particular exemplary embodiments of the foregoing, at least some of the hydrolysable groups Y are chlorine.

The present disclosure also describes an article including a substrate selected from a (co)polymeric film or an electronic device, the electronic device further including an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer comprises the reaction product of at least one of the foregoing urea (multi)-(meth)acrylate (multi)-silane precursor compounds of the formula R_S-N(R^5)-C(O)-N(H)-R_A, as described above.

In another aspect, the present disclosure describes an article, comprising: a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; a base (co)polymer layer on a major surface of the substrate; an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_S-N(R^5)-C(O)-N(H)-R_A, wherein: R_S is a silane containing group of the formula: -R^1-[Si(Y_p)(R^2)$_{3-p}$]$_q$, wherein: R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group; p is 1, 2, or 3, and q is 1-5; R_A is a (meth)acryl group containing group of the formula: R^{11}-(A)$_n$, wherein: R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, A is a (meth)acryl group comprising the formula: X^2-C(O)-C(R^3)=CH_2, further wherein: X^2 is -O, -S, or –NR^3, R^3 is H, or C_1-C_4, and n=1 to 5; and R^5 is H, C_1 to C_6 alkyl or cycloalkyl, or R_S, with the proviso that at least one of the following conditions applies: n is 2 to 5, R^5 is R_S, or q is 2 to 5.

The present disclosure also describes an article including a substrate selected from a (co)polymeric film or an electronic device, the electronic device further including an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; a

base (co)polymer layer on a major surface of the substrate, an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer includes the reaction product of at least one of the foregoing urea (multi)-(meth)acrylate (multi)-silane precursor compounds of the formula R_{S1}-$N(R^4)$-C(O)-N(H)-R_{A1}. R_{S1} is a silane containing group of the formula -R^{1d}-$Si(Y_p)$ $(R^2)_{3-p}$, wherein R^{1d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group, and p is 1, 2, or 3. Additionally, R^4 is H, C_1 to C_6 alkyl or C_1 to C_6 cycloalkyl. R_{A1} is a (meth)acryl containing group of the formula R^{11d}-(A), wherein R^{11d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, and A is a (meth)acryl group comprising the formula X^2-C(O)-$C(R^3)$=CH_2, further wherein X^2 is -O, -S, or –NR^3, and R^3 is H, or C_1-C_4.

In another aspect, the present disclosure describes an article, comprising: a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; a base (co)polymer layer on a major surface of the substrate; an oxide layer on the base (co)polymer layer; and a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_{S1}-$N(R^4)$-C(O)-N(H)-R_{A1}, wherein: R_{S1} is a silane containing group of the formula: -R^{1d}-$Si(Y_p)(R^2)_{3-p}$, further wherein: R^{1d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, each Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group, and p is 1, 2, or 3; R^4 is H, C_1 to C_6 alkyl or C_1 to C_6 cycloalkyl; and R_{A1} is a (meth)acryl containing group of the formula: R^{11d}-(A), wherein: R^{11d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, and A is a (meth)acryl group comprising the formula: X^2-C(O)-$C(R^3)$=CH_2, further wherein: X^2 is -O, -S, or –NR^3, and R^3 is H, or C_1-C_4.

In any of the foregoing articles, each hydrolysable group Y is independently selected from an alkoxy group, an acetate group, an aryloxy group, and a halogen. In some particular

rare-earth metals, or a combination or mixture thereof. In some exemplary embodiments of any of the foregoing articles, the articles further include an oxide layer applied to the protective (co)polymer layer, optionally wherein the oxide layer includes silicon aluminum oxide.

The disclosure also describes methods of using a composite film as described above in an article selected from a photovoltaic device, a solid state lighting device, a display device, and combinations thereof. Exemplary solid state lighting devices include semiconductor light-emitting diodes (SLEDs, more commonly known as LEDs), organic light-emitting diodes (OLEDs), or polymer light-emitting diodes (PLEDs). Exemplary display devices include liquid crystal displays, OLED displays, and quantum dot displays. In another aspect, the present disclosure describes an electronic device incorporating the article as defined herein, wherein the substrate is a (co)polymer film and the electronic device is selected from a solid state lighting device, a display device, and combinations thereof.

The disclosure also describes a process including: (a) applying a base (co)polymer layer to a major surface of a substrate, (b) applying an oxide layer on the base (co)polymer layer, and (c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer includes a (co)polymer formed as the reaction product of at least one of the foregoing urea (multi)-(meth)acrylate (multi)-silane precursor compounds of the formula R_S-N(R^5)-C(O)-N(H)-R_A or R_{S1}-N(R^4)-C(O)-N(H)-R_{A1}, as previously described. The substrate is selected from a (co)polymeric film or an electronic device, the electronic device further including an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof.

In another aspect, the present disclosure describes a process, comprising: (a) applying a base (co)polymer layer to a major surface of a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; (b) applying an oxide layer on the base (co)polymer layer; and (c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises —a (co)polymer formed as ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_S-N(R^5)-C(O)-N(H)-R_A, wherein: R_S is a silane containing group of the formula: -R^1-[Si(Y_p)(R^2)$_{3-p}$]$_q$, wherein: R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene

group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group, p is 1, 2, or 3, and q is 1-5; R_A is a (meth)acryl group containing group of the formula: R^{11}-$(A)_n$, wherein: R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, A is a (meth)acryl group comprising the formula X^2-C(O)-$C(R^3)=CH_2$ wherein: X^2 is -O, -S, or $-NR^3$, where R^3 is H, or C_1-C_4;and n=1 to 5; and R^5 is H, C_1 to C_6 alkyl or cycloalkyl, or R_S, with the proviso that at least one of the following conditions applies: n is 2 to 5, R^5 is R_S, or q is 2 to 5.

In another aspect, the present disclosure provides a process, comprising: (a) applying a base (co)polymer layer to a major surface of a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof; (b) applying an oxide layer on the base (co)polymer layer; and (c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises ~~the~~ a (co)polymer formed as ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula: R_{S1}-$N(R^4)$-C(O)-N(H)-R_{A1}, wherein: R_{S1} is a silane containing group of the formula: -R^{1d}-$Si(Y_p)(R^2)_{3-p}$ wherein: R^{1d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, Y is a hydrolysable group, R^2 is a monovalent alkyl or aryl group, and p is 1, 2, or 3; R_{A1} is a (meth)acryl group containing group of the formula: R^{11d}-(A) wherein: R^{11d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms, and A is a (meth)acryl group comprising the formula X^2-C(O)-$C(R^3)=CH_2$: wherein X^2 is -O, -S, or $-NR^3$, further wherein R^3 is H, or C_1-C_4; and R^4 is H, C_1 to C_6 alkyl or cycloalkyl.

In some exemplary embodiments of the process, the at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound undergoes a chemical reaction to form the protective (co)polymer layer at least in part on the oxide layer. Optionally, the chemical reaction is selected from a free radical polymerization reaction, and a hydrolysis reaction. In any of the foregoing processes, each hydrolysable group Y is independently selected from an alkoxy group, an acetate group, an aryloxy group, and a halogen. In some

2. A composition of matter according to claim 1, wherein each hydrolysable group Y is independently selected from an alkoxy group, an acetate group, an aryloxy group, and a halogen.

3. A composition of matter according to 2, wherein at least some of the hydrolysable groups Y are chlorine.

4. An article, comprising:

a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

a base (co)polymer layer on a major surface of the substrate;

an oxide layer on the base (co)polymer layer; and

a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

$$R_S\text{-}N(R^5)\text{-}C(O)\text{-}N(H)\text{-}R_A,$$

wherein:

R_S is a silane containing group of the formula:

$$-R^1\text{-}[Si(Y_p)(R^2)_{3-p}]_q,$$

wherein:

R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

each Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group;

p is 1, 2, or 3, and

q is 1-5;

R_A is a (meth)acryl group containing group of the formula:

$R^{11}\text{-}(A)_n$, wherein:

R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

A is a (meth)acryl group comprising the formula:

$$X^2\text{-}C(O)\text{-}C(R^3)=CH_2,$$

further wherein:

X^2 is -O, -S, or $-NR^3$,

R^3 is H, or C_1-C_4, and

n=1 to 5; and

R^5 is H, C_1 to C_6 alkyl or cycloalkyl, or R_S, with the proviso that at least one of the following conditions applies:

n is 2 to 5, R^5 is R_S, or q is 2 to 5.

5. An article, comprising:

a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

a base (co)polymer layer on a major surface of the substrate;

an oxide layer on the base (co)polymer layer; and

a protective (co)polymer layer on the oxide layer, wherein the protective (co)polymer layer comprises ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

$$R_{S1}\text{-}N(R^4)\text{-}C(O)\text{-}N(H)\text{-}R_{A1},$$

wherein:

R_{S1} is a silane containing group of the formula:

$$-R^{1d}\text{-}Si(Y_p)(R^2)_{3-p},$$

further wherein:

R^{1d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

each Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group, and

p is 1, 2, or 3;

R^4 is H, C_1 to C_6 alkyl or C_1 to C_6 cycloalkyl; and

R_{A1} is a (meth)acryl containing group of the formula:

$$R^{11d}\text{-}(A),$$

12. The article of any one of claims 5-11, further comprising an oxide layer applied to the protective (co)polymer layer, optionally wherein the oxide layer comprises silicon aluminum oxide.

13. An electronic device incorporating the article according to any one of claims 5-12, wherein the substrate is a (co)polymer film and the electronic device is selected from a solid state lighting device, a display device, and combinations thereof.

14. An electronic device according to claim 13, wherein the solid state lighting device is selected from a semiconductor light-emitting diode device, an organic light-emitting diode device, and a polymer light-emitting diode device.

15. An electronic device according to claim 14, wherein the display device is selected from a liquid crystal display device, an organic light-emitting display device, and a quantum dot liquid crystal display device.

16. A process, comprising:

(a) applying a base (co)polymer layer to a major surface of a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

(b) applying an oxide layer on the base (co)polymer layer; and

(c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises a (co)polymer formed as ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

$$R_S\text{-}N(R^5)\text{-}C(O)\text{-}N(H)\text{-}R_A,$$

wherein:

R_S is a silane containing group of the formula:

$$-R^1\text{-}[Si(Y_p)(R^2)_{3-p}]_q,$$

wherein:

R^1 is a multivalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group,

p is 1, 2, or 3, and

q is 1-5;

R_A is a (meth)acryl group containing group of the formula:

$$R^{11}\text{-}(A)_n\,,$$

wherein:

R^{11} is a polyvalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more catenary oxygen atoms,

A is a (meth)acryl group comprising the formula $X^2\text{-}C(O)\text{-}C(R^3)=CH_2$ wherein:

X^2 is -O, -S, or $-NR^3$, where R^3 is H, or $C_1\text{-}C_4$;and n=1 to 5; and

R^5 is H, C_1 to C_6 alkyl or cycloalkyl, or R_S, with the proviso that at least one of the following conditions applies:

n is 2 to 5, R^5 is R_S, or q is 2 to 5.

17. A process, comprising:

(a) applying a base (co)polymer layer to a major surface of a substrate selected from a (co)polymeric film or an electronic device, the electronic device further comprising an organic light emitting device (OLED), an electrophoretic light emitting device, a liquid crystal display, a thin film transistor, a photovoltaic device, or a combination thereof;

(b) applying an oxide layer on the base (co)polymer layer; and

(c) depositing on the oxide layer a protective (co)polymer layer, wherein the protective (co)polymer layer comprises a (co)polymer formed as ~~the~~ a reaction product of at least one urea (multi)-(meth)acrylate (multi)-silane precursor compound of the formula:

$$R_{S1}\text{-}N(R^4)\text{-}C(O)\text{-}N(H)\text{-}R_{A1},$$

wherein:

R_{S1} is a silane containing group of the formula:

$$\text{-}R^{1d}\text{-}Si(Y_p)(R^2)_{3-p}$$

wherein:

R^{1d} is a divalent alkylene, arylene, alkarylene, or aralkylene group, said alkylene, arylene, alkarylene, or aralkylene groups optionally containing one or more

catenary oxygen atoms,

Y is a hydrolysable group,

R^2 is a monovalent alkyl or aryl group, and