covalent coupling can be achieved using bifunctional crosslinkers that couple the amine or carboxyl group on the surface to a functional group, such as an amine or sulfhydryl, on the biomolecule. Selection of the crosslinker determines the type of covalent bond that will be formed. Functional and covalently reactive groups, such as N-oxy succinimide, maleimide and hydrazide groups, can also be grafted onto a product or surface. These reactive groups are coupled to the products and surfaces via a photolinkable spacer arm resulting in a stable, yet reactive surface.

Surfaces that are hydrophilic and neutrally charged are considered low binding. Since some compounds passively adsorb to surfaces through hydrophobic and ionic interactions, a surface lacking these characteristics naturally inhibits nonspecific immobilization via these forces.

Some non-modified products and surfaces, such as plastics, are hydrophobic in nature and can bind compounds through passive interactions. This type of surface is referred to as medium binding and is primarily suitable for the immobilization of large molecules that have large hydrophobic regions that can interact with the surface.

Some products and surfaces, such as plastics having benzene rings, can be modified to be what is considered high binding via the use of radiation. The radiation effectively incorporates carboxylic acid on the accessible carbons of the benzene ring. The resulting surface is primarily hydrophobic with intermittent carboxyl groups capable of ionic interactions with positively charged groups on biomolecules. The mechanism of immobilization is passive adsorption through hydrophobic and ionic interactions. This is considered a general purpose surface capable of binding compounds that possess ionic groups and/or hydrophobic regions.

Products and surfaces can also be modified to possess positively charged amine groups. This type of surface lacks hydrophobic character and is strictly ionic in nature. Using the appropriate buffers and pH, this surface can be used to ionically couple to small negatively charged compounds. Such products and surfaces can be used with bifunctional crosslinkers (i.e., glutaraldehyde, carbodiimide) to covalently couple to functional groups (primary amines, thiols, carboxyls) on biomolecules.

The modifying compounds can also be linked to each other (e.g., oligomerized or polymerized) prior to, as part of, or following attachment to the product or surface. For example, methacrylate attachment of compounds can result in both polymerization of modifying compounds (via a polymethacrylate backbone) and attachment to the product or surface. Many other oligomerizable or polymerizable attachment groups can be used in a similar manner. The modifying compounds can also be oligomerized or polymerized in a separate reaction from the attachment to the product or surface.

Products and surfaces can also be chemically modified by, for example, employing techniques established for producing microarrays. For example, compounds can be spotted or printed. Positioning and localization can also be achieved by specific location and distribution of attachment groups on the product or surface. If photoactivated crosslinkers are used, different compounds or different patterns could be generated by use of activating wavelengths at different stages of the modification. Alternatively, masks can be used to achieve the same effect with a single type of photoactivatable crosslinker. Etching of the product or surface can also be used to create patterns of attachment. Use of such techniques allows more precision in the location, density, and gradient of chemical modification on the products and surfaces.

##]

Every compound within the description and definitions herein is intended to be and should be considered to be specifically disclosed herein. Further, every subgroup that can be identified within the above definition is intended to be and should be considered to be specifically disclosed herein. As a result, it is specifically contemplated that any compound or subgroup of compounds can be either specifically included for or excluded from use or included in or excluded from a list of compounds. For example, as one option, a group of compounds is contemplated where each compound is as defined herein but where R_6 is not substituted alkenyl or alkynyl. As another example, a group of compounds is contemplated where each compound is as defined herein and has a specific beneficial effect.

Any type or form of modified alginate, any type or form of alginate modification, and any type or form of reagent for modifying alginate can be, independently and in any combination, specifically included or excluded in any of the disclosed modified alginates, alginate modifications, reagents for alginate modifications, methods, and kits, and in any context, combination, or use. For example, any type or form of esterification reagent, amidation reagent, click reagent, alkyne-containing reagent, azide-containing

reagent, phosphorylating reagent, and ketone reagent, such as those described above and in the examples, can be, independently and in any combination, specifically included or excluded from use to modify alginates, and any alginate modifications and any modified alginates that include or are based on such reagents can be, independently and in any combination, specifically included or excluded in any of the disclosed modified alginates, alginate modifications, reagents for alginate modifications, methods, and kits, and in any context, combination, or use.

VI. Methods of Assessing Biocompatibility

Biocompatibility of the disclosed products and materials can be assessed using any suitable techniques. Examples of useful techniques are described below.

A. Assessing Cytotoxicity

The cytotoxicity of the disclosed surface modified products and materials can be evaluated on HeLa cells. The surface modified products and materials can be loaded into containers, such as wells of 96-well plates. The containers can be coated with an attachment molecule, such as poly-L-lysine, if appropriate. Unmodified product and material and saline can be loaded into containers as controls. HeLa cells can then be seeded into the wells and incubated for 3 days at 37°C in a humidified chamber.

A cell viability assay using 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) can then be performed, in which the media is aspirated from all containers and an appropriate volume (such as 100 µl for 96-well plate wells) of DMEM media without phenol red and an appropriate volume (such as 10 µl for 96-well plate wells) of MTT (5mg/ml) added to all of the containers. The containers can then be incubated for 4 hours at 37°C in a humidified chamber. After incubation, an appropriate volume (such as 85µl for 96-well plate wells) of solution is aspirated and an appropriate volume (such as 100µl for 96-well plate wells) of DMSO is added. Purple formazan crystals form during the assay in proportion to the number of viable HeLa cells present in each container. The contents of each container can be pipetted up and down to solubilize the formazan crystals prior to measurement. The containers can then be incubated at 37°C for 10 minutes after which the bubbles from agitation are removed. The plate can be read using a UV/Vis reader at 540nm with a reference at 700nm. The viability can be normalized to cells seeded in containers with no product or material.

B. Assessing Foreign Body Response/Inflammatory Response

Cathepsin activity, which can be detected by fluorescence, can be used as an indicator of foreign body response (a form of inflammatory response). Mice, such as 8-

12 week old male SKH1 mice, can be used to assess foreign body response of the disclosed products and materials. After injection or implantation of the product of material, cathepsin activity can be measured using an *in vivo* fluorescence assay at various times after injection or implantation. For example, imaging can be taken at 7
5 days after injection or implantation. 24 hours before *in vivo* fluorescence imaging, 2 nmol of ProSense-680 (VisEn Medical, Woburn, MA, excitation wavelength 680 ± 10 nm, emission 700 ± 10 nm) can be dissolved in 150 μ l sterile PBS and injected into the tail vein of each mouse to image cathepsin activity.

In vivo fluorescence imaging can be performed with an *in vivo* fluorescence
10 imaging system, such as the IVIS-Spectrum measurement system (Xenogen, Hopkinton, MA). The can be maintained under inhaled anesthesia during imaging, using, for example, 1-4% isoflurane in 100% oxygen at a flow rate of 2.5 L/min. Images and data can be collected as appropriate for the imaging device being use. As an example, images can be presented in fluorescence efficiency, which is defined as the ratio of the collected
15 fluorescent intensity to an internal standard of incident intensity at the selected imaging configuration. Regions of interest (ROIs) can be designated around the site of each injection.

Relative cathepsin activity at the point of injection or implantation of products and materials can be imaged. The fluorescence intensity can be measured and normalized
20 to the fluorescence response measured using the unmodified form of the product or material in order to quantify the biocompatibility of the surface modified products and materials as compared to unmodified products and materials.

Inflammatory response can also be assessed by detecting and measuring a suite of cytokines. The cytokine levels can indicate a high or low inflammatory response. For
25 example, low protein levels of, for example, TNF- α , IL-13, IL-6, G-CSF, GM-CSF, IL-4, CCL2, and CCL4 which are known mediators of the foreign body response and fibrosis (Rodriguez et al., *J. Biomed. Mater. Res. A* 89:152–159 (2009)), can indicate a lack of or lower foreign body response.

C. Assessing Fibrosis

30 FACS analysis can be performed on retrieved products and materials and appropriate times after implantation to characterize the different immune populations that are recruited to the products and materials compared to control product or material. For example, the presence of macrophages, neutrophils, myofibroblasts, of a combination thereof, on products and materials or at the location of the products and

materials indicate a fibrotic response. Cells were tagged with markers for macrophages (CD11b+, CD68+), neutrophils (CD11b+, Ly6g+), or myofibroblasts (SMA). FACS was used to determine the levels of these fibrosis-associated cell types in proximity to the product or material.

5 **D. qPCR Analysis of Innate Immune and Fibrosis Markers**

 Total RNA is isolated from a source—such as capsules or products retrieved from an animal after implantation for a period of time (or tissues removed from an animal)—by snap freezing in liquid nitrogen immediately following excision, using, for example, TRIzol (Invitrogen; Carlsbad, CA) according to the manufacturer's
10 instructions. In addition, to help ensure complete tissue disruption, strong mechanical disruption with a Polytron homogenizer can also be employed. By this process, gene expression signatures are proportional and representative of the entire cell population present on and/or around retrieved materials. Before reverse transcription using, for example, the High Capacity cDNA Reverse Transcription kit (Cat. #4368814; Applied
15 Biosystems, Foster City, CA), all samples are first normalized for comparison by loading the same input total RNA in a set volume (1 µg total RNA in a volume of 20 µl, for example) for each sample. cDNA (4.8 µl; 1:20 dilution in a total volume of 16 µl, for example), including a nucleic acid stain, such as SYBR Green, and PCR primers, is amplified by qPCR with the following appropriate primers (such as the primers shown in
20 Table 1). These primers (Table 1) were designed using Primer Express software (Applied Biosystems, Carlsbad, CA, USA) and evaluated using LaserGene software (DNASar, Madison, WI, USA) to ensure either mouse or rat (host)-specificity. Other primers can be designed by similar or equivalent analysis. Samples are incubated, for example, at 95°C for 10 min followed by 40 cycles of 95°C for 15 sec and 60°C for 1 min in, for example,
25 an ABI PRISM 7900HT Sequence Detection System (Applied Biosystems). Results are analyzed using a suitable method, such as the comparative C_T (DDC_T) method as described by Applied Biosystems. Results are presented, for example, as relative RNA levels compared to the RNA expression in either mock-implanted control cell samples (peripheral intraperitoneal fat tissue, or free floating intraperitoneal lavage cells) after
30 normalization to the β-actin RNA content of each sample.

Table 1. Mouse (m) or rat (r)-specific (host) forward and reverse primer sets used for qPCR analysis of RNA levels. Gene names are also shown in parentheses.

Gene	Primers (5' to 3'): Sense & Antisense
Mouse Collagen 1a1 (<i>mColla1</i>)	Forward: 5' –CATGTTTCAGCTTTGTGGACCT-3' (SEQ ID NO:1)
	Reverse: 5'-GCAGCTGACTTCAGGGATGT-3' (SEQ ID NO:2)
Mouse Collagen 1a2 (<i>mColla2</i>)	Forward: 5'-GCAGGTTACCTACTCTGTCCT-3' (SEQ ID NO:3)
	Reverse: 5'-CTTGCCCCATTCAATTTGTCT-3' (SEQ ID NO:4)
Mouse Alpha Smooth Muscle actin (<i>mActa2</i>)	Forward: 5'-CGCTTCCGCTGCCAGAGACT-3' (SEQ ID NO:5)
	Reverse: 5'-TATAGGTGGTTTCGTGGATGCCCGCT-3' (SEQ ID NO:6)
Mouse Myeloid cell Marker CD11b (<i>mItgam</i>)	Forward: 5'-CCAAGAGAATGCAAAAGGCTTT-3' (SEQ ID NO:7)
	Reverse: 5'-GGGGGGCTGCAACAACCACA-3' (SEQ ID NO:8)
Mouse Macrophage Marker CD68 (<i>mCd68</i>)	Forward: 5'-GCCCCAGTACAGTCTACCTGG-3' (SEQ ID NO:9)
	Reverse: 5'-AGAGATGAATTCTGCGCCAT-3' (SEQ ID NO:10)
Mouse neutrophil Marker Gr1 (<i>mLy6g</i>)	Forward: 5'-TGCCCCCTTCTCTGATGGATT-3' (SEQ ID NO:11)
	Reverse: 5'-TGCTCTTGACTTGCTTCTGTGA-3' (SEQ ID NO:12)
Mouse β -actin (<i>mActB</i>)	Forward: 5' - GCTTCTTTGCAGCTCCTTCGTT-3' (SEQ ID NO:13)
	Reverse: 5'-CGGAGCCGTTCTCGACGACC-3' (SEQ ID NO:14)
Rat Collagen 1a1 (<i>rColla1</i>)	Forward: 5'-CATGTTTCAGCTTTGTGGACCT-3' (SEQ ID NO:15)
	Reverse: 5'-GCAGCTGACTTCAGGGATGT-3' (SEQ ID NO:16)
Rat Collagen 1a2 (<i>rColla2</i>)	Forward: 5'-CCTGGCTCTCGAGGTGAAC-3' (SEQ ID NO:17)
	Reverse: 5'-CAATGCCAGAGGACCAG-3' (SEQ ID NO:18)
Rat Alpha Smooth Muscle actin (<i>rActa2</i>)	Forward: 5'-TGCCATGTATGTGGCTATTCA-3' (SEQ ID NO:19)
	Reverse: 5'-ACCAGTTGTACGTCCAGAAGC-3' (SEQ ID NO:20)
Rat Pdx1 (<i>rPdx1</i>)	Forward: 5'-CTCTCGTGCCATGTGAACC-3' (SEQ ID NO:21)
	Reverse: 5'-TTCTCTAAATTGGTCCCAGGAA-3' (SEQ ID NO:22)
Rat β -actin (<i>rActB</i>)	Forward: 5' - ACCTTCTTGCAGCTCCTCCGTC-3' (SEQ ID NO:23)
	Reverse: 5'-CGGAGCCGTTGTGACGACG-3' (SEQ ID NO:24)

E. FACS Analysis

- 5 Single-cell suspensions from capsules or products freshly excised from an animal after implantation for a period of time (or of tissues freshly excised from an animal) are prepared using, for example, a gentleMACS Dissociator (Miltenyi Biotec, Auburn, CA) according to the manufacturer's protocol. Single-cell suspensions are prepared in a passive PEB dissociation buffer (1X PBS, pH 7.2, 0.5% BSA, and 2 mM EDTA) and
- 10 suspensions are passed through 70 μ m filters (for example, Cat. #22363548, Fisher Scientific, Pittsburgh, PA). This process removes the majority of cells adhered to the

surface (>90%). The single-cell populations thus derived are then subjected to red blood cell lysis with 5 ml of 1X RBC lysis buffer (Cat. #00-4333, eBioscience, San Diego, CA, USA) for 5 min at 4°C. The reaction is terminated by the addition of 20 ml of sterile 1X PBS. The cells remaining are centrifuged at 300-400g at 4°C and resuspended in a minimal volume (~50 µl) of, for example, eBioscience Staining Buffer (Cat. #00-4222) for antibody incubation. All samples are then co-stained in the dark for 25 min at 4°C with fluorescently tagged monoclonal antibodies specific for the appropriate cell markers, such as for CD68 (for example, CD68-Alexa647, Clone FA-11, Cat. #11-5931, BioLegend at 1 µl (0.5 µg) per sample), Ly-6G (Gr-1) (for example, Ly-6G-Alexa-647, Clone RB6-8C5, Cat. #108418, BioLegend at 1 µl (0.5 µg) per sample), or CD11b (for example, CD11b-Alexa-488, Clone M1/70, Cat. #101217, BioLegend at 1 µl (0.2 µg) per sample). Two ml of, for example, eBioscience Flow Cytometry Staining Buffer (Cat. #00-4222, eBioscience) is then added, and the samples are centrifuged at 400-500g for 5 min at 4°C. Supernatants are removed by aspiration, and this wash step is repeated two more times with staining buffer. Following the third wash, each sample is resuspended in 500 µl of, for example, FlowCytometry Staining Buffer and run through a 40 µm filter (for example, Cat. #22363547, Fisher Scientific) for eventual FACS analysis using a FACS machine (for example, BD FACSCalibur (cat. #342975), BD Biosciences, San Jose, CA, USA). For proper background and laser intensity settings, unstained, single antibody, and IgG (labeled with, for example, Alexa-488 or Alexa-647, BioLegend) controls can also be run.

F. Fabrication of Alginate Hydrogel Capsules and Cell Encapsulation

All buffers are sterilized by autoclave and alginate solutions are sterilized by filtration through a 0.2 µm filter. After solutions are sterilized, aseptic processing is implemented by performing capsule formation in a type II class A2 biosafety cabinet to maintain sterility of manufactured microcapsules/spheres for subsequent implantation. The hydrogel capsules are formed by the following protocol.

To solubilize alginates, SLG20 (NovaMatrix, Sandvika, Norway) is dissolved at 1.4% weight to volume in 0.8% saline. TMTD alginate is initially dissolved at 5% weight to volume in 0.8% saline, and then blended with 3% weight to volume SLG100 (also dissolved in 0.8% saline) at a volume ratio of 80% TMTD alginate to 20% SLG100.

Forming different sized capsules: for 300 µm diameter capsules, a 30 gauge blunt tipped needle (SAI Infusion Technologies) is used with a voltage of 7-8 kV. For 500 µm

diameter capsules, a 25 gauge blunt tipped needle (SAI Infusion Technologies) is used with a voltage of 5-7 kV. For 1.5 mm capsules, an 18 gauge blunt tipped needle (SAI Infusion Technologies) is used with a voltage of 5-7 kV.

Cells, such as human islet cells or cultured human cells, are used for encapsulation. Immediately prior to encapsulation, the cultured human cell clusters are centrifuged at 1,400 rpm for 1 minute and washed with Ca-free Krebs-Henseleit (KH) Buffer (4.7mM KCl, 25mM HEPES, 1.2mM KH_2PO_4 , 1.2mM $\text{MgSO}_4 \times 7\text{H}_2\text{O}$, 135mM NaCl, pH $\approx$ 7.4, $\approx$ 290 mOsm). After washing, the human cells are centrifuged again and all supernatant is aspirated. The human cell pellet is then re-suspended in the SLG20 or TMTD alginate solutions at cluster densities of 1,000, 250, and 100 clusters per 0.5 ml alginate solution.

An electrostatic droplet generator is set up as follows: an ES series 0-100 KV, 20 Watt high voltage power generator (Gamma ES series, Gamma High Voltage Research, FL, USA) is connected to the top and bottom of a blunt tipped needle (SAI Infusion Technologies, IL, USA). This needle is attached to a 5 mL lure lock syringe (BD, NJ, USA) which is clipped to a syringe pump (Pump 11 Pico Plus, Harvard Apparatus, MA, USA) that is oriented vertically. The syringe pump pumps alginate out into a glass dish containing a 20 mM barium 5% mannitol solution (Sigma Aldrich, MO, USA). The settings of the PicoPlus syringe pump are 12.06 mm diameter and 0.2 mL/min flow rate. Immediately after crosslinking, the encapsulated human cell clusters are washed 4 times with 50 mL of CMRLM media and cultured overnight in a spinner flask at 37°C prior to transplantation. Due to an inevitable loss of human cell clusters during the encapsulation process, the total number of encapsulated clusters are recounted post-encapsulation.

G. Analysis of Cell Viability of Encapsulated Cells and/or Protein Secreted from Encapsulated Cells

Encapsulated cells are added in 3 ml of fresh medium to each well of a six-well tissue-culture polystyrene plate. Culturing of encapsulated cells is maintained for four days. Afterwards, supernatant samples can be collected and frozen at -20 °C for future analysis, such as by Western blot or ELISA. Encapsulated cells are collected into new plates. Both encapsulated cells are washed in HEPES buffer and subjected to live-dead fluorescent staining (Invitrogen) for viability assessment. The proportion of encapsulated cells that are viable (live) can be calculated. The secretion level of one or more proteins of interest, such as insulin from islet cells or a protein of interest secreted by a recombinant cell, can be assessed by analyzing the supernatant by Western blot or

ELISA. The level of secretion can be assessed by, for example, raw level, normalized level (normalized to the level of a housekeeping secreted protein, for example), or either of these compared to the level measured from control cells.

H. Insulin Secretion Analysis

5 Encapsulated islet cell insulin responses are assessed by loading capsules or product containing encapsulated islet cells into a microfluidic device modified for encapsulated islets (Nourmohammadzadeh et al., Analytical Chem. 85:11240-11249 (2013)). The encapsulated islet cells can be, for example, newly encapsulated or retrieved after implantation into a subject, such as a mouse. Perifusate samples are
10 collected every minute (500 μ L/min) by an automated fraction collector (Gilson, model 203B, WI, USA). Insulin concentrations are quantified every other minute using, for example, a chemiluminescent insulin ELISA (Alpco, NH, USA). The following perifusion protocol is used: (1) KRB2 (0-20 min); (2) 20 mM glucose or 30 mM KCl (20-55 min); (3) KRB2 (55-100 min). An appropriate measure of the secreted insulin can
15 be calculated. For example, the area under the curve for each insulin curve can be calculated in order to statistically compare groups using one-way ANOVA ($p < 0.05$ as significant).

Biological and temporal characteristics of the disclosed products can be assessed by any suitable analysis. For example, the length of time a product implanted into a
20 subject remains acceptably free of fibrotic effects, produces a desired effect, maintains encapsulated cell viability, or combinations thereof can be assessed. Analogously, the suitability of surface modifications for facilitating desirable biological and temporal characteristics of the disclosed products can be assessed in similar ways. In some embodiments, a product with surface modifications as described herein, if implanted into
25 and retrieved from an immunocompetent animal, such as a C57BL/6J mouse, as described herein, can have one or more of the following properties:

(a) expression of one or more immune and fibrosis markers on the product will be less than 3-fold higher, 2.5-fold higher, 2-fold higher, or 1.5-fold higher than in untreated control tissue at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360
30 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis, ELISA, or qPCR analysis as known in the art or as described herein;

(b) expression of one or more immune and fibrosis markers on the product will be less than 3-fold higher, 2.5-fold higher, 2-fold higher, or 1.5-fold higher than in

untreated control tissue at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis, ELISA, or qPCR analysis as known in the art or as described herein;

5 (c) the cell population of one or more immune- and fibrosis-associated cells on the product will be less than 20%, 18%, 15%, 12%, 10%, or 5% of the cell population observed for a control similar product lacking the surface modification at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, FACS analysis or ELISA as
10 known in the art or as described herein;

 (d) expression of a cell viability marker from cells encapsulated in the product will be more than 2-fold higher, 3-fold higher, 3.5-fold higher, 4-fold higher, 5-fold higher, or 10-fold higher observed for similar encapsulated cells comprised in a control similar product lacking the surface modification at least 14 days, 30 days, 60 days, 120
15 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, FACS analysis, Western blot analysis, ELISA, histology, or qPCR analysis as known in the art or as described herein;

 (e) secretion of a protein of interest from cells encapsulated in the product will be detectable at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after
20 implantation into the immunocompetent animal as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein;

 (f) secretion of insulin from islet cells encapsulated in the product will be detectable at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after
25 implantation into the immunocompetent animal as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein; and

 (g) at least 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, or 10% of the cells encapsulated in the product will be viable for at least 14 days, 30 days, 60 days, 120
30 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, cell viability analysis as known in the art or as described herein.

The compounds used for the surface modification can be assessed for facilitating desirable biological and temporal characteristics on products by, for example, fabricating alginate capsules modified with the compound to encapsulate human islet cells, implanting the alginate capsules into and retrieving the alginate capsules from a

C57BL/6J mouse as described herein, and assessing a suitable property of the retrieved alginate capsules. In some embodiments, the retrieved alginate capsules can have one or more of the following properties:

5 (a) expression of an islet cell viability marker from the alginate capsules will be more than 2-fold higher, 3-fold higher, 3.5-fold higher, 4-fold higher, 5-fold higher, or 10-fold higher observed for a control similar alginate capsule lacking the surface modification at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, FACS analysis, Western blot analysis, ELISA, histology, or qPCR analysis as known in the art or as described herein;

(b) secretion of insulin from the islet cells encapsulated in the alginate capsule will be detectable at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein;

15 (c) expression of one or more immune and fibrosis markers on the alginate capsule will be less than 3-fold higher, 2.5-fold higher, 2-fold higher, or 1.5-fold higher than in untreated control tissue at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis, ELISA, or qPCR analysis as known in the art or as described herein;

20 (d) expression of one or more immune and fibrosis markers on the alginate capsule will be less than 3-fold higher, 2.5-fold higher, 2-fold higher, or 1.5-fold higher than in untreated control tissue at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis, ELISA, or qPCR analysis as known in the art or as described herein;

25 (e) the cell population of one or more immune- and fibrosis-associated cells on the alginate capsule will be less than 20%, 18%, 15%, 12%, 10%, or 5% of the cell population observed for a control similar product lacking the surface modification at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, FACS analysis or ELISA as known in the art or as described herein;

(f) expression of a cell viability marker from the islet cells encapsulated in the alginate capsule will be more than 2-fold higher, 3-fold higher, 3.5-fold higher, 4-fold

higher, 5-fold higher, or 10-fold higher observed for similar encapsulated cells comprised in a control similar product lacking the surface modification at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, FACS analysis, Western blot analysis, ELISA, histology, or qPCR analysis as known in the art or as described herein;

(g) secretion of a protein of interest from the islet cells encapsulated in the alginate capsule will be detectable at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein; and

(h) at least 50%, 45%, 40%, 35%, 30%, 25%, 20%, 15%, or 10% of the the islet cells encapsulated in the product will be viable for at least 14 days, 30 days, 60 days, 120 days, 240 days, or 360 days after implantation into the immunocompetent animal as determined by, for example, cell viability analysis as known in the art or as described herein.

In some embodiments of the product, a similar product, if implanted into and retrieved from a C57BL/6J mouse as described herein has the following property: expression of one or more immune and fibrosis markers on the product will be less than 3-fold higher than in untreated control tissue at least 30 days after implantation into the C57BL/6J mouse as determined by, for example, Western blot analysis, ELISA, or qPCR analysis as known in the art or as described herein.

In some embodiments of the product, a similar product, if implanted into and retrieved from a C57BL/6J mouse as described herein has the following property: the cell population of one or more immune- and fibrosis-associated cells on the product will be less than 20% of the cell population observed for an identical product lacking the surface modification at least 14 days after implantation into the C57BL/6J mouse as determined by, for example, FACS analysis, Western blot analysis, ELISA, or histology as known in the art or as described herein.

In some embodiments of the product, alginate capsules, (a) fabricated as described herein to encapsulate human islet cells and (b) having the surface modification of the product on the outer surface of alginate capsules at a similar density as on the surface or a surface of the product, provides encapsulated human islet cells that, if implanted into and retrieved from a C57BL/6J mouse as described herein has the following property: expression of an islet cell viability marker from the alginate capsules will be more than 2-fold higher observed for an identical alginate capsule

lacking the surface modification at least 30 days after implantation into the C57BL/6J mouse as determined by, for example, FACS analysis, Western blot analysis, ELISA, histology, or qPCR analysis as known in the art or as described herein.

5 In some embodiments of the product, alginate capsules, (a) fabricated as described herein to encapsulate human islet cells and (b) having the surface modification of the product on the outer surface of alginate capsules at a similar density as on the surface or a surface of the product, provides encapsulated human islet cells that, if implanted into and retrieved from a C57BL/6J mouse as described herein has the following property: the encapsulated islet cells will be able to secrete detectable levels
10 of insulin at least 30 days after implantation into the C57BL/6J mouse as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein.

In some embodiments of the product, the product includes encapsulated cells, where the encapsulated cells, if implanted, via implantation of the product, into and retrieved from a C57BL/6J mouse as described herein has the following property:
15 expression of a cell viability marker from the encapsulated cells will be more than 2-fold higher observed for similar encapsulated cells included in an identical product lacking the surface modification at least 30 days after implantation into the C57BL/6J mouse as determined by, for example, FACS analysis, Western blot analysis, ELISA, histology or qPCR analysis as known in the art or as described herein.

20 In some embodiments of the product, the product includes encapsulated cells expressing and secreting a protein of interest, where the encapsulated cells, if implanted, via implantation of the product, into and retrieved from a C57BL/6J mouse as described herein has the following property: the encapsulated islet cells will be able to secrete detectable levels of the protein of interest at least 30 days after implantation into the
25 C57BL/6J mouse as determined by, for example, Western blot analysis or ELISA as known in the art or as described herein.

For testing of a product of interest, suitable products can be, for example, a product identical to the product of interest, a corresponding product to the product of interest, a similar product to the product of interest, a product having identical surface
30 modification as the product of interest, a product having a corresponding surface modification as the product of interest, or a product having a similar surface modification as the product of interest. For testing of a compound, chemical modification, or surface modification of interest, suitable products can be, for example, a product surface

modified with the compound of interest, a product with the chemical modification of interest, or a product with the surface modification of interest.

VII. Methods of Using

The products described herein, can be used in applications where improved biocompatibility and physical properties (such as being anti-fibrotic), as compared to other commercially available products, are useful or preferred. These include, but are not limited to tissue engineering, invasive sensors, drug delivery, gene transfection systems, medical nanotechnology and biotechnology, implantable medical devices.

The products described herein can be used to treat a broad spectrum of diseases, disorders, and conditions. For example, products that include cells or tissues can be used to treat disorders characterized by a need for a product produced by the cell or tissue or of a reaction mediated by a product of the cell. For example, the cell or cell product can metabolize glucocerebroside or detoxify compounds. For type I and III Gaucher's disease, enzyme replacement treatment with intravenous recombinant glucocerebrosidase is generally used to hydrolyze the beta-glucosidic linkage of, an intermediate in glyclipid metabolism. Toxin-specific antibodies can be used in prophylaxis or treatment of infections caused by bacteria such as *Bacillus anthracis* and *Clostridium difficile*. In some embodiments, the cell or tissue can produce a product useful to treat a disorder. For example, where the cell is an islet cell and the disorder is diabetes. In some embodiments, the product can include a cell that metabolizes or modifies a substrate produced by the subject.

Table 2. List of disorders and the cells or cell-produced substance that can be used to treat the disorder.

Cell or Cell-produced Substance	Disorder
Stem cells	Neurodegenerative diseases, diabetes, heart diseases and many other conditions
Pancreatic islet cells	Diabetes
Autologous haemopoietic stem cell transplantation	Chronic inflammatory autoimmune diseases including severe forms of scleroderma, multiple sclerosis, and lupus
Chimeric antigen receptor T cells	Cancers to be treated include non-solid

	cancers and solid cancers, for examples, carcinoma, blastoma, and sarcoma, and leukemia or lymphoid malignancies, benign and malignant tumors, and malignancies e.g., sarcomas, carcinomas, and melanomas.
Hepatocyte cell therapy	Liver diseases such as cirrhosis, liver cancer and hepatitis.
Allogeneic differentiated osteoblastic cells	Orthopedic conditions including impaired fracture, a delayed union fracture, osteonecrosis and osteoporosis.
Chemically induced neuron cells from pluripotent cells	neurodegenerative disorder selected from the group consisting of Alzheimer's Disease (AD), Huntington's Disease (HD), Parkinson's Disease (PD) Amyotrophic Lateral Sclerosis (ALS), Multiple Sclerosis (MS) and Cerebral Palsy (CP), Dentatorubro-pallidoluysian Atrophy (DRPLA), Neuronal Intranuclear Hyaline Inclusion Disease (NIHID), dementia with Lewy bodies, Down's Syndrome, Hallervorden-Spatz disease, prion diseases, argyrophilic grain dementia, corticobasal degeneration, dementia pugilistica, diffuse neurofibrillary tangles, Gerstmann-Straussler-Scheinker disease, Hallervorden-Spatz disease, Jakob-Creutzfeldt disease, Niemann-Pick disease type 3, progressive supranuclear palsy, subacute

	sclerosing panencephalitis, Spinocerebellar Ataxias, Pick's disease, and dentatorubral-pallidoluysian atrophy
	Disorders of Amino Acid Metabolism
phenylalanine hydroxylase	Phenylketonuria (PKU)
biopterin cofactor	Malignant PKU
fumarylacetoacetate hydrolase	Type 1 tyrosinemia
tyrosine aminotransferase	Type 2 tyrosinemia
protein(s) involved in tyrosine breakdown	Alkaptonuria
cystathionine- β -synthase or methylenetetrahydrofolate reductase or protein(s) involved in formation of the methylcobalamin form of vitamin B ₁₂	Homocystinuria and Hyperhomocysteinemia
branched-chain ketoacid dehydrogenase complex	Maple Syrup Urine disease
	Disorders of Organic Acid Metabolism
propionyl-CoA carboxylase	Propionic Acidemia
pyruvate carboxylase and 3-methylcrotonyl-CoA carboxylase	Multiple Carboxylase deficiency
methylmalonyl-CoA mutase; protein(s) involved in vitamin B ₁₂ metabolism	Methylmalonic Acidemia
	Disorders of Fatty Acid Metabolism
protein(s) involved in regulation or utilization of lipoproteins	Hyperlipidemia and hypercholesterolemia
very long chain acyl-CoA dehydrogenase; long chain hydroxyacyl-CoA dehydrogenase; dehydrogenase; medium chain acyl-	Fatty Acid Oxidation disorders

CoA dehydrogenase; short chain acyl CoA dehydrogenase; short chain hydroxyacyl-CoA dehydrogenase	
protein(s) involved in glycogenolysis	Glycogen Storage diseases
galactose-1-phosphate uridyl transferase	Galactosemia
enzyme(s) that build the carbohydrate side-chains on proteins	Congenital Disorders of Glycosylation
	Disorders of Purine and Pyrimidine Metabolism
protein(s) involved in balance between purine synthesis and disposal	Purine Overproduction
hypoxanthine phosphoribosyl- transferase	Lesch-Nyhan syndrome
	Lysosomal Storage Disorders
cerebrosidase	Gaucher disease Types I and II
beta-hexosaminidase A	Tay-Sachs disease
α -galactosidase	Fabry disease
α -iduronidase (Hurler syndrome); iduronate sultatase (Hunter syndrome); iduronate sultatase (Hunter syndrome)	Hurler syndrome, Hunter syndrome
enzyme(s) involved in heparan sulfate degradation	Sanfilippo syndrome
arylsulfatase B	Maroteaux-Lamy syndrome
galactose 6-sulfatase; β -galactosidase	Morquio syndrome
carbaryl phosphate synthetase; ornithine transcarbarylase; citrullinemia; argininosuccinic aciduria	Disorders of Urea Formation
	Disorders of Peroxisomal Metabolism
protein(s) involved in branched-chain	Refsum disease

fatty acid production and/or breakdown	
alanine-glyoxylate transaminase	Alanine-glyoxylate transaminase defect
Cellular metabolic enzymes	Enzyme deficiency diseases
Muscle cell metabolic enzymes	metabolic disorders of the muscle (e.g. Pompe's disease)

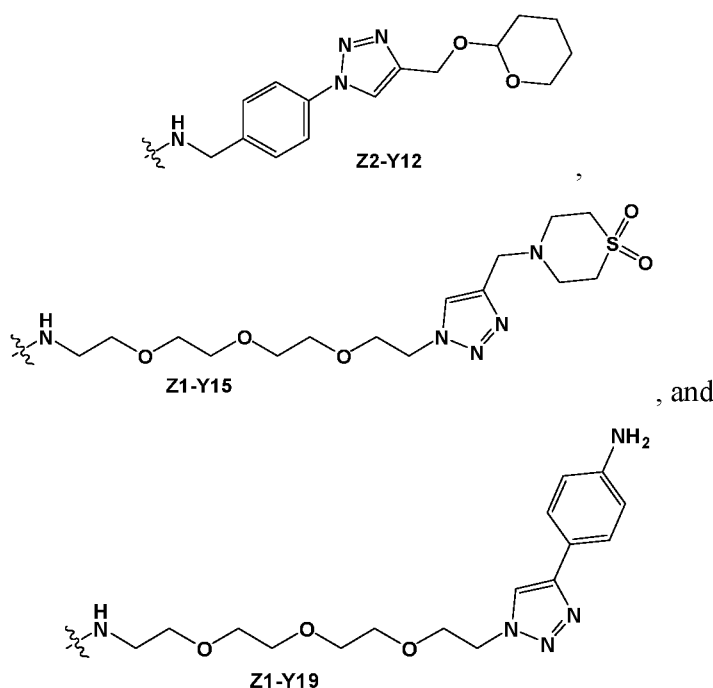
Table 3. List of products and devices that can be used to treat the disorder.

Product	Disorder
Bioartificial liver devices	Liver diseases
Heart pacemakers	Any conditions that case abnormal heart rhythms
Breast implants	Misshaped breasts
Spine screws, rods and artificial discs	Spinal fusion surgeries
Intra-uterine devices	
Artificial knees	Disability associated with knee cap or joints
Coronary stents	Unstable angina or heart attach due to blacked arteries
Artificial eye lenses	Cataract
Metal screws, pins, plates and rods	Bone fractures
Artificial hips	Disability associated with hips
Intestinal stents	Bowl obstruction

Examples

5 Example 1.

It was discovered that alginates modified with the Z2-Y12, Z1-Y15, or Z1-Y19 moieties exhibit lower foreign body responses. It has now been discovered that carboxy-polystyrene (C-PS) exhibits lower foreign body responses when modified with Z2-Y12, Z1-Y15, or Z1-Y19 moieties. 500 µm carboxy-polystyrene (C-PS) beads were modified with the following moieties:



After purification, the beads were implanted into the intraperitoneal (IP) space of C57BL/6J mice. After 14 days post-implantation, the beads were retrieved and the amounts of fibrotic or collagenous overgrowth/encapsulation on the implants were analyzed.

Results

Compared to unmodified control C-PS beads, modified C-PS beads showed no clumping or collagenous encapsulation. The control implants showed extreme levels of clumping and fibrotic deposition between beads/capsules. These results mimic similar studies with alginate microcapsules, and show that the chemical derivatizations can successfully mitigate immunological and fibrotic reactions to other biomedical device-relevant materials. These results are surprising, given that the environment on the surface of the beads or device and surface densities of the chemical derivatizations are different from that in the modified alginate polymer.

The materials presented here represent a key advancement in the development of fibrosis-resistant materials. While these compounds have been developed in the context of cell encapsulation and bead surface modification, the compounds are broadly applicable as anti-fibrotic coatings for other biomedical devices.

Example 2.

This example shows that various materials, including synthetic materials, exhibit lower foreign body responses when modified with E9 (Z2-Y12). The surfaces of

polystyrene, glass, PDMS, and medical-grade silicone have been modified successfully with the E9 molecule, and after 2 weeks implantation into the intraperitoneal space of a C57BL/6 mouse show dramatically reduced foreign body responses. Since many of these very same materials are used for implantable medical devices, such as implanted catheters in the brain, these results have profound implications for medical device composition and manufacture.

Stainless steel / Glass:

Beads were stirred in piranha solution for 1h at room temperature. Beads were washed by ultra-sonication in water, then ethanol, then acetone for 10 min each and then dried by blowing nitrogen over them. Immediate after drying the beads were stirred in a 10% (v/v) silane/toluene solution for 48h at 55°C. Cleaning was done by ultra-sonication in Toluene and Dichloromethane for 5 min each. The beads were dried under Argon and cured in an oven at 70°C for 3h to prevent air oxidation.

The beads were stirred in water and succinic acid, 2-chloro-4,6-dimethoxy-1,3,5-triazine (CDMT) and N-methylmorpholine (NMM) were added. The suspension was stirred at 55°C overnight. The beads were washed with water, methanol, and acetone to remove unreacted material.

The beads were stirred in a water/acetonitrile solution and E9, CDMT, and NMM was added. The beads were stirred overnight at 55°C. Beads were washed with water, methanol, and acetone. The conjugation was analyzed by X-ray photoelectron spectroscopy (XPS).

Polystyrene-COOH / PMMA-COOH:

To PS/PMMA beads in water/acetonitrile (3:2), E9 NMM and a spatula tip of CDMT was added. The solution was overhead stirred at 50°C overnight. The beads were washed three times with methanol and then three times with ethanol. The beads were dried under reduced pressure. Materials are characterized via XPS.

Plasma treated plastics, ceramics, and metals:

Materials were plasma treated for 1min on each side and immediately dropped into a 0.2mol solution of E9 in 5% DMSO in toluene. The reaction was stirred for 90min and the materials were washed three times in methanol and three times in ethanol. The materials are dried under high vacuum overnight. Materials are characterized via XPS.

XPS analysis of glass shows the ratios of the elements present on the surfaces of the glass. Table 4 shows a quantitative measure of the amount of each element present, the numbers being derived from the corresponding areas under the peaks in the figure. In

this case, the data show that the surface of the glass samples have carbon, oxygen, sodium, magnesium and silicon, which is indicative of the presence of surface modifications. From the standard deviations, one can determine that the elemental variations between the three glass samples are small.

5 **Table 4.** Atomic Concentration Table

Cl _{1s}	O _{1s}	Na _{1s}	Mg _{2p}	Si _{2p}	
0.314	0.733	1.102	0.167	0.368	RSF
58.791	137.408	206.930	37.158	80.087	Corrected RSF
30.13	48.41	2.26	3.37	15.83	Glass 1
25.77	52.88	0.98	2.60	17.77	Glass 2
29.11	50.62	1.99	1.53	16.75	Glass 3
28.34	50.63	1.74	2.50	16.78	Mean
2.28	2.24	0.68	0.92	0.97	Standard Deviation

XPS analysis of unmodified polydimethylsiloxane (PDMS) and PDMS modified with compound E9 (Z2-Y12) show that there is a significantly higher amount of elemental nitrogen on the surface of E9-modified PDMS compared to unmodified PDMS (Table 5). For example, (i) the amount of elemental nitrogen in the E9-modified PDMS sample is 7.66, much higher than the value of 1.06 in the unmodified PDMS sample; and (ii) the standard deviation of elemental nitrogen (4.67) is higher than the average amount of nitrogen (4.36) between the samples. Also worth noting is the difference between detected amounts of silicon in the two samples: the values are 10.04 and 18.38 in E9-modified PDMS and in unmodified PDMS, respectively. The lower value in E9-modified PDMS indicates that the surface of the sample has been coated.

15 **Table 5.** Atomic Concentration Table

Cl _{1s}	N _{1s}	O _{1s}	Si _{2p}	
0.314	0.499	0.733	0.368	RSF
58.791	93.486	137.408	80.087	Corrected RSF
59.28	7.66	23.02	10.04	1.PDMS-E9
50.88	1.06	29.69	18.38	2.PDMS
55.08	4.36	26.35	14.21	Mean
5.94	4.67	4.71	5.90	Standard Deviation

Analysis of the atomic concentration of elemental nitrogen present on the surface of a 1300 x 1300 μm section of a E9-modified PDMS sample indicates that some areas have a high amount of elemental nitrogen compared to other areas.

XPS analysis of E9-modified silicone show that the surfaces of the silicone samples have been successfully modified with E9 (Table 6). In particular, the averages and standard deviations of elemental nitrogen indicate similar densities of surface E9 in the three samples.

5 **Table 6.** Atomic Concentration Table

C1s	N1s	O1s	Si2p	
0.314	0.499	0.733	0.368	RSF
58.791	93.486	137.408	80.087	Corrected RSF
57.03	4.61	24.45	13.91	Silicone1
54.58	5.09	25.15	15.17	Silicone2
53.03	4.78	26.39	15.80	Silicone3
54.88	4.83	25.33	14.96	Mean
2.02	0.25	0.98	0.96	Standard Deviation

XPS analysis of glass shows that the surface of the glass samples have carbon, oxygen, sodium, magnesium and silicon (Table 7), which is indicative of the presence of surface modifications. From the standard deviations, one can determine that the elemental variations between the two glass samples are small.

10 **Table 7.** Atomic Concentration Table

C1s	N1s	O1s	F1s	Na1s	Si2p	
0.314	0.499	0.733	1.000	1.102	0.368	RSF
58.791	93.468	137.408	187.576	206.930	80.087	Corrected RSF
35.22	4.98	42.95	0.44	1.01	15.40	3.Glass-batch 1
39.82	5.87	36.80	2.02	0.80	14.69	4.Glass-batch2
37.52	5.42	39.87	1.23	0.90	15.05	Mean
3.25	0.63	4.35	1.12	0.15	0.50	Standard Deviation

Grafting E9 to the surface of carboxylic acid terminated polystyrene microspheres (300-500 μm in diameter) reduces fibrosis. Carboxylic acid modified polystyrene or E9 surface modified polystyrene were implanted to the intraperitoneal space of C57BL/6 mice for 14 days. Bright field images of retrieved microspheres revealed extensive clumping and fibrotic coating of the unmodified microspheres and no clumping or coating for the modified microspheres.

Grafting E9 to the surface of PDMS or medical grade silicone cylinders (5 mm diameter X 1 mm height) reduces fibrosis. Bright field images obtained from unmodified PDMS cylinders or E9 modified PDMS cylinders after retrieval from the intraperitoneal

space of C57BL/6 mice (14-day implantation study) reveal extensive fibrotic coating of unmodified cylinders and no visible coating of modified cylinders. Bright field images obtained from E9 modified or unmodified PDMS cylinders and E9 modified or unmodified medical grade silicone cylinders after retrieval from the intraperitoneal space of C57BL/6 mice (14-day implantation study) reveal extensive fibrotic coating of both unmodified PDMS cylinders and unmodified silicon cylinders and no visible coating of modified PDMS cylinders and modified silicon cylinders. E9 modified or unmodified PDMS cylinders and E9 modified or unmodified medical grade silicone cylinders after retrieval from the intraperitoneal space of C57BL/6 mice (14-day implantation study) were stained for cellular deposition (DAPI, F-actin) and myofibroblasts (α -SMA), the presence of which indicate fibrotic reaction. Confocal immunofluorescence images reveal extensive staining for all three markers on both unmodified PDMS cylinders and unmodified silicon cylinders and minimal staining of modified PDMS cylinders and modified silicon cylinders.

15

Disclosed are compounds, materials, compositions, and components that can be used for, can be used in conjunction with, can be used in preparation for, or are products of the disclosed method and compositions. These and other materials are disclosed herein, and it is understood that when combinations, subsets, interactions, groups, etc. of these materials are disclosed that while specific reference of each various individual and collective combinations and permutation of these compounds may not be explicitly disclosed, each is specifically contemplated and described herein. For example, if a compound is disclosed and discussed and a number of modifications that can be made to a number of molecules including the compound are discussed, each and every combination and permutation of compound and the modifications that are possible are specifically contemplated unless specifically indicated to the contrary. Thus, if a class of molecules A, B, and C are disclosed as well as a class of molecules D, E, and F and an example of a combination molecule, A-D is disclosed, then even if each is not individually recited, each is individually and collectively contemplated. Thus, in this example, each of the combinations A-E, A-F, B-D, B-E, B-F, C-D, C-E, and C-F are specifically contemplated and should be considered disclosed from disclosure of A, B, and C; D, E, and F; and the example combination A-D. Likewise, any subset or combination of these is also specifically contemplated and disclosed. Thus, for example, the sub-group of A-E, B-F, and C-E are specifically contemplated and should be

considered disclosed from disclosure of A, B, and C; D, E, and F; and the example combination A-D. Further, each of the materials, compositions, components, etc. contemplated and disclosed as above can also be specifically and independently included or excluded from any group, subgroup, list, set, etc. of such materials. These concepts
5 apply to all aspects of this application including, but not limited to, steps in methods of making and using the disclosed compositions. Thus, if there are a variety of additional steps that can be performed it is understood that each of these additional steps can be performed with any specific embodiment or combination of embodiments of the disclosed methods, and that each such combination is specifically contemplated and
10 should be considered disclosed.

It must be noted that as used herein and in the appended claims, the singular forms "a," "an," and "the" include plural reference unless the context clearly dictates otherwise. Thus, for example, reference to "a compound" includes a plurality of such compounds, reference to "the compound" is a reference to one or more compounds and
15 equivalents thereof known to those skilled in the art, and so forth.

Throughout the description and claims of this specification, the word "comprise" and variations of the word, such as "comprising" and "comprises," means "including but not limited to," and is not intended to exclude, for example, other additives, components, integers or steps.

20 "Optional" or "optionally" means that the subsequently described event, circumstance, or material may or may not occur or be present, and that the description includes instances where the event, circumstance, or material occurs or is present and instances where it does not occur or is not present.

Ranges may be expressed herein as from "about" one particular value, and/or to
25 "about" another particular value. When such a range is expressed, also specifically contemplated and considered disclosed is the range from the one particular value and/or to the other particular value unless the context specifically indicates otherwise. Similarly, when values are expressed as approximations, by use of the antecedent "about," it will be understood that the particular value forms another, specifically contemplated
30 embodiment that should be considered disclosed unless the context specifically indicates otherwise. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint unless the context specifically indicates otherwise. Finally, it should be understood that all of the individual values and sub-ranges of values contained within an explicitly

disclosed range are also specifically contemplated and should be considered disclosed unless the context specifically indicates otherwise. The foregoing applies regardless of whether in particular cases some or all of these embodiments are explicitly disclosed.

Unless defined otherwise, all technical and scientific terms used herein have the
5 same meanings as commonly understood by one of skill in the art to which the disclosed method and compositions belong. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present method and compositions, the particularly useful methods, devices, and materials are as described. Publications cited herein and the material for which they are cited are hereby
10 specifically incorporated by reference. Nothing herein is to be construed as an admission that the present invention is not entitled to antedate such disclosure by virtue of prior invention. No admission is made that any reference constitutes prior art. The discussion of references states what their authors assert, and applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that,
15 although a number of publications are referred to herein, such reference does not constitute an admission that any of these documents forms part of the common general knowledge in the art.

Although the description of materials, compositions, components, steps, techniques, etc. may include numerous options and alternatives, this should not be
20 construed as, and is not an admission that, such options and alternatives are equivalent to each other or, in particular, are obvious alternatives. Thus, for example, a list of different compounds does not indicate that the listed compounds are obvious one to the other, nor is it an admission of equivalence or obviousness.

Unless defined otherwise, all technical and scientific terms used herein have the
25 same meanings as commonly understood by one of skill in the art to which the disclosed invention belongs. Publications cited herein and the materials for which they are cited are specifically incorporated by reference.

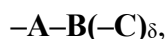
Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific embodiments of the invention
30 described herein. Such equivalents are intended to be encompassed by the following claims.

CLAIMS

1. An implant comprising a surface that does not comprise alginate, in which the surface comprises a material modified with a moiety of structure $-X-R_1$,

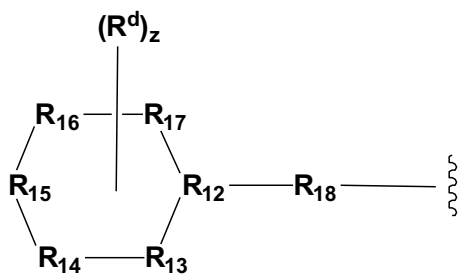
in which:

5 X is oxygen, sulfur, or NR_2 , in which R_2 is hydrogen, alkyl, or substituted alkyl, and R_1 has the structure



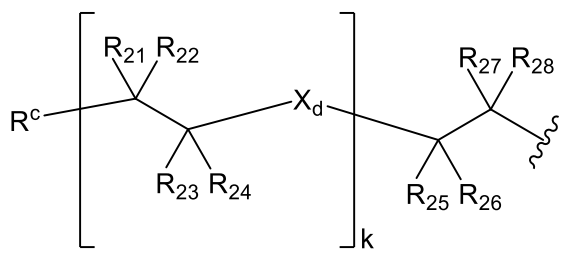
Formula XII

in which A is



Formula VI

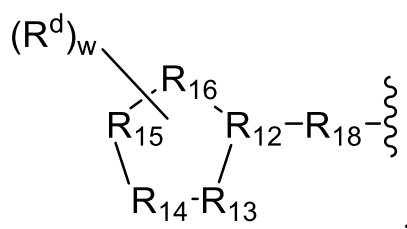
in which R^{18} in A is $-(CR_{19}R_{19})_p-$, p is an integer from 0 to 5, each R_{19} is hydrogen, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, z is an integer from 0 to 11, R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} in A are independently C or N, in which the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and in which R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency, or



Formula VIII

in which R_{21} , R_{22} , R_{23} , R_{24} , R_{25} , R_{26} , R_{27} , and R_{28} in **A** are independently hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, carbonyl, substituted carbonyl, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, substituted heterocyclic, poly(ethylene glycol), or poly(lactic-co-glycolic acid), k is an integer from 0 to 20, each X_d is independently absent, O, or S, and R^c is **B**,

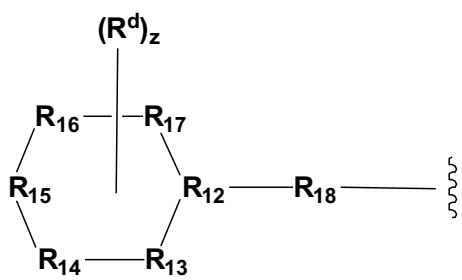
in which **B** is



Formula IX

in which R^{18} in **B** is $-(CR_{19}R_{19})_p-$, p is an integer from 0 to 5, each R_{19} is hydrogen, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, w is an integer from 0 to 4, R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} in **B** are independently C or N, in which the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and in which R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency,

in which **C** is



Formula VI

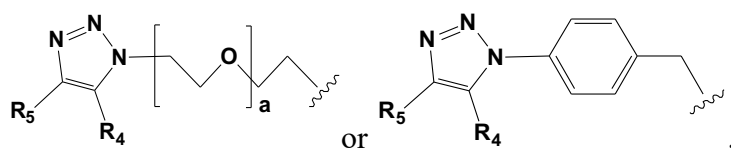
alkyl, substituted carbonyl, substituted heteroaryl, or substituted alkyl,

in which R^{18} in **C** is $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, in which p and q are independently integers from 0 to 5, X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, each
 5 R_{19} is hydrogen, R_{20} is alkyl or substituted alkyl, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, z
 10 is an integer from 0 to 11, in which R_{12} , R_{13} , R_{14} , R_{15} , R_{16} , and R_{17} in **C** are independently C, O, N, S, S(O), or S(O)₂, in which the bonds between adjacent R_{12} to R_{17} are double or single according to valency, and in which R_{12} to R_{17} are bound to none, one, or two hydrogens according to valency, and
 in which δ is 1.

- 15 2. An implant according to Claim 1, in which the material modified with the moiety of structure -X-R₁ is a polymeric material.
3. An implant according to Claim 2, in which the polymeric material comprises polystyrene, substituted polystyrene, polyethylene, polypropylene, polyacetylene, poly(vinyl chloride), polyolefin copolymer, poly(urethane), polyacrylate, polymethacrylate,
 20 polyacrylamide, polymethacrylamide, poly(methyl methacrylate), poly(2-hydroxyethyl methacrylate), polyester, polysiloxane, polydimethylsiloxane, polyether, poly(orthoester), poly(carbonate), poly(hydroxyalkanoate), polyfluorocarbon, polytetrafluoroethylene, natural latex, collagen, cellulosic polymer, alkyl cellulose, polycarbonate, polyamide, nylon, polyalkene, polysulfone, polyacrylonitrile, poly(glycolic acid), poly(L-lactic acid), poly(lactic
 25 glycolic acid), or polydioxanone.
4. An implant according to Claim 2 or 3, in which the polymeric material comprises polyether, polyester, polysulfone, polydimethylsiloxane, or polytetrafluoroethylene.
5. An implant according to any preceding claim which contains biological material.
6. An implant according to Claim 5, in which the biological material comprises a cell.

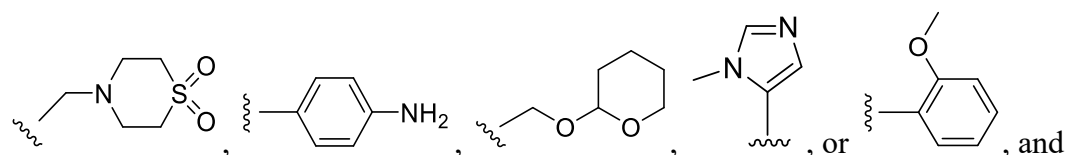
7. An implant according to Claim 6, in which the cell is a genetically engineered cell.
8. An implant according to Claim 6 or 7, in which the cell is a hormone-producing cell.
9. An implant according to Claim 8, in which the hormone-producing cell comprises an insulin-producing cell.
10. An implant according to Claim 9, in which the insulin-producing cell comprises an islet beta cell.
11. An implant according to Claim 6, 7 or 8, in which the cell is derived from a retinal epithelial cell line.
12. An implant according to any of Claims 6 to 11, in which the cell produces a therapeutic agent.
13. An implant according to any of Claims 6 to 12, in which the cell in the implant is viable for at least 14 days after implantation.
14. An implant according to any preceding claim, in which the implant further comprises a pore size of between about 0.1 μm and 2 μm or between about 0.1 μm and 1 μm .
15. An implant according to any preceding claim, in which:

R_1 is, independently in one or more sites of modification on the material,



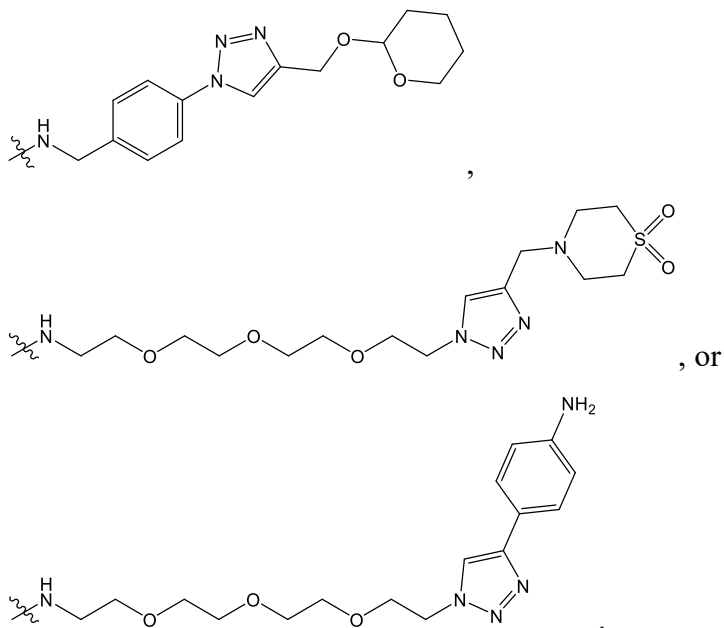
R_4 , and R_5 , are, independently, hydrogen, methyl, $-\text{CH}_2\text{-OH}$, or **C**,

in which, **C** is $-\text{C}(\text{O})\text{CH}_3$, $-\text{CH}_2\text{-N}(\text{CH}_2\text{-CH}_3)_2$,

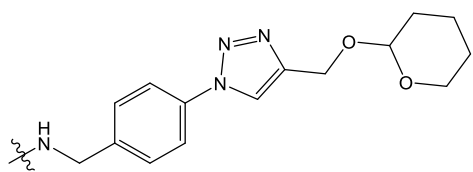


a is an integer between 1 and 20, inclusive.

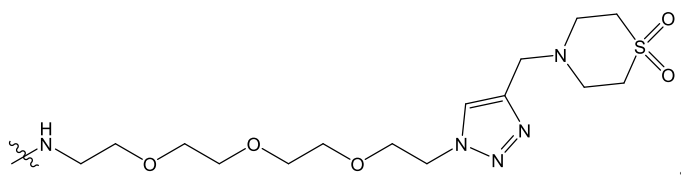
16. An implant according to any preceding claim, in which the moiety of structure $-\text{X-R}_1$ comprises:



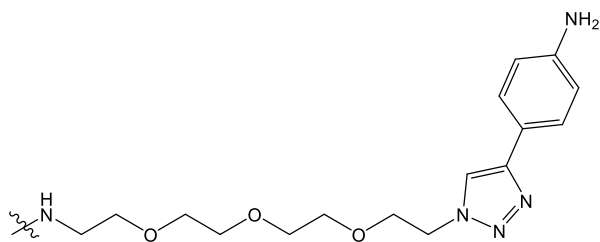
17. An implant according to any preceding claim, in which the moiety of structure $-X-R_1$ comprises:



18. An implant according to any of Claims 1 to 16, in which the moiety of structure $-X-R_1$ comprises:



19. An implant according to any of Claims 1 to 16, in which the moiety of structure $-X-R_1$ comprises:

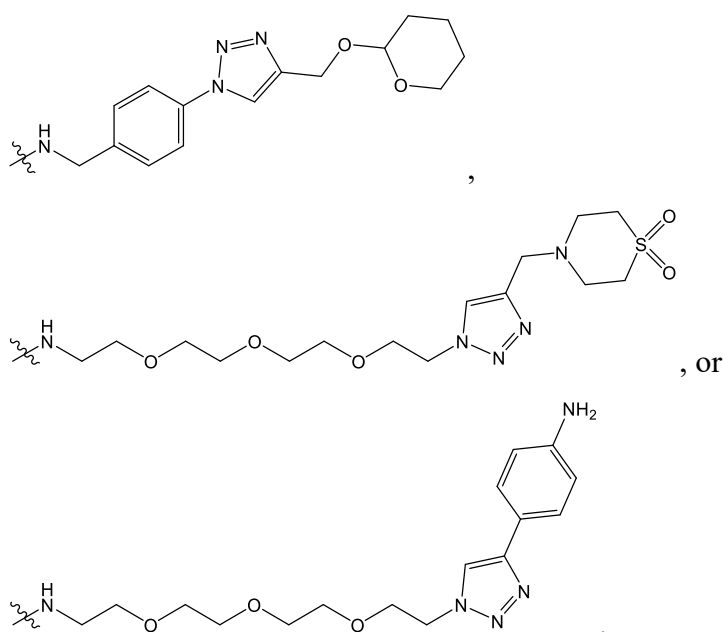


20. An implant according to any preceding claim, in which the surface is an exterior surface.

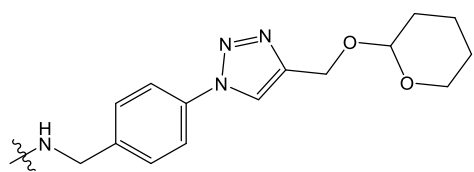
21. An implant according to any of Claims 1 to 19, in which the surface is an interior surface.

22. An implant according to any preceding claim, in which the moiety of structure $-X-R_1$ is covalently attached to the surface.

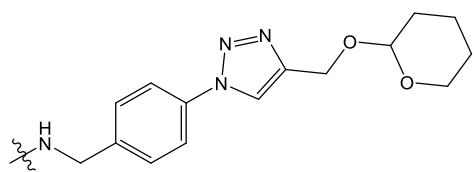
5 23. An implant according to Claim 20, 21 or 22, in which the moiety of structure $-X-R_1$ comprises:



10 24. An implant according to Claim 20, in which the surface is an exterior surface and the moiety of structure $-X-R_1$ comprises



25. An implant according to Claim 21, in which the surface is an interior surface and the moiety of structure $-X-R_1$ comprises



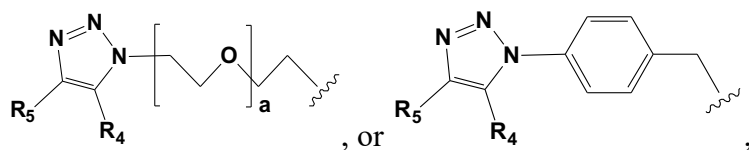
26. An implant comprising a cell that produces a therapeutic agent, in which the implant comprises a surface that does not comprise alginate and the surface comprises a material modified with a moiety of structure $-X-R_1$,

in which:

5 X is oxygen, sulfur, or NR_2 ,

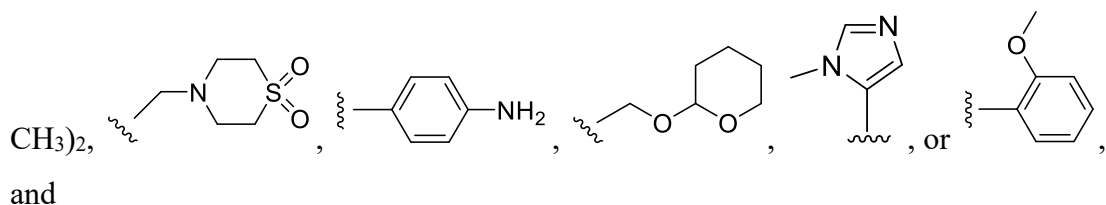
R_2 is hydrogen, alkyl, or substituted alkyl,

R_1 has the structure



in which

10 R_4 and R_5 are, independently, hydrogen, methyl, $-CH_2-OH$, $-C(O)CH_3$, $-CH_2-N(CH_2-$



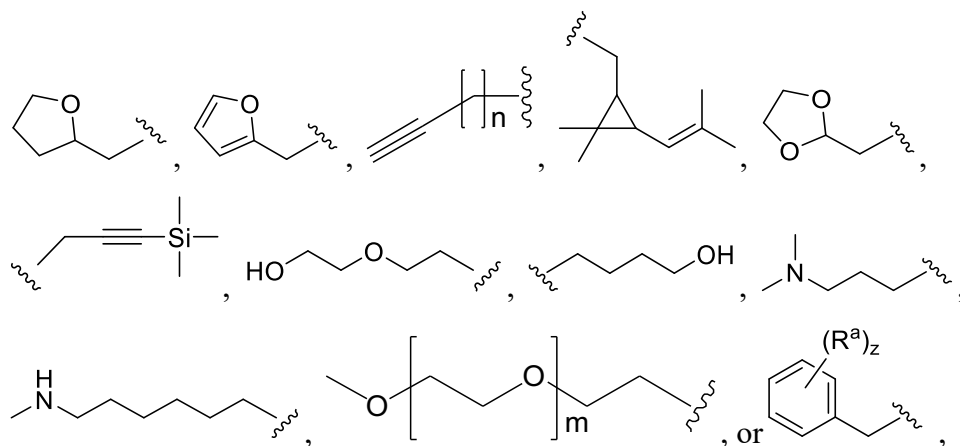
a is an integer from 1 to 30.

27. An implant comprising a surface that does not comprise alginate, in which the surface
15 comprises a material modified with a moiety of structure $-X-R_1$,

in which

X is oxygen, sulfur, or NR_2 , in which R_2 is hydrogen, alkyl, or substituted alkyl, and

R_1 is, independently in one or more sites of chemical modification,



in which R^a is alkylamino, dialkylamino, hydroxy, substituted alkyl, alkenyl, substituted
 5 alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, heteroaryl, substituted
 heteroaryl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, alkylthio, substituted
 alkylthio, arylthio, substituted arylthio, carbonyl, substituted carbonyl, carboxyl,
 substituted carboxyl, amino, substituted amino, amido, substituted amido, polyaryl,
 substituted polyaryl, cyclic, substituted cyclic, heterocyclic, substituted heterocyclic,
 10 amino acid, poly(ethylene glycol), peptide, polypeptide group, arylalkyl, substituted
 arylalkyl, sulfonyl, substituted sulfonyl, sulfonic acid, phosphoryl, substituted
 phosphoryl, phosphonyl, and substituted phosphonyl, or poly(lactic-co-glycolic acid),
 in which, n is an integer between 1 and 12, inclusive,

m is an integer between 3 and 16, inclusive, and

15 z is an integer between 1 and 5, inclusive.

28. An implant according to Claim 26 or 27, in which the material modified with the moiety
 of structure -X-R₁ is a polymeric material.

29. An implant according to Claim 28, in which the polymeric material comprises
 polystyrene, substituted polystyrene, polyethylene, polypropylene, polyacetylene, poly(vinyl
 20 chloride), polyolefin copolymer, poly(urethane), polyacrylate, polymethacrylate,
 polyacrylamide, polymethacrylamide, poly(methyl methacrylate), poly(2-hydroxyethyl
 methacrylate), polyester, polysiloxane, polydimethylsiloxane, polyether, poly(orthoester),
 poly(carbonate), poly(hydroxyalkanoate), polyfluorocarbon, polytetrafluoroethylene, natural
 latex, collagen, cellulosic polymer, alkyl cellulose, polycarbonate, polyamide, nylon,
 25 polyalkene, polysulfone, polyacrylonitrile, poly(glycolic acid), poly(L-lactic acid), poly(lactic
 glycolic acid), or polydioxanone.

30. An implant according to Claim 28 or 29, in which the polymeric material comprises polyether, polyester, polysulfone, polydimethylsiloxane, or polytetrafluoroethylene.
31. An implant according to any of Claims 27 to 30, in which the implant contains biological material.
- 5 32. An implant according to Claim 31, in which the biological material comprises a cell.
33. An implant according to Claim 26 or 32, in which the cell is a genetically engineered cell.
34. An implant according to Claim 26, 32 or 33, in which the cell is a hormone-producing cell.
- 10 35. An implant according to Claim 34, in which the hormone-producing cell comprises an insulin-producing cell.
36. An implant according to Claim 35, in which the insulin-producing cell comprises an islet beta cell.
37. An implant according to any of Claims 26 or 32 to 34, in which the cell is derived from
15 a retinal epithelial cell line.
38. An implant according to any of Claims 32 to 37, in which the cell produces a therapeutic agent.
39. An implant according to any preceding claim, in which the implant comprises a cardiac pacemaker, a catheter, a needle injection catheter, a blood clot filter, a vascular transplant, a
20 balloon, a stent transplant, a biliary stent, an intestinal stent, a bronchial stent, an esophageal stent, a ureteral stent, an aneurysm-filling coil or other coil device, a surgical repair mesh, a transmyocardial revascularization device, a percutaneous myocardial revascularization device, a fiber, a hollow fiber, a membrane, a textile, a blood container, a titer plate, an adsorber media, a dialyzer, a connecting piece, a sensor, a valve, an endoscope, a filter, a pump
25 chamber, or another medical device intended to have hemocompatible properties.
40. An implant according to any preceding claim, in which the density of the moiety on the surface of the implant is at least 0.1 chemical derivatizations per μm^2 .

41. An implant according to any preceding claim, in which the concentration of surface modifications by the moiety is between 0.1 and 50 percent of the total modification sites.
42. An implant according any of Claims 12, 26 or 38, in which the therapeutic agent is a protein.
- 5 43. An implant according to Claim 42, in which the protein is selected from insulin, phenylalanine hydroxylase, bipterin cofactor, fumarylacetoacetate hydrolase, tyrosine aminotransferase, protein(s) involved in tyrosine breakdown, cystathionine- β -synthase, methylenetetrahydrofolate reductase, protein(s) involved in formation of the methylcobalamin form of vitamin B₁₂, branched-chain ketoacid dehydrogenase complex, propionyl-CoA
- 10 carboxylase, pyruvate carboxylase, 3-methylcrotonyl-CoA carboxylase, methylmalonyl-CoA mutase, protein(s) involved in vitamin B₁₂ metabolism, protein(s) involved in regulation or utilization of lipoproteins, very long chain acyl-CoA dehydrogenase, long chain hydroxyacyl-CoA dehydrogenase, dehydrogenase, medium chain acyl-CoA dehydrogenase, short chain acyl CoA dehydrogenase, short chain hydroxyacyl-CoA dehydrogenase, protein(s) involved in
- 15 glycogenolysis, galactose-1-phosphate uridyl transferase, enzyme(s) that build the carbohydrate side-chains on proteins, protein(s) involved in balance between purine synthesis and disposal, hypoxanthine phosphoribosyl-transferase, cerebrosidase, beta-hexosaminidase A, α -galactosidase, α -iduronidase, iduronate sulfatase, enzyme(s) involved in heparan sulfate degradation, arylsulfatase B, galactose 6-sulfatase, β -galactosidase, carbamyl phosphate
- 20 synthetase, ornithine transcarbamylase, protein(s) involved in branched-chain fatty acid production and/or breakdown, alanine-glyoxylate transaminase, cellular metabolic enzymes, and muscle cell metabolic enzymes.
44. An implant according to any of Claims 12, 26, 38, or 42, in which the therapeutic agent is provided in a sufficient amount to treat a disease or disorder selected from diabetes,
- 25 lysosomal storage disorders, neurodegenerative disorders, chronic inflammatory autoimmune diseases, cancer, liver diseases, impaired fracture, delayed union fraction, osteonecrosis, osteoporosis, disorders of amino acid metabolism, disorders of organic acid metabolism, disorders of fatty acid metabolism, disorders of purine metabolism, disorders of pyrimidine metabolism, disorders of urea formation, and disorders of peroxisomal metabolism.
- 30 45. An implant according to Claim 44, in which the disease or disorder is selected from diabetes or a lysosomal storage disorder.

46. An implant according to any of Claims 6 to 8 and 32 to 34, in which the cell is derived from a cell type selected from liver cells, hepatoblasts, liver stellate cells, biliary cells, hepatocytes, pancreatic islet cells, isolated pancreatic beta cells, insulinoma cells, kidney cells, epidermal cells, epithelial cells, neural cells, neuron cells, glial cells, astrocytes, ganglion
5 cells, retinal epithelial cells, adrenal medulla cells, lung cells, cardiac muscle cells, osteoblast cells, osteoclast cells, bone marrow cells, spleen cells, thymus cells, glandular cells, blood cells, T cells, B cells, macrophage lineage cells, lymphocytes, monocytes, endocrine hormone-producing cells, parathyroid, thyroid, or adrenal cells, cells of intestinal origin and other cells acting primarily to synthesize and secret or to metabolize materials, endothelial cells, capillary
10 endothelial cells, fibroblasts, dermal fibroblasts, myogenic cells, keratinocytes, smooth muscle cells, progenitor cells, bone marrow progenitor cells, adipose progenitor cells, hepatic precursor cells, endothelial progenitor cells, peripheral blood progenitor cells, progenitor cells from muscle, progenitor cells from skin, and marrow stromal cells.

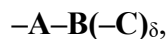
47. An implant according to Claim 42 or 46, in which the cell is genetically engineered to
15 produce a therapeutic protein selected from blood clotting factors, factor VIII, factor IX, tissue factor, von Willebrand factor, cytokines, interleukins, cytokine receptors, hormones, anti-diuretic hormone (ADH), human growth hormone (hGH), prolactin, growth hormone-releasing hormone (GHRH), thyroid stimulating hormone (TSH), thyrotropin-releasing hormone (TRH), adrenocorticotrophic hormone (ACTH), follicle-stimulating hormone (FSH),
20 luteinizing hormone (LH), luteinizing hormone-releasing hormone (LHRH), thyroxine, calcitonin, parathyroid hormone, aldosterone, cortisol, epinephrine, glucagon, insulin, estrogen, progesterone, testosterone, growth factors, vascular endothelial growth factor (VEGF), nerve growth factor (NGF), platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), epidermal growth factor (EGF), transforming growth factor (TGF), insulin-like
25 growth factor-I (IGF-I) and insulin-like growth factor-II (IGF-II).

48. An implant for use in providing a therapeutic agent to a subject, in which the implant comprises:

- (i) a cell that produces the therapeutic agent, and
- (ii) a surface that does not comprise alginate, in which the surface comprises a
30 material modified with a moiety of structure $-X-R_1$, and in which:

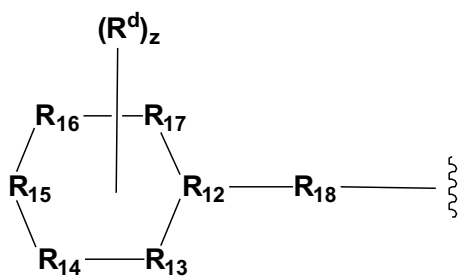
X is oxygen, sulfur, or NR_2 , in which R_2 is hydrogen, alkyl, or substituted alkyl, and

R₁ has the structure



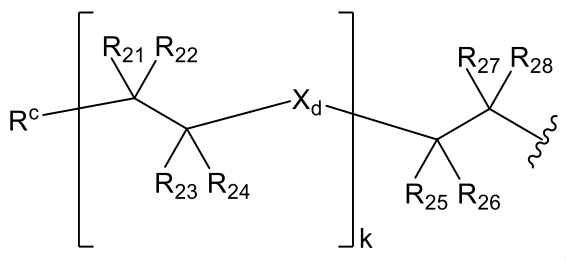
Formula XII

in which A is



Formula VI

in which R¹⁸ in A is -(CR₁₉R₁₉)_p-, p is an integer from 0 to 5, each R₁₉ is hydrogen, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, z is an integer from 0 to 11, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ in A are independently C or N, in which the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and in which R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency, or

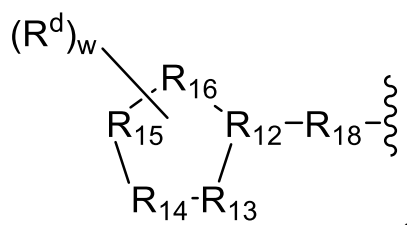


Formula VIII

in which R₂₁, R₂₂, R₂₃, R₂₄, R₂₅, R₂₆, R₂₇, and R₂₈ in A are independently hydrogen, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl, substituted aryl, heteroaryl, substituted heteroaryl, arylalkyl, substituted arylalkyl, alkoxy, substituted alkoxy, aroxy, substituted aroxy, carbonyl, substituted carbonyl,

carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, substituted heterocyclic, poly(ethylene glycol), or poly(lactic-co-glycolic acid), k is an integer from 0 to 20, each X_d is independently absent, O, or S, and R^c is **B**,

5 in which **B** is

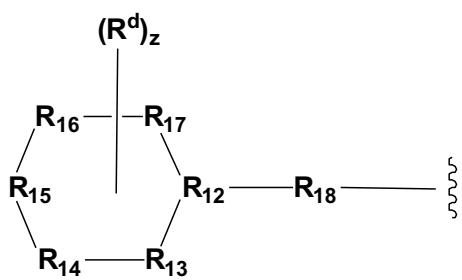


Formula IX

10 in which R^{18} in **B** is $-(CR_{19}R_{19})_p-$, p is an integer from 0 to 5, each R_{19} is hydrogen, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, w is an integer from 0 to 4, R_{12} , R_{13} , R_{14} , R_{15} , and R_{16} in **B** are independently C or N, in which the bonds between adjacent R_{12} to R_{16} are double or single according to valency, and in which R_{12} to R_{16} are bound to none, one, or two hydrogens according to valency,

15

in which **C** is



Formula VI

20

alkyl, substituted carbonyl, substituted heteroaryl, or substituted alkyl,

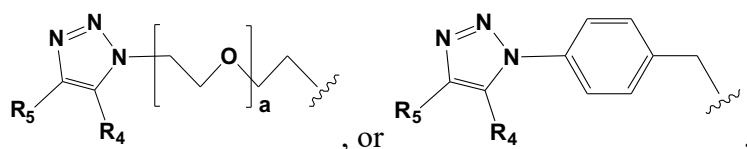
in which R^{18} in **C** is $-(CR_{19}R_{19})_p-$ or $-(CR_{19}R_{19})_p-X_b-(CR_{19}R_{19})_q-$, in which p and q are independently integers from 0 to 5, X_b is absent, -O-, -S-, -S(O)-, -S(O)₂-, or NR₂₀, each

R₁₉ is hydrogen, R₂₀ is alkyl or substituted alkyl, each R^d is independently alkyl, alkenyl, alkynyl, substituted alkyl, substituted alkenyl, substituted alkynyl, alkoxy, alkylamino, dialkylamino, hydroxy, aryl, substituted aryl, heteroaryl, substituted heteroaryl, substituted alkoxy, carboxyl, substituted carboxyl, amino, substituted amino, amido, substituted amido, cyclic, substituted cyclic, heterocyclic, or substituted heterocyclic, z is an integer from 0 to 11, in which R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ in C are independently C, O, N, S, S(O), or S(O)₂, in which the bonds between adjacent R₁₂ to R₁₇ are double or single according to valency, and in which R₁₂ to R₁₇ are bound to none, one, or two hydrogens according to valency, and

in which δ is 1.

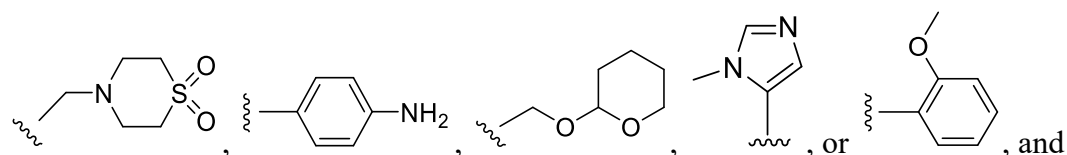
49. An implant for use according to Claim 48, in which:

R₁ is, independently in one or more sites of modification on the material,



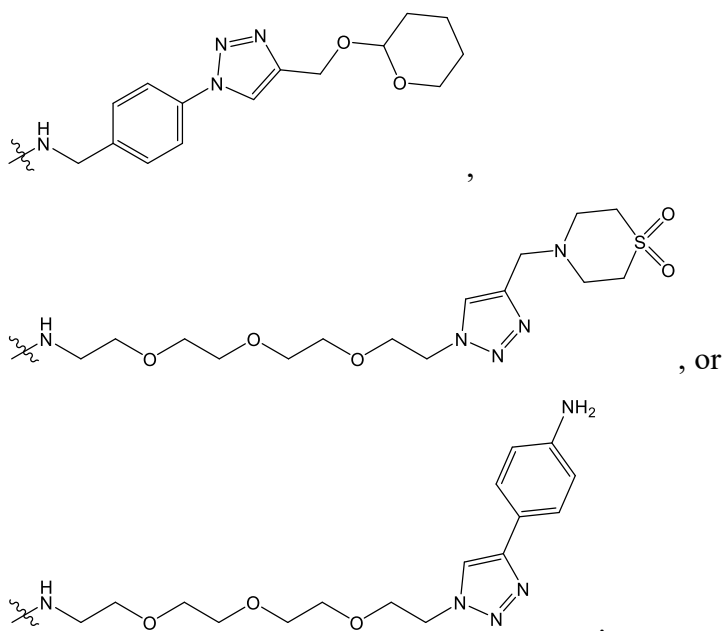
R₄, and R₅, are, independently, hydrogen, methyl, or -CH₂-OH or C,

in which, C is methyl, -C(O)CH₃, -CH₂-N(CH₂-CH₃)₂,



a is an integer between 1 and 20, inclusive.

50. An implant for use according to Claim 48 or 49, in which the moiety of structure -X-R₁ comprises:



51. An implant for use according to Claim 48, 49 or 50, in which the material modified with
5 the moiety of -X-R₁ comprises a polymeric material.

52. An implant for use according to Claim 51, in which the polymeric material comprises
polystyrene, substituted polystyrene, polyethylene, polypropylene, polyacetylene, poly(vinyl
chloride), polyolefin copolymer, poly(urethane), polyacrylate, polymethacrylate,
polyacrylamide, polymethacrylamide, poly(methyl methacrylate), poly(2-hydroxyethyl
10 methacrylate), polyester, polysiloxane, polydimethylsiloxane, polyether, poly(orthoester),
poly(carbonate), poly(hydroxyalkanoate), polyfluorocarbon, polytetrafluoroethylene, natural
latex, collagen, cellulosic polymer, alkyl cellulose, polycarbonate, polyamide, nylon,
polyalkene, polysulfone, polyacrylonitrile, poly(glycolic acid), poly(L-lactic acid), poly(lactic
glycolic acid), or polydioxanone.

53. An implant for use according to Claim 51 or 52, in which the polymeric material
15 comprises polyether, polyester, polysulfone, polydimethylsiloxane, or polytetrafluoroethylene.

54. An implant for use according to any of Claims 48 to 53, in which the cell is a genetically
engineered cell.

55. An implant for use according to any of Claims 48 to 54, in which the cell is a hormone-
20 producing cell.

56. An implant for use according to Claim 55, in which the hormone-producing cell
comprises an insulin-producing cell.

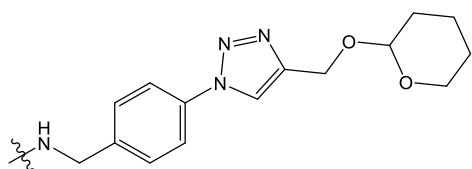
57. An implant for use according to Claim 56, in which the insulin-producing cell comprises an islet beta cell.

58. An implant for use according to any of Claims 48 to 55, in which the cell is derived from a retinal epithelial cell.

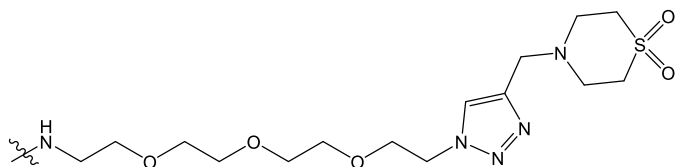
5 59. An implant for use according to any of Claims 48 to 58, in which the cell in the implant is viable for at least 14 days after implantation of the implant.

60. An implant for use according to any of Claims 48 to 59, in which the implant further comprises a pore size of between about 0.1 μm and 2 μm or between about 0.1 and 1 μm .

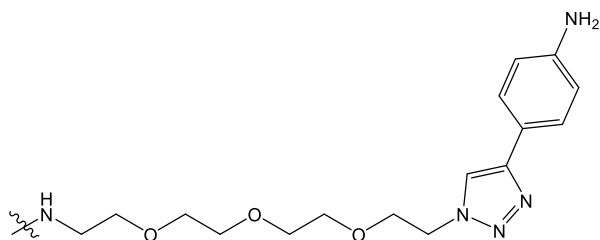
61. An implant for use according to any of Claims 48 to 60, in which the moiety of structure
10 $-\text{X}-\text{R}_1$ comprises:



62. An implant for use according to any of Claims 48 to 60, in which the moiety of structure
 $-\text{X}-\text{R}_1$ comprises:



15 63. An implant for use according to any of Claims 48 to 60, in which the moiety of structure
 $-\text{X}-\text{R}_1$ comprises:

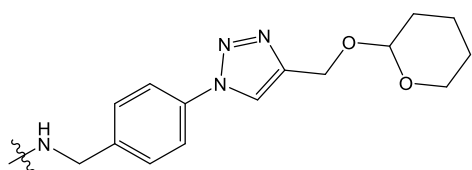


64. An implant for use according to any of Claims 48 to 63, in which the surface is an exterior surface.

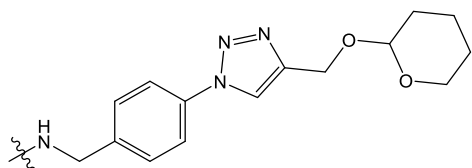
65. An implant for use according to any of Claims 48 to 63, in which the surface is an interior surface.

66. An implant for use according to any of Claims 48 to 65, in which the moiety of structure $-X-R_1$ is covalently attached to the surface.

5 67. An implant for use according to Claim 64, in which the surface is an exterior surface and the moiety of structure $-X-R_1$ comprises



68. An implant for use according to Claim 65, in which the surface is an interior surface and the moiety of structure $-X-R_1$ comprises



10

69. An implant for use according to any of Claims 48 to 68, in which the implant comprises a cardiac pacemaker, a catheter, a needle injection catheter, a blood clot filter, a vascular transplant, a balloon, a stent transplant, a biliary stent, an intestinal stent, a bronchial stent, an esophageal stent, a ureteral stent, an aneurysm-filling coil or other coil device, a surgical
15 repair mesh, a transmyocardial revascularization device, a percutaneous myocardial revascularization device, a fiber, a hollow fiber, a membrane, a textile, a blood container, a titer plate, an adsorber media, a dialyzer, a connecting piece, a sensor, a valve, an endoscope, a filter, a pump chamber, or another medical device intended to have hemocompatible properties.

20 70. An implant for use according to any of Claims 48 to 69, in which the density of the moiety on the surface of the implant is at least 0.1 chemical derivatizations per μm^2 .

71. An implant for use according to any of Claims 48 to 69, in which the concentration of surface modifications by the moiety is between 0.1 and 50 percent of the total modification sites.

72. An implant for use according to any of Claims 48 to 71, in which the therapeutic agent is a protein.

73. An implant for use according to Claim 72, in which the protein is selected from insulin, phenylalanine hydroxylase, bipterin cofactor, fumarylacetoacetate hydrolase, tyrosine
5 aminotransferase, protein(s) involved in tyrosine breakdown, cystathionine- β -synthase, methylenetetrahydrofolate reductase, protein(s) involved in formation of the methylcobalamin form of vitamin B₁₂, branched-chain ketoacid dehydrogenase complex, propionyl-CoA carboxylase, pyruvate carboxylase, 3-methylcrotonyl-CoA carboxylase, methylmalonyl-CoA mutase, protein(s) involved in vitamin B₁₂ metabolism, protein(s) involved in regulation or
10 utilization of lipoproteins, very long chain acyl-CoA dehydrogenase, long chain hydroxyacyl-CoA dehydrogenase, dehydrogenase, medium chain acyl-CoA dehydrogenase, short chain acyl CoA dehydrogenase, short chain hydroxyacyl-CoA dehydrogenase, protein(s) involved in glycogenolysis, galactose-1-phosphate uridyl transferase, enzyme(s) that build the carbohydrate side-chains on proteins, protein(s) involved in balance between purine synthesis
15 and disposal, hypoxanthine phosphoribosyl-transferase, cerebrosidase, beta-hexosaminidase A, α -galactosidase, α -iduronidase, iduronate sulfatase, enzyme(s) involved in heparan sulfate degradation, arylsulfatase B, galactose 6-sulfatase, β -galactosidase, carbamyl phosphate synthetase, ornithine transcarbamylase, protein(s) involved in branched-chain fatty acid production and/or breakdown, alanine-glyoxylate transaminase, cellular metabolic enzymes,
20 and muscle cell metabolic enzymes.

74. An implant for use according to any of Claims 48 to 73, in which the therapeutic agent is provided in a sufficient amount to treat a disease or disorder selected from diabetes, lysosomal storage disorders, neurodegenerative disorders, chronic inflammatory autoimmune diseases, cancer, liver diseases, impaired fracture, delayed union fraction, osteonecrosis,
25 osteoporosis, disorders of amino acid metabolism, disorders of organic acid metabolism, disorders of fatty acid metabolism, disorders of purine metabolism, disorders of pyrimidine metabolism, disorders of urea formation, and disorders of peroxisomal metabolism.

75. An implant for use according to Claim 74, in which the disease or disorder is selected from diabetes or a lysosomal storage disorder.

30 76. An implant for use according to any of Claims 48 to 54 or 58, in which the therapeutic agent is a blood clotting factor and the disease or disorder is hemophilia.

77. An implant for use according to any of Claims 48 to 55, in which the cell is derived from a cell type selected from liver cells, hepatoblasts, liver stellate cells, biliary cells, hepatocytes, pancreatic islet cells, isolated pancreatic beta cells, insulinoma cells, kidney cells, epidermal cells, epithelial cells, neural cells, neuron cells, glial cells, astrocytes, ganglion
5 cells, retinal epithelial cells, adrenal medulla cells, lung cells, cardiac muscle cells, osteoblast cells, osteoclast cells, bone marrow cells, spleen cells, thymus cells, glandular cells, blood cells, T cells, B cells, macrophage lineage cells, lymphocytes, monocytes, endocrine hormone-producing cells, parathyroid, thyroid, or adrenal cells, cells of intestinal origin and other cells acting primarily to synthesize and secret or to metabolize materials, endothelial cells, capillary
10 endothelial cells, fibroblasts, dermal fibroblasts, myogenic cells, keratinocytes, smooth muscle cells, progenitor cells, bone marrow progenitor cells, adipose progenitor cells, hepatic precursor cells, endothelial progenitor cells, peripheral blood progenitor cells, progenitor cells from muscle, progenitor cells from skin, and marrow stromal cells.

78. An implant for use according to Claim 54 or 55, in which the cell is genetically
15 engineered to produce a therapeutic protein selected from blood clotting factors (optionally factor VIII, factor IX, tissue factor, or von Willebrand factor), cytokines (optionally interleukins), cytokine receptors, hormones (optionally anti-diuretic hormone (ADH), human growth hormone (hGH), prolactin, growth hormone-releasing hormone (GHRH), thyroid stimulating hormone (TSH), thyrotropin-releasing hormone (TRH), adrenocorticotrophic
20 hormone (ACTH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), luteinizing hormone-releasing hormone (LHRH), thyroxine, calcitonin, parathyroid hormone, aldosterone, cortisol, epinephrine, glucagon, insulin, estrogen, progesterone, or testosterone) and growth factors (optionally vascular endothelial growth factor (VEGF), nerve growth factor (NGF), platelet-derived growth factor (PDGF), fibroblast growth factor (FGF),
25 epidermal growth factor (EGF), transforming growth factor (TGF), insulin-like growth factor-I (IGF-I) or insulin-like growth factor-II (IGF-II).