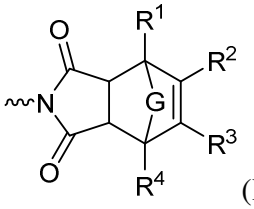
CLAIMS

1. A polymer, comprising:

a first repeat unit, the first repeat unit comprising at least one imide moiety and at least one indane-containing moiety; and

at least one end-cap group at one end of the polymer, the end-cap group comprising a masked maleimide group and being capable of undergoing a cycloreversion reaction at a temperature of at most 250°C in the solid state;

wherein the masked maleimide group comprises a moiety of structure (IXa):



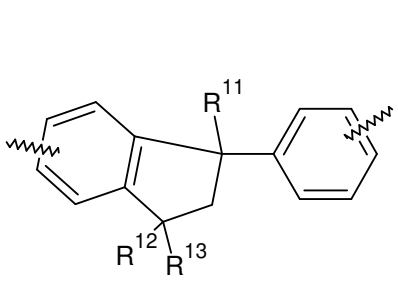
(IXa),

in which

G is -O-, -(NR^{100})-, -[$C(R^{101})=C(R^{102})$]-, or -[$C=C(R^{103})_2$]-, where each of R^{100}, R^{101}, R^{102}, and R^{103}, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, or an unsubstituted phenyl group, and

each of R^1, R^2, R^3 and R^4, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, an unsubstituted phenyl group, OR^{104}, CH_2OR^{105}, $CH_2OC(=O)R^{106}$, $CH_2C(=O)OR^{107}$, CH_2NHR^{108}, $CH_2NHC(=O)R^{109}$, $CH_2C(=O)N(R^{110})_2$, $C(=O)OR^{111}$, where each of R^{104}, R^{105}, R^{106}, R^{107}, R^{108}, R^{109}, R^{110}, and R^{111}, independently, is H or an unsubstituted C_1-C_6 linear, branched, or monocyclic alkyl group.

2. The polymer of claim 1, wherein the indane-containing moiety comprises



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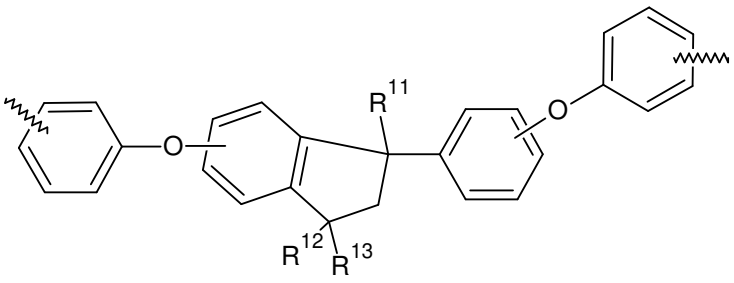

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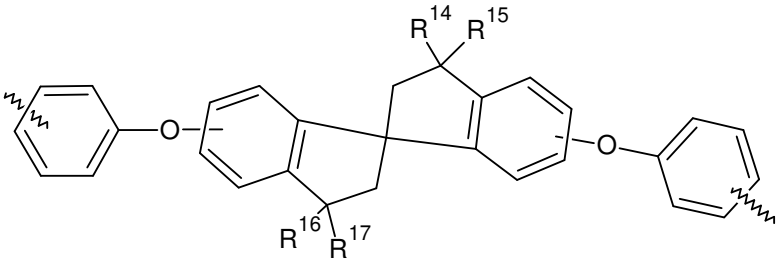

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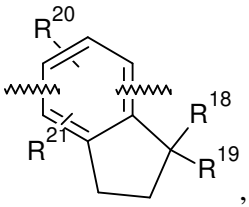

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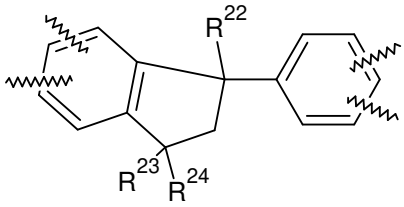

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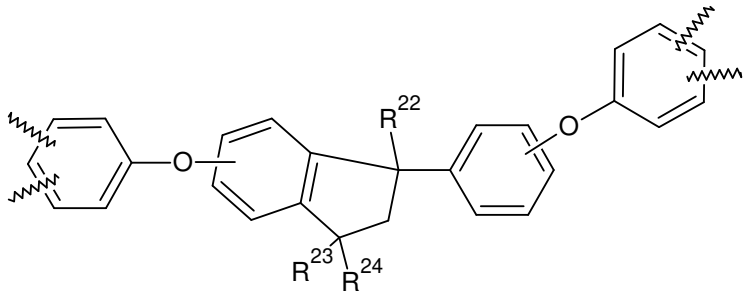

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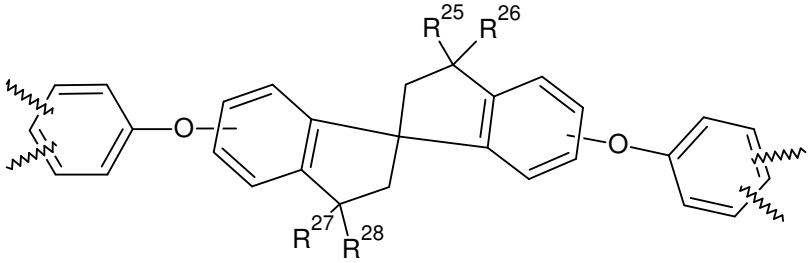

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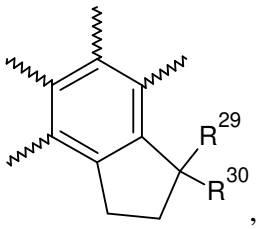
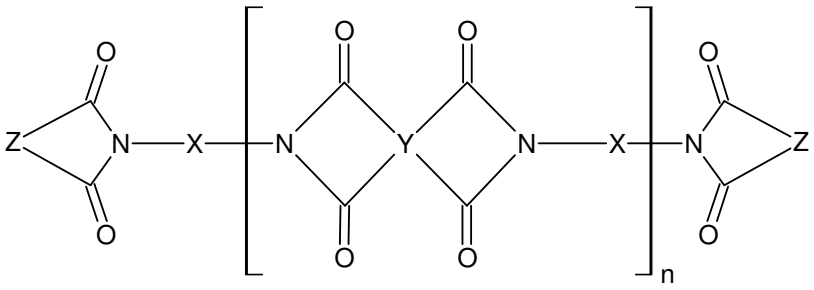


, in which each of R^{11}-R^{30}, independently, is H or a substituted or unsubstituted C_1-C_{10} linear or branched alkyl group.

3. The polymer of claim 2, wherein each of R^{11}-R^{30}, independently, is H or CH_3.

4. The polymer of claim 1, further comprising a second repeat unit different from the first repeat unit.

5. The polymer of claim 1, wherein the polymer is of structure I:



in which Z is a divalent organic group capable of undergoing a cycloreversion reaction, n is an integer greater than 5, each X, independently, is a divalent organic group, each Y, independently, is a tetravalent organic group, and at least one of X and Y comprises an indane-containing moiety.

6. The polymer of claim 1, wherein the polymer has a molecular weight of at least 1,000 g/mol.

7. A thermosetting composition, comprising:

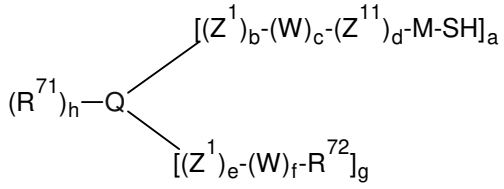
the polymer of claim 1;

at least one multifunctional thiol compound, the thiol compound comprising at least two thiol groups;

at least one solvent; and

optionally, at least one non-nucleophilic basic additive.

8. The composition of claim 7, wherein the multifunctional thiol compound is of structure (VI):



(VI),

in which

a is an integer ranging from 2 to 10;

c is an integer ranging from 1 to 10;

each of b, d, and e, independently, is an integer ranging from 0 to 1;

each of f, g, and h, independently, is an integer ranging from 0 to 10;

Q is a multivalent organic nucleus;

each of Z^1, W, and Z^{11}, independently, is a divalent linking group;

each of R^{71} and R^{72}, independently, is H, a substituted or unsubstituted, linear or branched C_1-C_6 alkyl group, or a substituted or unsubstituted C_3-C_{10} cycloaliphatic group; and

M is a substituted or unsubstituted C_1-C_6 linear or branched aliphatic group, a substituted or unsubstituted C_3-C_{10} cycloaliphatic group, or a substituted or unsubstituted C_6-C_{18} mononuclear or polynuclear aromatic group.

9. The composition of claim 8, further comprising the at least one non-nucleophilic basic additive.

10. The composition of claim 9, wherein the non-nucleophilic basic additive is a nitrogen-containing compound or a phosphorus-containing compound.

11. The composition of claim 7, wherein the polymer is from about 1 wt% to about 50 wt% of the composition.

12. The composition of claim 7, wherein the multifunctional thiol compound is from about 0.2 wt% to about 30 wt% of the composition.

13. The composition of claim 7, wherein the solvent is at least about 40 wt% of the composition.

14. A manufacturing process for producing a thermoset coating, comprising:

coating a substrate with the thermosetting composition of claim 7 to form a coated substrate, and

baking the coated substrate to cure the thermosetting composition, thereby forming a thermoset coating on the substrate.

15. The process of claim 14, wherein coating the substrate comprises applying the thermosetting composition on the substrate by ink jet printing, spin coating, spray coating, dip coating, roller coating, or dynamic surface tension coating.

16. A device, comprising a coated substrate prepared by the manufacturing process of claim 14.

17. A manufacturing process for producing a free-standing film, comprising:

coating a substrate with the thermosetting composition of claim 7 to form a film coated substrate,

baking the film coated substrate to remove at least a portion of the at least one solvent, and

releasing the film coating from the substrate to obtain a free-standing film.

18. A free-standing film obtained by the manufacturing process of claim 17.

19. A polymer, comprising the condensation product of:

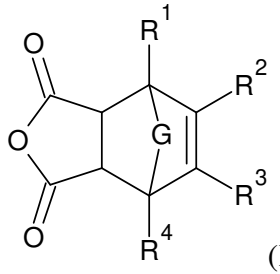
(a) at least one diamine;

(b) at least one dianhydride; and

(c) at least one monoanhydride comprising a masked maleic anhydride group;

wherein at least one of components (a) and (b) comprises an indane-containing moiety, the polymer comprises at least one end-cap group at one end, and the end-cap group comprises the masked maleic anhydride group and is capable of undergoing a cycloreversion reaction at a temperature of at most 250°C in the solid state;

wherein the monoanhydride comprising the masked maleic anhydride is of structure (IX):



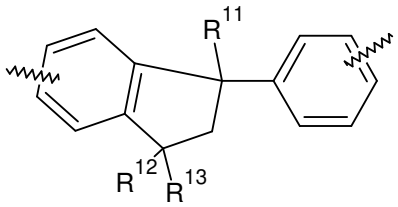
(IX),

in which

G is -O-, -(NR^{100})-, -[$C(R^{101})=C(R^{102})$]-, or -[$C=C(R^{103})_2$]-, where each of R^{100}, R^{101}, R^{102}, and R^{103}, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, or an unsubstituted phenyl group, and

each of R^1, R^2, R^3 and R^4, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, an unsubstituted phenyl group, OR^{104}, CH_2OR^{105}, $CH_2OC(=O)R^{106}$, $CH_2C(=O)OR^{107}$, CH_2NHR^{108}, $CH_2NHC(=O)R^{109}$, $CH_2C(=O)N(R^{110})_2$, $C(=O)OR^{111}$, where each of R^{104}, R^{105}, R^{106}, R^{107}, R^{108}, R^{109}, R^{110}, and R^{111}, independently, is H or an unsubstituted C_1-C_6 linear, branched, or monocyclic alkyl group.

20. The polymer of claim 19, wherein the indane-containing moiety comprises



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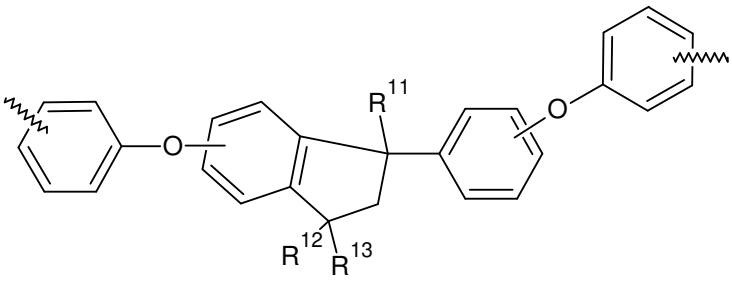

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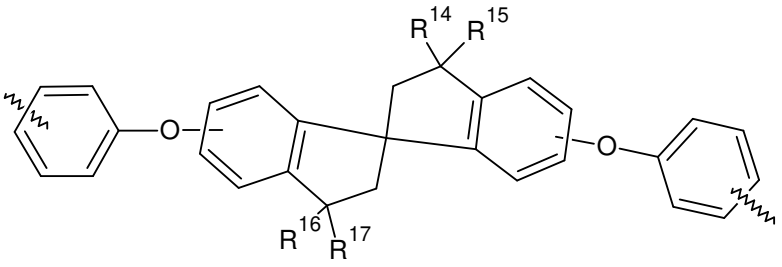

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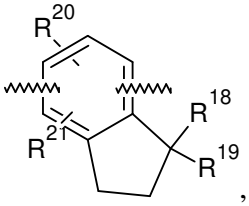

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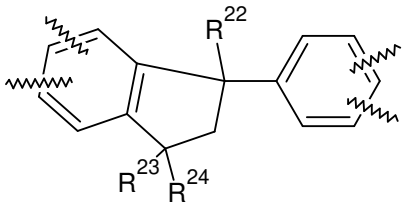

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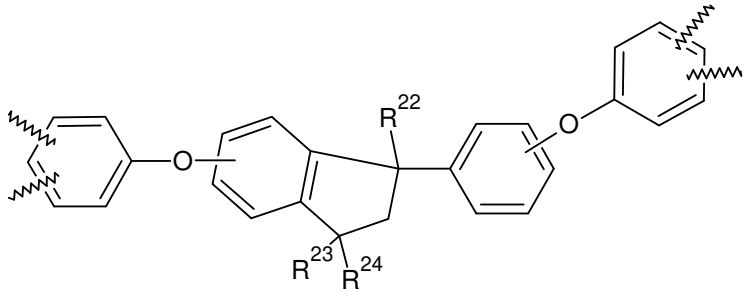

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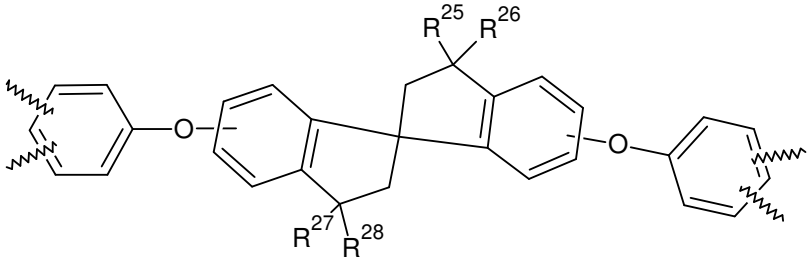
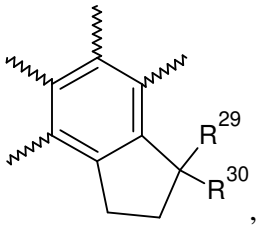


, or 

, in which each of R^{11}-R^{30}, independently, is H or a substituted or unsubstituted C_1-C_{10} linear or branched alkyl group.

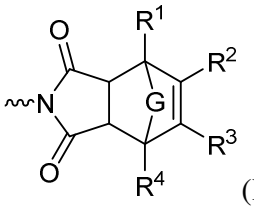
21. The polymer of claim 20, wherein each of R^{11}-R^{30}, independently, is H or CH_3.

22. The polymer of claim 19, wherein the component comprising the indane-containing moiety is at least about 25 mole% of components (a) and (b).

23. A polymer, comprising:

a first repeat unit, the first repeat unit comprising at least one imide moiety and at least one indane-containing moiety; and

at least one end-cap group at one end of the polymer, the end-cap comprises a moiety of structure (IXa):



(IXa),

in which

G is -O-, -(NR^{100})-, -[$C(R^{101})$=$C(R^{102})$]-, or -[C=$C(R^{103})_2$]-, where each of R^{100}, R^{101}, R^{102}, and R^{103}, independently, is H, a substituted or unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, or a substituted or unsubstituted phenyl group, and

each of R^1, R^2, R^3 and R^4, independently, is H, a substituted or unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, a substituted or unsubstituted phenyl group, OR^{104}, CH_2OR^{105}, $CH_2OC(=O)R^{106}$, $CH_2C(=O)OR^{107}$, CH_2NHR^{108}, $CH_2NHC(=O)R^{109}$, $CH_2C(=O)N(R^{110})_2$, $C(=O)OR^{111}$, where each of R^{104}, R^{105}, R^{106}, R^{107}, R^{108}, R^{109}, R^{110}, and R^{111},

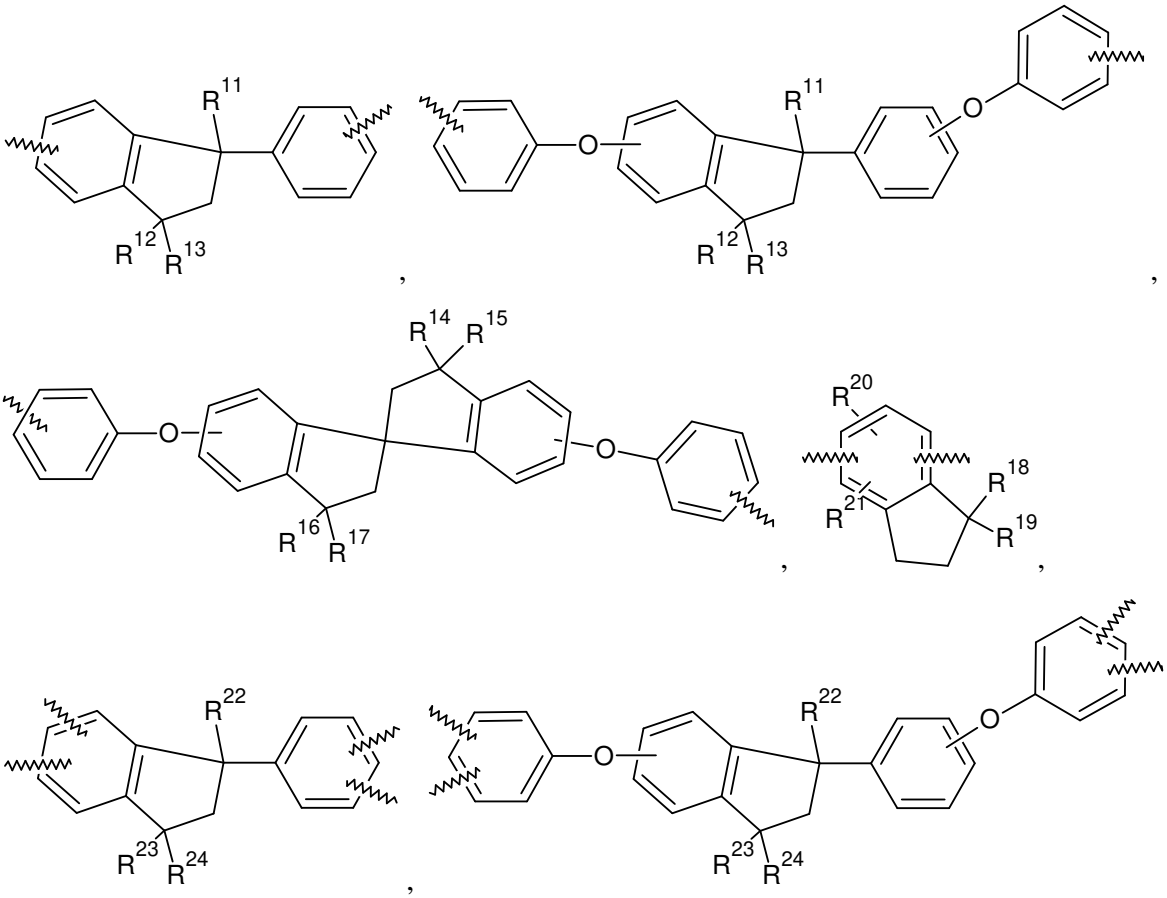
independently, is H or a substituted or unsubstituted C_1-C_6 linear, branched, or monocyclic alkyl group.

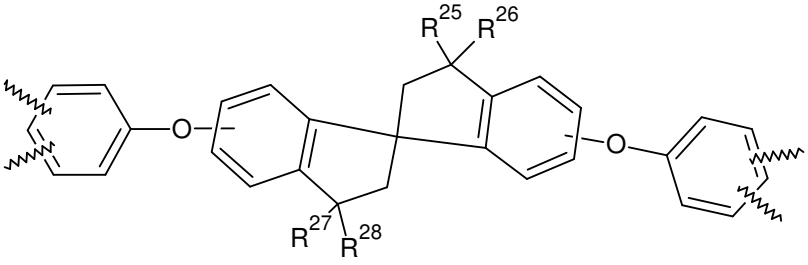
24. The polymer of claim 23, wherein

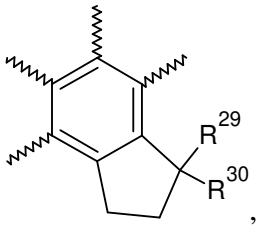
G is -O-, -(NR^{100})-, -[$C(R^{101})=C(R^{102})$]-, or -[$C=C(R^{103})_2$]-, where each of R^{100}, R^{101}, R^{102}, and R^{103}, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, or an unsubstituted phenyl group, and

each of R^1, R^2, R^3 and R^4, independently, is H, an unsubstituted C_1-C_{12} linear, branched, monocyclic or polycyclic alkyl group, an unsubstituted phenyl group, OR^{104}, CH_2OR^{105}, $CH_2OC(=O)R^{106}$, $CH_2C(=O)OR^{107}$, CH_2NHR^{108}, $CH_2NHC(=O)R^{109}$, $CH_2C(=O)N(R^{110})_2$, $C(=O)OR^{111}$, where each of R^{104}, R^{105}, R^{106}, R^{107}, R^{108}, R^{109}, R^{110}, and R^{111}, independently, is H or an unsubstituted C_1-C_6 linear, branched, or monocyclic alkyl group.

25. The polymer of claim 23, wherein the indane-containing moiety comprises





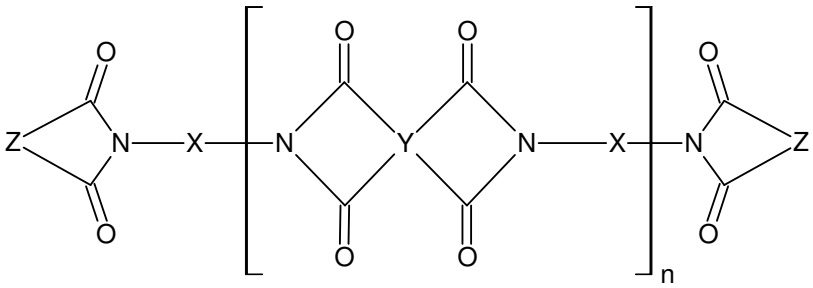
, or 

, in which each of R^{11}-R^{30}, independently, is H or a substituted or unsubstituted C_1-C_{10} linear or branched alkyl group.

26. The polymer of claim 25, wherein each of R^{11}-R^{30}, independently, is H or CH_3.

27. The polymer of claim 23, further comprising a second repeat unit different from the first repeat unit.

28. The polymer of claim 23, wherein the polymer is of structure I:



in which Z is a divalent organic group capable of undergoing a cycloreversion reaction, n is an integer greater than 5, each X, independently, is a divalent organic group, each Y, independently, is a tetravalent organic group, and at least one of X and Y comprises an indane-containing moiety.

29. The polymer of claim 23, wherein the polymer has a molecular weight of at least 1,000 g/mol.

30. A thermosetting composition, comprising:

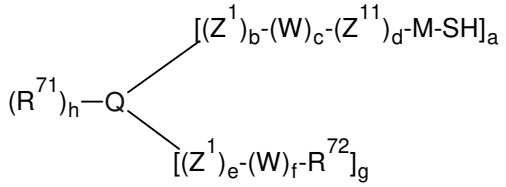
the polymer of claim 23;

at least one multifunctional thiol compound, the thiol compound comprising at least two thiol groups;

at least one solvent; and

optionally, at least one non-nucleophilic basic additive.

31. The composition of claim 30, wherein the multifunctional thiol compound is of structure (VI):



(VI),

in which

a is an integer ranging from 2 to 10;

c is an integer ranging from 1 to 10;

each of b, d, and e, independently, is an integer ranging from 0 to 1;

each of f, g, and h, independently, is an integer ranging from 0 to 10;

Q is a multivalent organic nucleus;

each of Z^1, W, and Z^{11}, independently, is a divalent linking group;

each of R^{71} and R^{72}, independently, is H, a substituted or unsubstituted, linear or branched C_1-C_6 alkyl group, or a substituted or unsubstituted C_3-C_{10} cycloaliphatic group; and

M is a substituted or unsubstituted C_1-C_6 linear or branched aliphatic group, a substituted or unsubstituted C_3-C_{10} cycloaliphatic group, or a substituted or unsubstituted C_6-C_{18} mononuclear or polynuclear aromatic group.

32. The composition of claim 31, further comprising the at least one non-nucleophilic basic additive.

33. The composition of claim 32, wherein the non-nucleophilic basic additive is a nitrogen-containing compound or a phosphorus-containing compound.

34. The composition of claim 30, wherein the polymer is from about 1 wt% to about 50 wt% of the composition.

35. The composition of claim 30, wherein the multifunctional thiol compound is from about 0.2 wt% to about 30 wt% of the composition.

36. The composition of claim 30, wherein the solvent is at least about 40 wt% of the composition.

37. A manufacturing process for producing a thermoset coating, comprising:

coating a substrate with the thermosetting composition of claim 30 to form a coated substrate, and

baking the coated substrate to cure the thermosetting composition, thereby forming a thermoset coating on the substrate.

38. The process of claim 37, wherein coating the substrate comprises applying the thermosetting composition on the substrate by ink jet printing, spin coating, spray coating, dip coating, roller coating, or dynamic surface tension coating.

39. A manufacturing process for producing a free-standing film, comprising:

coating a substrate with the thermosetting composition of claim 30 to form a film coated substrate,

baking the film coated substrate to remove at least a portion of the at least one solvent, and

releasing the film coating from the substrate to obtain a free-standing film.