monomers must be appropriately chosen as they are critical factors which must be stringently controlled. The choice of temperature affects the nanocrystal growth, which involves rearrangement and annealing of atoms during the synthesis process and the growth of the crystal. The choice of the monomer concentration affects the growth process of the nanocrystals. Hence, this process is a sophisticated process that requires control of a number of factors to achieve quantum dots of the desired size and distribution. In addition, due to the unpredictability associated with the crystal growth stage, this method may result in quantum dots that vary between batches, affecting the quality of the quantum dots.

There is a need to provide a quantum dot that overcomes, or at least ameliorates, one or more of the disadvantages described above.

There is a need to provide a method for forming a quantum dot that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

There is provided a metal oxide quantum dot having a plurality of pores disposed on the surface of the metal oxide quantum dot.

According to a first aspect, there is provided a metal oxide quantum dot having a plurality of pores disposed on the surface of said metal oxide quantum dot and having a hydrophilic coating on said metal oxide quantum dot.

Advantageously, the metal oxide quantum dot itself is porous. Hence, the metal oxide quantum dot may not need to be encapsulated or integrated with another porous compound to impart the porous property to the quantum dot.

Advantageously, the pores present on the metal oxide quantum dot may be used for incorporating therapeutic agents or small molecules for delivery to a desired site.

Advantageously, the metal oxide quantum dot may be biocompatible and may not be carcinogenic.

There is provided a method for forming a porous metal oxide quantum dot comprising the step of decomposing a metal salt in the presence of a pore-forming agent to form said porous metal oxide quantum dot.

According to a second aspect, there is provided a method for forming a porous metal oxide quantum dot comprising the step of decomposing a metal salt in the presence of a pore-forming agent and in an inert atmosphere to form said porous metal oxide quantum dot.

Advantageously, the method may form the pores *in situ* during formation of the metal oxide quantum dot.

Advantageously, the method may form a quantum dot having a desired fluorescence emission. This may be due to the selection of a decomposition temperature of the metal salt that then determines the particle size of the formed metal oxide, which in turn affects the color emitted by the quantum dot.

Advantageously, the method may be easy to scale up and may be less complicated than conventional methods. The disclosed method may avoid the nucleation and growth stages associated with conventional methods, leading to a more consistent product that is reproducible and does not suffer from batch-to-batch variation. According to a third aspect, there is provided a method for forming a water soluble porous metal oxide quantum dot comprising the steps of (a) decomposing a metal salt in the presence of a pore-forming agent to form a porous metal oxide quantum dot; and (b) coating the porous metal oxide quantum dot with a hydrophilic compound to form the water soluble porous metal oxide quantum dot.

Advantageously, the water soluble quantum dot may be used in biomedical applications.

According to a fourth aspect, there is provided a water soluble porous metal oxide quantum dot for use as a drug delivery agent.

Advantageously, the drug may be incorporated in the pores of the metal oxide quantum dot and delivered to a desired site *in vivo* or *in vitro*.

Claims

1. A metal oxide quantum dot having a plurality of pores disposed on the surface of said metal oxide quantum dot and having a hydrophilic coating on said metal oxide quantum dot.

2. The metal oxide quantum dot according to claim 1, wherein said pores have a dimension in the range of 2 nm to 50 nm.

3. The metal oxide quantum dot according to claim 1 or 2, wherein said metal is selected from Groups 8 to 14 of the Periodic Table of Elements.

4. The metal oxide quantum dot according to claim 3, wherein said metal is selected from the group consisting of zinc, iron, copper, tin and nickel.

5. The metal oxide quantum dot according to any one of the preceding claims, wherein said metal oxide quantum dot has a dimension of at least 30 nm.

6. The metal oxide quantum dot according to any one of the preceding claims, wherein said metal oxide quantum dot emits a fluorescence having a wavelength in the range of 350 nm to 650 nm.

7. The metal oxide quantum dot according to any one of the preceding claims, wherein said metal oxide quantum dot has a specific surface area in the range of 30 to 60 m^2g^{-1}.

8. The metal oxide quantum dot according to claim 1, wherein said hydrophilic coating comprises a water soluble compound.

9. The metal oxide quantum dot according to claim 8, wherein said water soluble compound is a water soluble polymer.

10. The metal oxide quantum dot according to claim 9, wherein said water soluble polymer is selected from the group consisting of a polysaccharide, a protein, a peptide and a synthetic polymer.

11. The metal oxide quantum dot according to claim 10, wherein said water soluble polymer is selected from the group consisting of xanthan, pectin, chitin, chitosan, dextran, carrageenan, guar gum, hyaluronic acid, albumin, glutathione, starch, starch derivative, hydroxypropylmethyl cellulose, hydroxypropyl cellulose, hydroxyethyl cellulose, sodium carboxy methyl cellulose, poly(ethylene glycol), polyvinyl pyrrolidone, polyvinyl alcohol, polyacrylic acid, polyacrylamides, N-(2-hydroxypropyl) methacrylamide, divinyl ether-maleic anhydride, polyoxazoline, polyphosphate and polyphosphazene.

12. A method for forming a porous metal oxide quantum dot comprising the step of decomposing a metal salt in the presence of a pore-forming agent and in an inert atmosphere to form said porous metal oxide quantum dot.

13. The method according to claim 12, wherein said metal is selected from Groups 8 to 14 of the Periodic Table of Elements.

14. The method according to claim 12 or 13, wherein said metal is selected from the group consisting of zinc, iron, copper, tin and nickel.

15. The method according to any one of claims 12 to 14, wherein said metal salt is a metal acetylacetonate, metal chloride, metal nitrate or metal acetate.

16. The method according to any one of claims 12 to 15, comprising the step of selecting said pore-forming agent from the group consisting of a coordinating agent, a solvent and combination thereof.

17. A method for forming a water soluble porous metal oxide quantum dot comprising the steps of:

(a) decomposing a metal salt in the presence of a pore-forming agent to form a porous metal oxide quantum dot; and

(b) coating said porous metal oxide quantum dot with a hydrophilic compound to form said water soluble porous metal oxide quantum dot.

18. The method according to claim 17, wherein said hydrophilic compound comprises a water soluble polymer selected from the group consisting of xanthan, pectin, chitin, chitosan, dextran, carrageenan, guar gum, hyaluronic acid, albumin, glutathione, starch, starch derivative, hydroxypropylmethyl cellulose, hydroxypropyl cellulose, hydroxyethyl cellulose, sodium carboxy methyl cellulose, poly(ethylene glycol), polyvinyl pyrrolidone, polyvinyl alcohol, polyacrylic acid, polyacrylamides, N-

(2-hydroxypropyl) methacrylamide, divinyl ether-maleic anhydride, polyoxazoline, polyphosphate and polyphosphazene.

19. A water soluble porous metal oxide quantum dot for use as a drug delivery agent.

20. A water soluble porous metal oxide quantum dot for use as a chemotherapeutic agent.

21. Use of a water soluble porous metal oxide quantum dot in the manufacture of a medicament for the treatment of cancer.