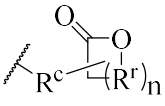
What is claimed is:

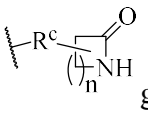
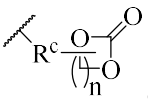
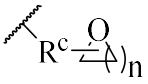
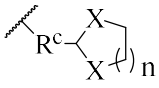
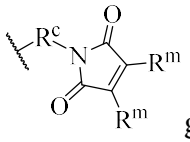
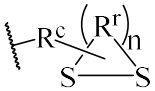
1. A tin cluster of the formula:

$[(R^{a1}Sn)(R^{a2}Sn)(R^{a3}Sn)(R^{a4}Sn)(R^{a5}Sn)(R^{a6}Sn)]O_6[(O_2C\text{-}R^{b1})(O_2C\text{-}R^{b2})(O_2C\text{-}R^{b3})(O_2C\text{-}R^{b4})(O_2C\text{-}R^{b5})(O_2C\text{-}R^{b6})]$

wherein

(A) each of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} is individually selected from the group consisting of an unsubstituted linear C_1-C_{10} alkyl group, a linear C_1-C_6 alkyl group substituted with a halogen, a linear C_1-C_6 alkyl group substituted with an amino group, a linear C_1-C_6 alkyl group substituted with a C_5–C_6 unsubstituted aromatic group, an unsubstituted branched C_3-C_{10} alkyl group, a branched C_3-C_{10} alkyl group substituted with a halogen, a C_1-C_{10} heteroalkyl group, a branched C_3-C_{10} alkyl group substituted with an amino group, an unsubstituted amine, a substituted amine, -Si$(CH_3)_3$, a benzyl group, a C_3-C_8 unsubstituted cyclic alkyl group, a C_3-C_8 cyclic alkyl group substituted with a halogen, a C_3-C_8 cyclic alkyl group substituted with an amino group, a C_4-C_8 unsubstituted aromatic group, a C_4-C_8 aromatic group substituted with a halogen, a C_4-C_8 aromatic group substituted with an amino group, a C_3-C_{10} heterocyclic group, an unsubstituted linear C_2-C_{10} alkenyl group, an unsubstituted branched C_3-C_{10} alkenyl group, an unsubstituted linear C_2-C_{10} alkynyl group and an unsubstituted branched C_4-C_{10} alkynyl group;

(B) each of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} is individually selected from the group consisting of H; an unsubstituted linear C_1-C_{10} alkyl group; a substituted linear C_1-C_{10} alkyl group substituted with one or more of a -CN group, an -OH group, an -OR' group, an -SR' or an -S-S-R' group where R' is a linear or branched C_1-C_4 alkyl group, a -C(=O)OR'' group where R'' is a linear or branched C_1-C_4 alkyl group, an -NO_2 group, a halogen or a -C(=O)H group; an unsubstituted branched C_3-C_{10} alkyl group; a substituted branched C_3-C_{10} alkyl group substituted with one or more of a -CN group, an -OH group, a -OR' group, an -SR' or an -S-S-R' group where R' is a linear or branched C_1-C_4 alkyl group, a -C(=O)OR'' group where R'' is a linear or branched C_1-C_4 alkyl unit, a -NO_2 group, a halogen or a -C(=O)H group; a C_3-C_8 unsubstituted cyclic alkyl group; a linear C_2-C_{10} alkenyl group; a branched C_3-C_{10} alkenyl group, a 5-membered heterocyclic ring; and a 6-membered heterocyclic ring; a  group where (i) n = 1-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl

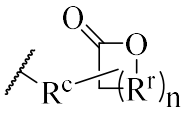
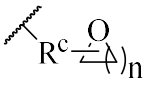
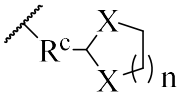
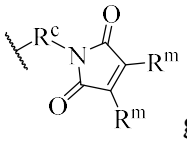
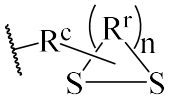
groups; a  group where n = 1-4, a  group where n = 1-4; a  group where n = 1-6; a  group where each X is individually selected from O and S and n = 1-4; a  group where each R^m group is independently selected from H, a linear C_1-C_4 chain or a branched C_3-C_4 chain; a  group where (i) n = 3-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; where R^c in each of the forgoing groups is (i) a direct covalent bond or (ii) an unsubstituted linear C_1-C_6 alkylene group, an unsubstituted branched C_3-C_6 alkylene group; and

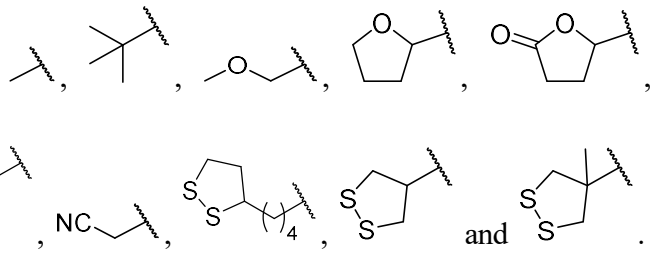
(C) **(i)** at least one of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} is different from the remainder of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} and/or **(ii)** at least one of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} is different from the remainder of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6}.

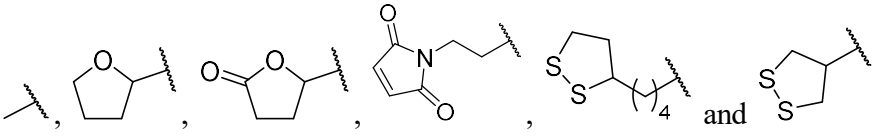
2. The tin cluster of claim 1, wherein **(A)** each of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} is individually selected from the group consisting of an unsubstituted linear C_1-C_4 alkyl group, an unsubstituted branched C_3-C_4 alkyl group, a C_2-C_6 alkenyl group and a C_4-C_6 unsubstituted aromatic group.

3. The tin cluster of claim 1, wherein **(A)** each of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} is individually selected from the group consisting of a $-CH_3$ group, a $-CH(CH_3)_2$ group, a $-C(CH_3)_3$ group, a $-CH{=}CH_2$ group, a $-CH_2CH{=}CH_2$ group, a $-CH_2CH_2CH{=}CH_2$ group, a $-CH_2CH_2CH_2CH_3$ group, a $-C_6H_5$ group and a $-CH_2-C_6H_5$ group.

4. The tin cluster of claim 1, wherein **(B)** each of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} is individually selected from the group consisting of -H; an unsubstituted linear C_1-C_6 alkyl group; a substituted linear C_1-C_6 alkyl group substituted with one or more of a -CN group, or an -OR' group where R' is a linear or branched C_1-C_4 alkyl group; an unsubstituted branched C_3-C_6 alkyl group; a substituted branched C_3-C_6 alkyl group substituted with one or more of a -CN group, or a -OR' group where R' is a linear

or branched C_1-C_4 alkyl group; a  group where (i) n = 1-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; a  group where n = 1-6; a  group where each X is individually selected from O and S and n = 1-4; a  group where each R^m group is independently selected from H, or a linear C_1-C_4 chain, or a branched C_3-C_4 chain; a  group where (i) n = 3-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; where R^c in each of the forgoing groups is (i) a direct covalent bond or (ii) an unsubstituted linear C_1-C_6 alkylene group, an unsubstituted branched C_3-C_6 alkylene group.

5. The tin cluster of claim 1, wherein **(B)** each of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} is individually selected from the group consisting of -H, , and .

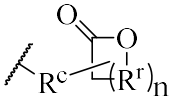
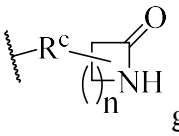
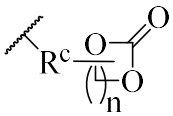
6. The tin cluster of claim 1, wherein **(A)** each of R^{a1}, R^{a2}, R^{a3}, R^{a4}, R^{a5} and R^{a6} is individually selected from the group consisting of -CH_3 group, a -$CH(CH_3)_2$ group, a -$CH{=}CH_2$ group, and a -$CH_2CH_2CH_2CH_3$ group and **(B)** each of R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} is individually selected from the group consisting of -H, , and .

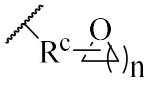
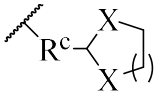
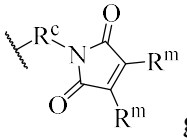
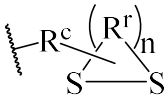
7. A tin cluster of the formula:

$$[(R^{a(i)}Sn)_{6-x}(R^{a(ii)}Sn)_x]O_6[(O_2C\text{-}R^{b(i)})_{6-y}(O_2C\text{-}R^{b(ii)})_y]$$

wherein

(A) **(i)** $R^{a(i)} \neq R^{a(ii)}$ and **(ii)** $R^{a(i)}$ and $R^{a(ii)}$ are each individually selected from the group consisting of an unsubstituted linear C_1-C_{10} alkyl group, a linear C_1-C_6 alkyl group substituted with a halogen, a linear C_1-C_6 alkyl group substituted with an amino group, a linear C_1-C_6 alkyl group substituted with a C_5–C_6 unsubstituted aromatic group, an unsubstituted branched C_3-C_{10} alkyl group, a branched C_3-C_{10} alkyl group substituted with a halogen, a C_1-C_{10} heteroalkyl group, a branched C_3-C_{10} alkyl group substituted with an amino group, an unsubstituted amine, a substituted amine, -$Si(CH_3)_3$, a benzyl group, a C_3-C_8 unsubstituted cyclic alkyl group, a C_3-C_8 cyclic alkyl group substituted with a halogen, a C_3-C_8 cyclic alkyl group substituted with an amino group, a C_4-C_8 unsubstituted aromatic group, a C_4-C_8 aromatic group substituted with a halogen, a C_4-C_8 aromatic group substituted with an amino group, a C_3-C_{10} heterocyclic group, an unsubstituted linear C_2-C_{10} alkenyl group, an unsubstituted branched C_3-C_{10} alkenyl group, an unsubstituted linear C_2-C_{10} alkynyl group and an unsubstituted branched C_4-C_{10} alkynyl group;

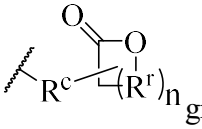
(B) **(i)** $R^{b(i)} \neq R^{b(ii)}$ and **(ii)** $R^{b(i)}$ and $R^{b(ii)}$ are each individually selected from the group consisting of H; an unsubstituted linear C_1-C_{10} alkyl group; a substituted linear C_1-C_{10} alkyl group substituted with one or more of a -CN group, an -OH group, an -OR' group, an -SR' or an -S-S-R' group where R' is a linear or branched C_1-C_4 alkyl group, a -C(=O)OR'' group where R'' is a linear or branched C_1-C_4 alkyl group, an -NO_2 group, a halogen or a -C(=O)H group; an unsubstituted branched C_3-C_{10} alkyl group; a substituted branched C_3-C_{10} alkyl group substituted with one or more of a -CN group, an -OH group, a -OR' group, an -SR' or an -S-S-R' group where R' is a linear or branched C_1-C_4 alkyl group, a -C(=O)OR'' group where R'' is a linear or branched C_1-C_4 alkyl unit, a -NO_2 group, a halogen or a -C(=O)H group; a C_3-C_8 unsubstituted cyclic alkyl group; a linear C_2-C_{10} alkenyl group; a branched C_3-C_{10} alkenyl group, a 5-membered heterocyclic ring; and a 6-membered heterocyclic ring; a  group where (i) n = 1-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; a  group where n = 1-4, a  group where n = 1-4; a

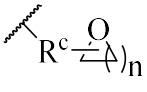
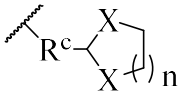
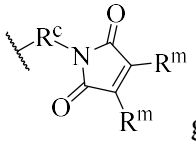
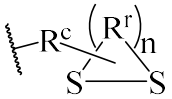
 group where n = 1-6; a  group where each X is individually selected from O and S and n = 1-4; a  group where each R^m group is independently selected from H, or a linear C_1-C_4 chain, or a branched C_3-C_4 chain; a  group where (i) n = 3-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; where R^c in each of the forgoing groups is (i) a direct covalent bond or (ii) an unsubstituted linear C_1-C_6 alkylene group, an unsubstituted branched C_3-C_6 alkylene group; and

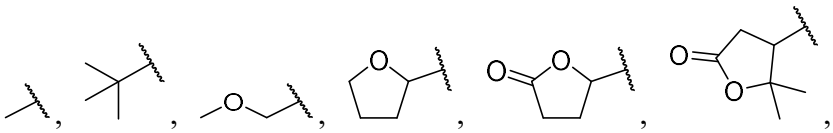
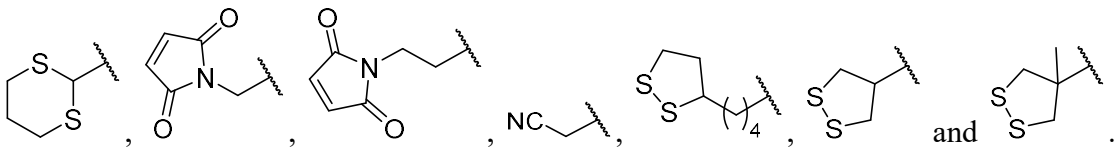
(C) **(i)** x and y each independently equal a whole number of 1 to 5 or **(ii)** one of x or y = 0 and the other of x or y = a whole number of 1 to 5.

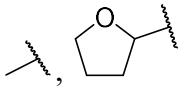
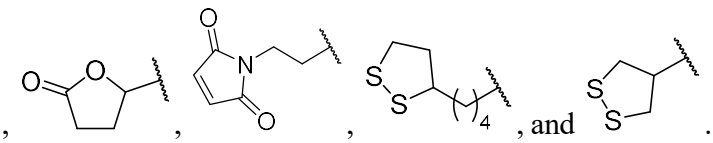
8. The tin cluster of claim 7, wherein **(A)** each of $R^{a(i)}$ and $R^{a(ii)}$ is individually selected from the group consisting of an unsubstituted linear C_1-C_4 alkyl group, an unsubstituted branched C_3-C_4 alkyl group, an unsubstituted linear C_2-C_6 alkenyl group, an unsubstituted branched C_3-C_6 alkenyl group and a C_4-C_6 unsubstituted aromatic group.

9. The tin cluster of claim 7, wherein **(A)** each of $R^{a(i)}$ and $R^{a(ii)}$ is individually selected from the group consisting of a $-CH_3$ group, a $-CH(CH_3)_2$ group, a $-C(CH_3)_3$ group, a $-CH=CH_2$ group, a $-CH_2CH=CH_2$ group, a $-CH_2CH_2CH=CH_2$ group, a $-CH_2CH_2CH_2CH_3$ group, a $-C_6H_5$ group and a $-CH_2-C_6H_5$ group.

10. The tin cluster of claim 7, wherein **(B)** each of $R^{b(i)}$ and $R^{b(ii)}$ is individually selected from the group consisting of -H; an unsubstituted linear C_1-C_6 alkyl group; a substituted linear C_1-C_6 alkyl group substituted with one or more of a -CN group, or an -OR' group where R' is a linear or branched C_1-C_4 alkyl group; an unsubstituted branched C_3-C_6 alkyl group; a substituted branched C_3-C_6 alkyl group substituted with one or more of a -CN group, or a -OR' group where R' is a linear or branched C_1-C_4 alkyl group; a  group where (i) n = 1-5 and (ii) each R^r is individually an

unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; a  group where n = 1-6; a  group where each X is individually selected from O and S and n = 1-4; a  group where each R^m group is independently selected from H, or a linear C_1-C_4 chain, or a branched C_3-C_4 chain; a  group where (i) n = 3-5 and (ii) each R^r is individually an unsubstituted methylene group or a methylene group substituted with one or two C_1-C_4 alkyl groups; where R^c in each of the forgoing groups is (i) a direct covalent bond or (ii) an unsubstituted linear C_1-C_6 alkylene group, an unsubstituted branched C_3-C_6 alkylene group.

11. The tin cluster of claim 7, wherein **(B)** each of $R^{b(i)}$ and $R^{b(ii)}$ is individually selected from the group consisting of -H, ,  and .

12. The tin cluster of claim 7, wherein **(A)** each of $R^{a(i)}$ and $R^{a(ii)}$ is individually selected from the group consisting of -CH_3 group, a -$CH(CH_3)_2$ group, a -$CH{=}CH_2$ group, and a -$CH_2CH_2CH_2CH_3$ group and **(B)** each of $R^{b(i)}$ and $R^{b(ii)}$ is individually selected from the group consisting of -H, , , and .

13. A mixture of tin clusters comprising more than one tin cluster of claim 1.

14. A mixture of tin clusters comprising more than one tin cluster of Table 1 according to

claim 7.

15. A spin-coatable formulation comprising:

(i) one or more of the Sn6-oxo clusters of claim 1; and

(ii) one or more solvents suitable for use in a spin-coating process.

16. A spin-coatable formulation comprising:

(i) one or more of the Sn6-oxo clusters of claim 15; and

(ii) one or more solvents suitable for use in a spin-coating process.