salt to surfactants, pH, etc. Also, high temperature and high pressure conditions are commonly necessary. Additionally, the difficult separation of nanoparticles from solution can be only performed by high speed centrifuge, and hence use of a reaction volume-limited autoclave is required. Therefore, a process for high quality and scalable synthesis of core/shell composites are still a big challenge.

[0008] There is therefore a need for an improved process for manufacturing composites comprising metal or metal oxide particles embedded in porous ceramic materials. Such a process would preferably be inexpensive, readily scalable and use moderate temperatures and pressures.

Summary ~~of Invention~~

[0009] According to a first aspect of the present ~~invention~~disclosure, there is provided a process for preparing a composite substance comprising particles of an oxide of a metal dispersed in a porous silica matrix, said process comprising:

a) Preparing a solution comprising a soluble salt of the metal, and a surfactant;
b) Adjusting the solution to a basic pH at which a hydroxide of the metal precipitates from the solution;
c) Preparing an aqueous suspension of the hydroxide of the metal, said suspension being at pH greater than 7, optionally greater than 10;
d) Adding to the suspension, with agitation (such as stirring), an alkoxysilane, so as to form composites comprising the hydroxide of the metal at least partially, optionally completely, coated with silica; and
e) Calcining the composites obtained in step d) so as to produce the composite substance.

[00010] The following options may be used in conjunction with the first aspect either individually or in any suitable combination.

[00011] The metal may be a transition metal. It may be a precious metal. It may be a rare earth metal. It may be selected from the group consisting of Mg, Ca, Sr, Ba, Sc, Y, Ti, Zr, V, Nb, Ta, Cr, Mo, W, Mn, Re, Fe, Ru, Os, Co, Rh, Ir, Ni,Pd, Pt, Cu, Ag, Au, Zn, Cd, Ga, In, Tl, Sn, Pb, Sb, Bi, La, Ce and Gd. Mixtures of any two or more of these may also be used. In some

alcoholic solution at a rate of about 1 to about 100 micromol/second, so as to form composites comprising the hydroxide of the metal at least partially, optionally completely, coated with silica, and stirring the suspension following addition of the alkoxysilane for at least about 10 hours;

e) Calcining the composites obtained in step d) for about 1 to about 5 hours at a temperature of about 400 to about 700°C so as to produce the composite substance; and

f) exposing the oxide of the metal to hydrogen or to one or more other reducing agents so as to reduce the oxide of the metal within the porous silica matrix so as to form particles of the metal within the porous silica matrix.

[00026] In a further embodiment, there is provided a process for preparing a composite substance comprising particles of an oxide of a metal dispersed in a porous silica matrix, wherein the metal is Cu, Ni, Cr, V, Co, Mn, Zn or Fe, said process comprising:

a) Preparing an aqueous solution comprising a soluble salt of the metal and a cetyltrimethylammonium salt;

b) Adding to the solution from step a) a sodium hydroxide solution so as to precipitate a hydroxide of the metal from the solution;

b') Separating the precipitated hydroxide of the metal from the solution;

c) Resuspending the hydroxide of the metal in an aqueous liquid and adjusting the resulting suspension to a pH greater than 7, optionally greater than about 10;

d) Adding to the suspension, with stirring, an alcoholic solution of tetraalkoxysilane, wherein the molar ratio of the tetraalkoxysilane to the metal hydroxide is between about 1:8 and about 8:1 and the alcoholic solution is added at a rate of about 1 to about 100 micromol/second, so as to form particles comprising the hydroxide of the metal at least partially coated with silica;

d') Separating the particles formed in step d) from the suspension and washing said particles with water; and

e) Calcining the particles obtained in step d) at about 500°C for about 1 to about 5 hours so as to produce the composite substance.

[00027] According to a second aspect of the present ~~invention~~disclosure, there is provided a composite substance prepared by the process ~~according to the first aspect~~as defined above.

[00028] According to a third aspect of the present ~~invention~~disclosure, there is provided a composite substance comprising particles of a metal or an oxide of ~~a~~the metal dispersed in a porous silica matrix, wherein each particle of said composite substance comprises a plurality of particles of the oxide of the metal dispersed therein. There

[00037] According to a fourth aspect of the present ~~invention~~disclosure, there is provided use of the composite substance ~~according to the second or third aspects~~as defined above in an application selected from the group consisting of methanol synthesis and reforming, steam and CO_2 reforming of methane, Fischer–Tropsch synthesis, CO oxidation, catalytic biomass tar decomposition, SO_2 oxidation, NO reduction, methane oxidation and chemical looping combustion.

[00038] According to a fifth aspect of the present ~~invention~~disclosure, there is provided a process for oxidising a fuel comprising exposing said fuel to a composite substance ~~according to the second or third aspects~~as defined above at sufficient temperature for combustion of the fuel. In this aspect, the composite substance comprises particles of an oxide of the metal dispersed in a porous silica matrix.

[00039] The following options may be used in conjunction with the fifth aspect either individually or in any suitable combination.

[00040] The temperature may be at least about 500 °C, or may be between about 500 and 1000 °C, or may be about 850 °C. The metal may be copper. The process may be chemical looping combustion.

[00041] In one embodiment, there is provided a process for oxidising a fuel comprising exposing said fuel to a composite substance according to the second or third aspects above, said the composite substance comprising particles of copper oxide dispersed in a porous silica matrix, at a temperature of at least about 500 °C, for combustion of the fuel.

[00042] In another embodiment, there is provided a chemical looping combustion process for oxidising a fuel comprising exposing said fuel to a composite substance according to the second or third aspects above, the composite substance comprising particles of an oxide of the metal dispersed in a porous silica matrix, at a temperature between about 500 and 1000 °C, for combustion of the fuel.

Brief Description of Drawings

[00043] Figure 1 is a scheme of the synthesis of highly dispersed CuO nanopaticles encapsulated in porous SiO_2 matrix;