A Polymer Dispersion

Technical Field

The present invention generally relates to a dispersion comprising a plurality of core-shell particles in a solvent. The present invention also relates to the use of the dispersion comprising a plurality of core-shell particles as an additive in the coating formulation.

Background Art

Coatings having a high total solar reflectance (TSR) or albedo are useful, particularly to reduce the solar heat gain of a building when applied on the roof, in facades, window and sidings etc. To date, this type of coating is considered as one of the most useful "green" approaches applied for the modern buildings. Additionally, coatings with high reflective properties, particularly in the near infrared (NIR) region, are useful for myriads of applications such as in military and automobile as fire retardant or intumescent coating as well as in other infrastructure related applications.

Total solar reflectance (TSR) is defined as the fraction of incident solar energy, which includes UV, visible and near infrared (NIR) wavelengths of about 200 to about 2500 nm, reflected from a surface and is an important parameter of a coating to reduce the heat build-up beneath the surface. High TSR value of coatings offers potential for cooling energy saving of a building (by air conditioning) and therefore indirectly reduces CO_2 emission and extension of the coating life due to reduced rate of degradation of coating materials at lower temperature.

Recently, there has been a tremendous interest within the coating industries to produce coatings with high TSR value, which are frequently termed as, among others, "cool coatings", "solar reflective coatings or "infrared reflective coatings". Such coatings are typically applied outdoor for example on roof or façade. The TSR of a coating is by and large determined by reflection, refraction and diffraction and dependent on several parameters including particle size, refractive index of the binder and additive to the coatings.

However, the TSR value of a coating or coated surface is reduced over time as the dirt accumulates thereby causing reduced heat shielding properties of the coating or coated surface.

Therefore, there is a need to provide a coating or a coated surface that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Coating and coated surface having enhanced of TSR and dirt-removal properties, which are capable of reducing the heat build-up of the coating or coated substrate, comprising fluorinated core-shell microparticle (CSMP) are disclosed herein.

Summary

There is provided a dispersion comprising

a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
b. a solvent;

wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%
Advantageously, the core-shell microparticles present in the despersion as described above may have a narrow size distribution and thus said microparticles may be of uniform size distribution. Further advantageously, the at least one fluorinated monomer may be available in a large quantity that renders the manufacturing process of the dispersion of the present disclosure cost-effective.

In one aspect, there is provided a method of increasing total solar reflectance (TSR) of a substrate, the method comprising the step of forming a coating of a mixture of a dispersion with a coating material, on a surface of said substrate, wherein the dispersion comprises:

a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
b. a solvent;

wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%.

There is provided use of a dispersion comprising

a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
b. a solvent;

wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%, as an additive in a coating formulation.

In another aspect, there is provided a dispersion when used to coat a surface of a substrate to increase total solar reflectance of the substrate, wherein the dispersion comprises:

a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
b. a solvent;

wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%.

Advantageously, the coating formulation resulted from the mixing of a coating material with the additive described herein may be stable for an extended period of time. Hence, when dispersed in a suitable solvent, the resulting dispersion may not undergo aggregation or coagulation. Yet advantageously, the dispersion of the present disclosure may be compatible with the water-based coating materials.

Further advantageously, the coating formulation described in the present disclosure exhibit better total solar reflectance (TSR) as compared to the commercially available cool coating, when applied onto a surface of a substrate. In addition, the coating formulation comprising the dispersion of the present disclosure advantageoulsy may not be leached when applied onto the surface of a substrate.

There is provided a method of increasing total solar reflectance (TSR) of a substrate comprising the step of forming a coating of a mixture of a dispersion with a coating material on a surface of said substrate, wherein said dispersion comprises a solvent with a plurality of core-shell particles disposed therein, said core-shell particles having at least one non-fluorinated polymer in the core and at least one fluorinated polymer or fluorinated copolymer in at least one shell layer of the shell, and said core-shell particles forming a solid content of at least 10% of the dispersion.

Advantageously, the substrate coated with the coating formulation of the present disclosure display improved total solar reflectance (TSR) as compared to the commercially available cool coating (in the absence of the dispersion of the present disclosure), when applied onto a surface. Yet advantageously, the coated substrate may also exhibit anti-dirt property owing to the presence of the omniphobic dispersion of the present disclosure. Therefore, advantageously the

coated substrate above may exhibit dual functionality that is improved or enhanced TSR and anti-dirt properties.

There is provided a coated article comprising a layer of a dispersion coated thereon, said dispersion comprises a solvent with a plurality of core-shell particles disposed therein, said core-shell particles having at least one non-fluorinated polymer in the core and at least one fluorinated polymer or fluorinated copolymer in at least one shell layer of the shell, and said core-shell particles forming a solid content of at least 10% of the dispersion.

Advantageously, the coating formulation, the coated substrate or the coated article is capable of reflecting solar light and repel dirt. This may be termed as “dual-functionality” where the coating formulation, the coated substrate or the coated article has two properties – that of total solar reflectance and anti-dirt capabilities. The total solar reflectance may be improved or enhanced as compared to a similar coating formulation but without the dispersion of the presnet application.

The coating formulation, coated substrate or coated article as defined in the present disclosure may have the dual-functionalities due to the presence of a methacylate functional group present in the at least one fluorinated polymer or fluorinated copolymer in at least one shell layer of the shell. The methacylate functional group may be part of a 2,2,3,4,4,4-Hexafluorobutyl Methacrylate momoner in the shell of the core-shell particle.

Definitions

The following words and terms used herein shall have the meaning indicated:

"Alkyl" as a group or part of a group refers to a straight or branched aliphatic hydrocarbon group, preferably a C_1–C_{50} alkyl, preferably a C_1–C_{12} alkyl, more preferably a C_1-C_{10} alkyl, most preferably C_1-C_6 unless otherwise noted. Examples of suitable straight and branched C_1-C_6 alkyl substituents include methyl, ethyl, n-propyl, 2-propyl, n-butyl, sec-butyl, t-butyl, hexyl, and the like. The group may be a terminal group or a bridging group.

The term “anti-dirt” as used herein refers to the ability of a surface to repel dirt that may be organic and/ or inorganic molecules. Such term therefore may encompass hydrophobicity, oleophobicity or both of these terms (which is then termed as omniphobicity). The surface having such property is therefore termed as being hydrophobic, oleophobic or omniphobic.

The word “substantially” does not exclude “completely” e.g. a composition which is “substantially free” from Y may be completely free from Y. Where necessary, the word “substantially” may be omitted from the definition of the invention.

Unless specified otherwise, the terms "comprising" and "comprise", and grammatical variants thereof, are intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, unrecited elements.

As used herein, the term "about", in the context of concentrations of components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

Claims

1. A method of increasing total solar reflectance (TSR) of a substrate, the method comprising the step of forming a coating of a mixture of a dispersion with a coating material, on a surface of said substrate, wherein the dispersion comprises:

   a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
   b. a solvent;

   wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%.

2. The method of claim 1, wherein said shell comprises a fluorinated copolymer of at least two fluorinated monomers in the same shell layer.

3. The method of claim 1 or 2, wherein said fluorinated polymer or fluorinated copolymer comprises a fluoroalkyl monomer with at least one of an acrylate monomer or a methacrylate monomer, or mixtures thereof.

4. The method of claim 3, wherein said fluorinated polymer is selected from the group consisting of poly(2,2,2-Trifluoroethyl Acrylate), poly(2,2,2-Trifluoroethyl Methacrylate), poly(2,2,3,3-Tetrafluoropropyl Acrylate), poly(2,2,3,3-Tetrafluoropropyl Methacrylate), poly(2,2,2,3,3-Pentafluoropropyl Acrylate, poly(2,2,2,3,3-Pentafluoropropyl Methacrylate, poly(2,2,3,4,4,4-Hexafluorobutyl Acrylate), poly(2,2,3,4,4,4-Hexafluorobutyl Methacrylate), poly(2,2,3,3,4,4,4-Heptafluorobutyl Acrylate), poly(2,2,3,3,4,4,4-Heptafluorobutyl Methacrylate), poly(2,2,3,3,4,4,5,5-Octafluoropentyl Acrylate), poly(2,2,3,3,4,4,5,5-Octafluoropentyl Methacrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Methacrylate), poly(1H,1H-Perfluorooctyl Acrylate), poly(1H,1H-Perfluorooctyl Methacrylate) poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl Methacrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-Heneicosafluorododecyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-Heneicosafluorododecyl Methacrylate and mixtures thereof.

5. The method of claim 3, wherein said fluorinated copolymer comprises at least two monomers selected from the group consisting of 2,2,3,4,4,4-Hexafluorobutyl Acrylate, 2,2,3,4,4,4-Hexafluorobutyl Methacrylate, 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Methacrylate, 1H,1H-Perfluorooctyl Acrylate, 1H,1H-Perfluorooctyl Methacrylate.

6. The method of any one of the preceding claims, wherein the solvent is an aqueous solvent.

7. The method of any one of the preceding claims, wherein the core-shell particles have an average particle size in the range of 50 to 800 nm.

8. The method of any one of the preceding claims, wherein the core-shell particles have an average shell thickness in the range of 5 to 50 nm.

9. The method of any one of the preceding claims, wherein the solid content of the dispersion is in the range of 35 wt% to 60 wt%.

10. The method of any one of claims 1 to 9, wherein said coating has a thickness in the range of 50 to 500 μm.

11. The method of any one of claims 1 to 10, further comprising the step of heat treating the coating.

12. The method of any one of claims 1 to 11, wherein the coating formed on the substrate is capable of repelling dirt.

13. A dispersion when used to coat a surface of a substrate to increase total solar reflectance of the substrate, wherein the dispersion comprises:

    a. a plurality of core-shell particles, wherein the core comprises at least one non-fluorinated polymer and the shell comprises at least one shell layer having at least one fluorinated polymer or fluorinated copolymer therein; and
    b. a solvent;

    wherein said dispersion has a solid content of the core-shell particles of at least 10 wt%.

14. The dispersion when used of claim 13, wherein said shell comprises a fluorinated copolymer of at least two fluorinated monomers in the same shell layer.

15. The dispersion when used of claim 13 or 14, wherein said fluorinated polymer or fluorinated copolymer comprises a fluoroalkyl monomer with at least one of an acrylate monomer or a methacrylate monomer, or mixtures thereof.

16. The dispersion when used of claim 15, wherein said fluorinated polymer is selected from the group consisting of poly(2,2,2-Trifluoroethyl Acrylate), poly(2,2,2-Trifluoroethyl Methacrylate), poly(2,2,3,3-Tetrafluoropropyl Acrylate), poly(2,2,3,3-Tetrafluoropropyl Methacrylate), poly(2,2,2,3,3-Pentafluoropropyl Acrylate), poly(2,2,2,3,3-Pentafluoropropyl Methacrylate), poly(2,2,3,4,4,4-Hexafluorobutyl Acrylate), poly(2,2,3,4,4,4-Hexafluorobutyl Methacrylate), poly(2,2,3,3,4,4,4-Heptafluorobutyl Acrylate), poly(2,2,3,3,4,4,4-Heptafluorobutyl Methacrylate), poly(2,2,3,3,4,4,5,5-Octafluoropentyl Acrylate), poly(2,2,3,3,4,4,5,5-Octafluoropentyl Methacrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Methacrylate), poly(1H,1H-Perfluorooctyl Acrylate), poly(1H,1H-Perfluorooctyl Methacrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10-Heptadecafluorodecyl Methacrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-Heneicosafluorododecyl Acrylate), poly(3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,11,11,12,12,12-Heneicosafluorododecyl Methacrylate and mixtures thereof.

17. The dispersion when used of claim 15, wherein said fluorinated copolymer comprises at least two monomers selected from the group consisting of 2,2,3,4,4,4-Hexafluorobutyl Acrylate, 2,2,3,4,4,4-Hexafluorobutyl Methacrylate, 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Acrylate, 3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctyl Methacrylate, 1H,1H-Perfluorooctyl Acrylate, and 1H,1H-Perfluorooctyl Methacrylate.

18. The dispersion when used of any one of claims 13 to 17, wherein the solvent is an aqueous solvent.

19. The dispersion when used of any one of claims 13 to 18, wherein the core-shell particles have an average particle size in the range of 50 to 800 nm.

20. The dispersion when used of any one of claims 13 to 19, wherein the core-shell particles have an average shell thickness in the range of 5 to 50 nm.

21. The dispersion when used of any one of claims 13 to 20, wherein the solid content of the dispersion is in the range of 35 wt% to 60 wt%.

22. The dispersion when used of any one of claims 13 to 21, wherein the dispersion is an additive in a coating formulation, wherein said coating formulation is capable of reflecting solar light and repelling dirt.