wherein the metal particles are disposed within the pores of the porous silica particle.

In another aspect, there is provided a method of preparing a composite material comprising a mixture of a plurality of metal particles and a porous silica particle material, comprising the steps of:

a) dissolving a surfactant in water, followed by mixing surfactant solution with a base and an alkyl ester, wherein the resulting solution is stirred at a suitable temperature;

b) adding a solution of silicate precursor into the solution of step a), wherein the resulting mixture is stirred at a suitable temperature to thereby form a suspension of silica particle;

c) immersing a purified and air-dried silica particle having a porous structure into a solution of metal ions to allow the metal ions to impregnate into the pores of the silica particle, wherein the resulting suspension is stirred for a period of time;

d) adding a solution of a reducing agent into the suspension of step c) to form a solution of impregnated silica particle; and

e) purifying and drying the solution of impregnated silica particle under inert gas flow to thereby form said composite material;

wherein said composite material is a nanostructured composite material having a cavity in the range of 40 nm to 80 nm.

Advantageously, the composite material may be obtained in a facile method via a one-step emulsion preparation method under mild condition. Accordingly, such process may require a simple production setup and therefore may be regarded as low cost process.

Claims

1. A composite material comprising a mixture of a plurality of metal particles and a porous silica particle, wherein said plurality of metal particles is disposed within the pores of said porous silica particle, wherein said composite material is a nanostructured composite material having a cavity in the range of 40 nm to 80 nm.

2. The composite material according to claim 1, wherein said porous silica particle comprises a nanosized channel.

3. The composite material according to claim 1 or 2, wherein said metal particle is a metal nanoparticle.

4. The composite material according to claim 3, wherein the metal of said metal nanoparticle is selected from Group 8 of the Periodic Table.

5. The composite material according to any one of claims 1 to 4, wherein the particle size of the metal particle is in the range of 1 nm to 50 nm.

6. The composite material according to any one of claims 1 to 5, wherein said porous silica particle is a porous silica nanoparticle.

7. The composite material according to claim 6, wherein the particle size of said porous silica nanoparticle is in the range of 20 nm to 1000 nm.

8. The composite material according to claim 6 or 7, wherein said porous silica nanoparticle is selected from the group consisting of tetraethyl orthosilicate (TEOS), tetramethyl orthosilicate, tetrapropyl orthosilicate tetrabutyl orthosilicate and tetraisopropyl orthosilicate.

9. The composite material according to claim 1, wherein said nanostructured composite material having a cavity in the centre has an oxygen scavenging performance in the range of 190 cm^3/g to 210 cm^3/g of metal.

10. A method of preparing a composite material comprising a mixture of a plurality of metal particles and a porous silica particle material, comprising the steps of:

a) dissolving a surfactant in water, followed by mixing surfactant solution with a base and an alkyl ester, wherein the resulting solution is stirred at a suitable temperature;
b) adding a solution of silicate precursor into the solution of step a), wherein the resulting mixture is stirred at a suitable temperature to thereby form a suspension of silica particle;
c) immersing a purified and air-dried silica particle having a porous structure into a solution of metal ions to allow the metal ions to impregnate into the pores of the silica particle, wherein the resulting suspension is stirred for a period of time;
d) adding a solution of a reducing agent into the suspension of step c) to form a solution of impregnated silica particle; and
e) purifying and drying the solution of impregnated silica particle under inert gas flow to thereby form said composite material;

wherein said composite material is a nanostructured composite material having a cavity in the range of 40 nm to 80 nm.

11. The method according to claim 10, wherein said metal ions are iron ions derived from the iron salt selected from the group consisting of iron chloride, iron bromide, iron fluoride, iron iodide, iron sulfate, iron nitrate, iron oxalate, iron gluconate, iron acetylacetonate, iron fumarate and iron phosphate.

12. The method according to claim 10 or 11, wherein said reducing agent is selected from the group consisting of sodium borohydride, lithium aluminum hydride, diisobutylaluminium hydride (DIBAL-H) and sodium cyanoborohydride.

13. A composition comprising:

a) a composite material comprising a mixture of a plurality of metal particles and a porous silica particle material, wherein said plurality of metal particles is disposed within the pores of said porous silica particle, wherein said composite material is a nanostructured composite material having a cavity in the range of 40 nm to 80 nm; and
b) a polymeric matrix.

14. The composition according to claim 13, wherein said polymeric matrix is selected from the group consisting of montmorillonite, bentonite, laponite, kaolinite, saponite, vermiculite and mixtures thereof.

15. A method of preparing a composition comprising:

a) a composite material comprising a mixture of a plurality of metal particles and a porous silica particle material; and
b) a polymeric matrix,

wherein said plurality of metal particles is disposed within the pores of said porous silica particle, wherein said composite material is a nanostructured composite material having a cavity in the range of 40 nm to 80 nm, and

wherein said method comprises the steps of dispersing said composite material in a solution of alkyl alcohol and adding an amount of polymeric matrix.

16. An article containing a composition comprising a composite material and a polymeric matrix according to claim 13.

17. The article according to claim 16, wherein said article is a transparent coated film.

18. Use of an article according to claim 16 or 17 as a packaging film for food packaging having improved oxygen barrier.