(a) agitating a mixture of inorganic particle and organic solvent;
(b) adding titania precursor dropwise into the mixture of step (a) under agitation; and
(c) adding catalyst to the mixture of step (b), thereby converting said titania precursor to titania which then forms a coating on said inorganic particle;
wherein steps (a) to (c) are performed at neutral pH and ambient temperature.

In another aspect, the present disclosure refers to a method of forming a titania-coated inorganic particle comprising the steps of:
(a) agitating a mixture of inorganic particle and organic solvent;
(b) adding titania precursor dropwise into the mixture of step (a) under agitation; and
(c) adding catalyst to the mixture of step (b) two or more times at predetermined time intervals, wherein each time interval is at least 0.5 hours apart, thereby converting said titania precursor to titania which then forms a coating on said inorganic particle;
wherein steps (a) to (c) are performed at neutral pH range of 6.0 to 8.0 without adding any acid/base and ambient temperature.

In a further aspect, the present disclosure refers to a titania-coated particle produced by the methods disclosed herein.

In another aspect, the present disclosure refers to a use of the titania-coated particle disclosed herein in reflective coatings for thermal insulation applications, antimicrobial coatings or UV-shielding for packing applications.

Advantageously, the disclosed methods may provide a uniform titania-coating on the surface of an inorganic particle or substrate material.

Further advantageously, the loading of titania precursors may be easily adjusted, thereby maximizing utilization of the titania precursors.

Also advantageously, the disclosed methods may produce substrates which are uniformly coated with titania. Having a highly uniform titania-coating is beneficial as it leads to an increase in the interfacial area with refractive index difference, which increases solar light reflectance. Another advantage of having a more uniform titania coating is that the interface between the titania coating and the substrate is better utilized for increasing solar light reflectance performance, photolytic antimicrobial activity or ultraviolet(UV)-shielding ability.

Further advantageously, the disclosed methods result in high yield of titania such as above 90 %, which provides cost savings advantage.

Also advantageously, the thickness of the titania coating on the substrate may be easily tuned by adjusting the ratio of substrate material to metal oxide precursor in the surface reactions.

Further advantageously, the disclosed method may be undertaken at ambient conditions, such as at neutral pH and ambient temperature. This is a departure from some attempted methods which rely heavily on pH adjustment (either highly acidic or highly basic), or temperature adjustment (heating or cooling), surfactant utilization, precipitator utilization, preheating or post annealing treatment of the substrate materials to form TiO_2 from precursor. These controls and treatments usually result in more operation procedures and equipment usage. The disclosed methods advantageously do not require the use of any surfactant.

Also advantageously, the disclosed method is cost effective while allowing the ability to tune the uniformity and thickness of the titania-coating without any obvious freestanding TiO_2 agglomerates which advantageously increases the solar light reflectance property of the titania-coated substrates.

Claims

1. A method of forming a titania-coated inorganic particle comprising the steps of:
(a) agitating a mixture of inorganic particle and organic solvent;
(b) adding titania precursor dropwise into the mixture of step (a) under agitation; and
(c) adding catalyst to the mixture of step (b) two or more times at predetermined time intervals, wherein each time interval is at least 0.5 hours apart,
thereby converting said titania precursor to titania which then forms a coating on said inorganic particle;
wherein steps (a) to (c) are performed at neutral pH range of 6.0 to 8.0 without adding any acid/base and ambient temperature.

2. The method according to claim 1, wherein in step (a), the mass ratio of inorganic particle to organic solvent is in the range of 0.02:1 to 0.1:1.

3. The method according to any one of the preceding claims, wherein in step (b), the mass ratio of titania precursor to organic solvent is in the range of 0.01:1 to 0.12:1.

4. The method according to any one of the preceding claims, wherein in step (b), said titania precursor is added dropwise to the mixture of step (a) at a rate in the range from 0.1 g/min to 5 g/min.

5. The method according to any one of the preceding claims, wherein in step (c), the mass ratio of total amount of catalyst added over predetermined time intervals to organic solvent is in the range of 0.006:1 to 0.1:1.

6. The method according to any one of the preceding claims, wherein the ratio of titania precursor to inorganic particle is in the range of 1:1 to 7:1 (mmol/g).

7. The method according to any one of the preceding claims, wherein the molar ratio of catalyst to titania precursor is in the range of 9:1 to 16:1.

8. The method according to any one of the preceding claims, wherein said titania precursor is a titanium alkoxide.

9. The method according to any one of the preceding claims, wherein said inorganic particle is selected from the group consisting of hollow glass beads, silicate platelets, silica glass particles, borosilicate glass particles, aluminosilicate glass particles, and mixtures thereof.

10. The method according to any one of the preceding claims, wherein said organic solvent is selected from the group consisting of alcohols, ketones, ethers, and mixtures thereof.

11. The method according to any one of the preceding claims, wherein said catalyst is selected from the group comprising of tap water, distilled water and deionized water.

12. The method according to claim 11, further comprising the step of:
(d) annealing the particles at a temperature of 200 °C to 1000 °C for 2 hours at a heating rate of 1 °C min^{-1}m, thereby obtaining titania-coated particles that are coated with crystalline titania.

13. The method according to any one of the preceding claims, wherein the yield of titania is above 90%.

14. The method of any one of the preceding claims, wherein the titania-coated particle is coated with a uniform titania coating.

15. The method of any one of the preceding claims, wherein said titania-coated particle is coated with titania with a thickness in the range of 20 nm to 500 nm.