CLAIMS

1. A method for preparing a transition-metal adamantane carboxylate salt, the method comprising:

mixing a transition-metal hydroxide and a diamondoid compound having at least one carboxylic acid moiety to form a reactant mixture, where M is a transition metal and the transition metal hydroxide has the formula $M(OH)_2$, and the diamondoid compound is 1-adamantane carboxylic acid,

where the transition-metal hydroxide and the 1-adamantane carboxylic acid are mixed in amounts that provide a ratio of M^{2+} to 1-adamantane carboxylic acid of from 0.5:1 to 1.0:1; and

hydrothermally treating the reactant mixture at a reaction temperature of from 100°C to 200°C for a reaction time of at least 12 hours to form the transition-metal adamantane carboxylate salt.

2. The method of claim 1, wherein in the transition metal hydroxide that has the formula $M(OH)_2$, M is chosen from Co, Cu, and Ni.

3. The method of claim 1 or 2, wherein the transition-metal hydroxide is $Co(OH)_2$ and the reaction temperature is 110 °C.

4. The method of claim 1 or 2, wherein the transition-metal hydroxide is $Ni(OH)_2$ and the reaction temperature is 150 °C.

5. The method of claim 1 or 2, wherein the transition-metal hydroxide is $Cu(OH)_2$ and the reaction temperature is 110 °C.

6. The method of any of claims 1-5, wherein the reaction temperature is from 100°C to 180°C

7. A method for preparing a nanocomposite, the method comprising:

thermally decomposing a transition-metal adamantane carboxylate salt to form the nanocomposite by heating the transition-metal adamantane

carboxylate salt in air at a decomposition temperature of greater than 200°C for a decomposition time of at least 1 hour;

the transition-metal adamantane carboxylate salt prepared by:

mixing a transition-metal hydroxide and a diamondoid compound having at least one carboxylic acid moiety to form a reaction mixture, where M is a transition metal and the transition metal hydroxide has the formula $M(OH)_2$, and the diamondoid compound is 1-adamantane carboxylic acid,

where the transition-metal hydroxide and the 1-adamantane carboxylic acid are mixed in amounts that provide a ratio of M^{2+} to 1-adamantane carboxylic acid of from 0.5:1 to 1.0:1; and

hydrothermally treating the reactant mixture at a reaction temperature of from 100°C to 200°C for a reaction time of at least 12 hours to form the transition-metal adamantane carboxylate salt.

8. The method of claim 7, wherein the decomposition temperature is at least 450°C.

9. The method of claim 7 or 8, wherein the nanocomposite comprises transition-metal oxide particles dispersed on a carbon support.

10. The method of any of claims 7-9, wherein the nanocomposite comprises from 70 wt.% to 80 wt.% metal oxide and from 20 wt.% to 30 wt.% carbon, based on the total weight of the nanocomposite.

11. The method of any of claims 7-10, wherein the transition-metal adamantane carboxylate salt comprises Co-AC and the nanocomposite comprises a microporous matrix and crystallites of cobalt oxide.

12. The method of any of claims 7-10, wherein the transition-metal adamantane carboxylate salt comprises Ni-AC and the nanocomposite comprises crystallites of NiO configured as porous nanowhiskers.

13. The method of any of claims 7-10, wherein the transition-metal adamantane carboxylate salt comprises Cu-AC and the nanocomposite comprises carbon sheets and nanoparticles of copper oxide supported on carbon sheets.

14. The method of claim 13, wherein the copper oxide comprises CuO, Cu_2O, or a mixture of CuO and Cu_2O.

15. A catalyst system comprising:

(a) a transition-metal adamantane carboxylate salt prepared by:

mixing a transition-metal hydroxide and a diamondoid compound having at least one carboxylic acid moiety to form a reaction mixture, where M is a transition metal and the transition metal hydroxide has the formula $M(OH)_2$, and the diamondoid compound is 1-adamantane carboxylic acid,

where the transition-metal hydroxide and the 1-adamantane carboxylic acid are mixed in amounts that provide a ratio of M^{2+} to 1-adamantane carboxylic acid of from 0.5:1 to 1.0:1; and

hydrothermally treating the reactant mixture at a reaction temperature of from 100°C to 200°C for a reaction time of at least 12 hours to form the transition-metal adamantane carboxylate salt;

(b) a nanocomposite prepared by:

thermally decomposing the transition-metal adamantane carboxylate of (a) to form the nanocomposite by heating the transition-metal adamantane carboxylate salt in air at a decomposition temperature of greater than 200°C for a decomposition time of at least 1 hour; or

(c) a mixture of (a) and (b).