

A HEAT ABSORBING COMPOSITION

Technical Field

The present invention generally relates to a
5 composition for use in a coating and in a heat exchanging
system. The present invention also relates to a method of
producing the coating.

Background

10 In tropical regions, buildings are under the hot sun
throughout the year. The solar radiation from the sun
causes the exterior walls of buildings to increase in
temperature. The heat emitted from these buildings and
walls causes an increase in ambient temperature and this
15 increase in ambient temperature is felt especially in
densely built-up areas as the buildings may form a heat-
sink. However, not only does the ambient temperature
increase, the temperature within the buildings also
increases.

20 Hence, to mitigate the discomfort of the heat within
the buildings, traditional cooling methods such as air-
conditioning are used. These methods however consume a
lot of energy.

There are alternative methods to reduce the reliance
25 on traditional energy consuming cooling methods.

For example, solar reflective paints have been
developed to coat the exterior walls of buildings,
thereby preventing solar radiation from heating up the
building interior. However, as solar reflective paints
30 only reflect away solar radiation, they do not
effectively exploit such energy.

Solar selective coatings have also been developed
wherein the coatings have properties of solar reflectance
or solar absorbance. These solar selective coatings

typically comprise of metallic-ceramic (cermet) composites and endeavor to provide high solar absorption and low thermal emittance. However, for such coatings, there are trade-offs between oxidation resistance, high absorption and low emittance. Specifically, for coatings with high absorption and low emittance, the oxidation resistance is typically compromised. Furthermore, solar selective coatings comprised of multiple layers of cermet composites to achieve properties of high solar absorption and low thermal emittance. Hence, to control the thickness of the cermet layers, precise deposition techniques, such as sputtering deposition, are used, which are relatively expensive, tedious and energy consuming.

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

There is also a need to provide a cost effective method of cooling buildings.

Summary

In one aspect, there is provided a coating composition comprising a polymer matrix, comminuted microparticles comprising a mixture of silicates, silicon oxides, aluminates, aluminum oxides and zirconium oxides, said comminuted microparticles having a particle size of from 0.5 μm to 50 μm and a dispersant to disperse said comminuted microparticles in said polymer matrix, wherein the comminuted microparticles comprise nano-sized pores, wherein the comminuted microparticles are present in an amount from 10 wt% to 40 wt% of the total weight of the coating composition, and wherein said coating composition has less than 20% reflectance of solar radiation.

According to an embodiment, there is provided a composition comprising microparticles having a particle size of from about 0.5 μm to about 50 μm with less than about 20% reflectance of solar radiation.

5 Advantageously, the microparticles having a particle size of from about 0.5 μm to about 50 μm confer onto the composition low reflectance values of less than about 20% reflectance of solar radiation. Hence, the disclosed composition possesses high absorbance of solar radiation.

10 In one embodiment, the composition absorbs solar radiation.

 If the microparticles have a particle size of less than 0.5 μm , the surface area of the microparticles

increases thereby permitting the reflection of an increased amount of solar radiation, resulting in high reflectance values above 20%. On the other hand, a composition comprising microparticles having a particle
5 size of more than 50 μm will cause cracking of coatings and will thus be more difficult to use as a coating.

In one embodiment, the microparticles comprise nano-sized pores. Advantageously, the nano-sized pores minimize the reflection of solar radiation and thus
10 confer low reflectance onto the composition.

According to an embodiment, there is provided a coating comprising a polymer matrix, microparticles having a particle size of from about 0.5 μm to about 50 μm and a dispersant to disperse said microparticles in
15 said polymer matrix, wherein the coating has less than about 20% reflectance of solar radiation.

The disclosed coating may exhibit lower solar reflectance as compared to prior art coatings. Accordingly, the disclosed coating may exhibit higher
20 solar absorbance and thus higher solar transferability, as compared to prior art coatings. Advantageously, the disclosed coating may be able to absorb larger amounts of heat from solar radiation as compared to prior art coatings.

Advantageously, the disclosed coating may be
25 chemically stable and color stable under continuous solar radiation and high temperatures of about 100°C.

According to another aspect, there is provided a method of producing a coating having less than about 20%
30 reflectance of solar radiation, the method comprising the steps of: a. providing particles having an initial particle size of from about 0.5 μm to about 150 μm ; b. mixing the particles having an initial particle size of from about 0.5 μm to about 150 μm with a polymer matrix

and a dispersant to obtain a substantially homogenous mixture; and c. comminuting the particles in said homogenous mixture to obtain the coating, wherein the coating comprises comminuted microparticles having a particle size of from about 0.5 μm to about 50 μm and wherein the comminuted microparticles comprise nano-sized pores.

The comminuting step may be undertaken under ambient conditions. Hence, the method advantageously may not require high temperature or high pressure conditions.

According to another aspect, there is provided a heat exchanging system comprising at least one substrate coated with the coating composition as defined above, wherein said at least one substrate is in thermal communication with a fluid.

The heat exchanging system may be adapted to receive heat energy from solar radiation. Accordingly, the heat exchanging system may be mounted on any external surface exposed to solar radiation. Advantageously, the amount of solar radiation received and absorbed by the at least one substrate coated with the coating as defined above is maximized.

In an embodiment, the heat exchanging system is mounted on the exterior wall or the roof of buildings.

In other embodiments, the heat exchanging system may be mounted on the external surface of outdoor industrial plant equipment, such as the chemical reactors of oil refineries.

The fluid may be a heat exchange fluid adapted to absorb heat transferred from said at least one substrate.

The heat absorbed by the at least one coated substrate may be transferred to the fluid. The heated fluid may be configured to exit the heat exchanging system, thereby cooling the heat exchanging system and thus the buildings on which the system is mounted on.

According to another aspect, there is provided a paint comprising a coating composition as defined above.

Definitions

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

5 The term "particle size" is to be interpreted broadly to refer to the diameter of the particles where they are substantially spherical. The particles may be non-spherical and the particle size range may refer to the equivalent diameter of the particles relative to spherical particles or may refer to a dimension (length, 10 breadth, height or thickness) of the non-spherical particle.

The prefix "nano" as used in the context of the specification is to be interpreted broadly to, unless specified, refer to an average particle size of between 15 about 1 nm to about 1000 nm. The prefix "micro" as used in the context of the specification is to be interpreted broadly to, unless specified, refer to an average particle size of between about 1 μm to about 1000 μm .

20 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.

25 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.

30 As used herein, the term "about", in the context of concentrations of components of the formulations, typically means $\pm 5\%$ of the stated value, more typically $\pm 4\%$ of the stated value, more typically $\pm 3\%$ of the stated value, more typically, $\pm 2\%$ of the stated value, even more typically $\pm 1\%$ of the stated

value, and even more typically +/- 0.5% of the stated value.

Throughout this disclosure, certain embodiments may be disclosed in a range format. It should be understood
5 that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the
10 possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from
15 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Detailed Disclosure of Embodiments

20 Exemplary, non-limiting embodiments of a composition will now be disclosed.

In one embodiment, there is provided a composition comprising microparticles having a particle size of from about 0.5 μm to about 50 μm with less than about 20%
25 reflectance of solar radiation.

Solar radiation is the amount of energy impinging on a specific area of the Earth. When solar radiation strikes an object, one or more of the following may occur: reflection, absorption or transmission. For
30 example, a part of the incident solar radiation may be reflected off the surface of the object, a part may be absorbed within the object and a part may be transmitted through the object. Accordingly, the total Incident solar energy (I) on an object may be expressed by the sum of

the solar Reflectance (R), solar Absorbance (A), and solar Transmittance (T):

$$I = A + T + R$$

Hence, the solar Absorbance can be expressed as:

5
$$A = I - R - T$$

As is evident by the above equations, if an opaque coating is applied on the surface of a heat exchanger, the solar radiation Transmittance (T) may be considered to be so small such that T is considered to zero. Thus,
10 the solar Absorbance (A) for opaque materials may be expressed as:

$$A = I - R$$

Accordingly, a material that has higher solar Reflectance (R) will thus have lower solar Absorbance
15 (A), thereby resulting in a reduction of heat energy accumulated within the material. On the contrary, lower Reflectance (R) of solar energy will result in higher solar Absorbance (A), which enhances molecular vibration and generates heat accumulation within the material.

20 Accordingly, as the disclosed composition has a low reflectance of less than about 20% reflectance of solar radiation, it is thus capable of absorbing a large amount of heat energy from solar radiation. The heat absorbed may be transferred through the composition. Hence, the
25 disclosed composition may advantageously be capable of transferring the absorbed heat and exhibiting high solar transferability.

Solar radiation comprises a spectrum of infrared, visible and ultraviolet light. Advantageously, in an
30 embodiment, the disclosed composition has been found to be substantially better at absorbing solar radiation in the infrared region. Accordingly, in an embodiment, the disclosed composition may advantageously be capable of absorbing a higher amount of solar radiation having

wavelengths in the infrared region as compared to prior art compositions.

The disclosed microparticles may have an average particle size of from about 0.5 μm to about 50 μm . The average particle size of the microparticles may be selected from the group consisting of from about 0.5 μm to about 50 μm , from about 1 μm to about 50 μm , from about 5 μm to about 50 μm , from about 10 μm to about 50 μm , from about 15 μm to about 50 μm , from about 20 μm to about 50 μm , from about 25 μm to about 50 μm , from about 30 μm to about 50 μm , from about 35 μm to about 50 μm , from about 40 μm to about 50 μm , from about 0.5 μm to about 40 μm , from about 0.5 μm to about 35 μm , from about 0.5 μm to about 30 μm , from about 0.5 μm to about 25 μm , from about 0.5 μm to about 20 μm , from about 0.5 μm to about 15 μm , from about 0.5 μm to about 10 μm , from about 0.5 μm to about 5 μm , from about 1 μm to about 50 μm , from about 5 μm to about 20 μm , and from about 5 μm to about 15 μm .

In one embodiment, the microparticles have a particle size of from about 5 μm to about 15 μm .

In one embodiment, the microparticles comprise nano-sized pores.

The nano-sized pores may have a pore size of from about 1 nm to about 500 nm. The pore size of the nano-sized pores may be selected from the group consisting of from about 1 nm to about 500 nm, from about 50 nm to about 500 nm, from about 100 nm to about 500 nm, from about 150 nm to about 500 nm, from about 200 nm to about 500 nm, from about 250 nm to about 500 nm, from about 300 nm to about 500 nm, from about 350 nm to about 500 nm, from about 400 nm to about 500 nm, from about 450 nm to about 500 nm, from about 1 nm to about 450 nm, from about 1 nm to about 400 nm, from about 1 nm to about 350 nm,

from about 1 nm to about 300 nm, from about 1 nm to about 250 nm, from about 1 nm to about 200 nm, from about 1 nm to about 150 nm, from about 1 nm to about 100 nm, and from about 1 nm to about 50 nm.

5 In one embodiment, the nano-sized pores have a pore size of from about 1 nm to about 300 nm.

 The nano-sized pores may be present on the surface of the microparticles. Due to the nano-sized pores being present on the surface of the microparticles, the
10 microparticles present a substantially uneven surface. Advantageously, the uneven surface prevents a high amount of solar radiation from being reflected and thus confers the property of low reflectance onto the composition. Accordingly, the microparticles comprising the nano-sized
15 pores may be able to absorb large amounts of heat.

 In one embodiment, the nano-sized pores are dispersed substantially over the whole surface of the microparticle, causing the unevenness to occur substantially across the surface.

20 The microparticles may be comprised of a material capable of absorbing heat energy from solar radiation. Advantageously, the material used is capable of withstanding high temperatures. Hence, the lifespan of the microparticles, and thus the composition, may be
25 prolonged. Accordingly, the disclosed composition and coating may also be chemically stable and color stable under continuous solar radiation and high temperatures of about 100°C.

 In one embodiment, the microparticles are comprised
30 of a ceramic material.

 In another embodiment, the microparticles are comprised of a material selected from the group consisting of silicates, silicon oxides, aluminates, aluminum oxides, zirconium oxides and mixtures thereof.

Exemplary, non-limiting embodiments of a coating will now be disclosed.

In one embodiment, there is provided a coating comprising a polymer matrix, microparticles having a
5 particle size of from about 0.5 μm to about 50 μm and a dispersant to disperse said microparticles in said polymer matrix, wherein the coating has less than about 20% reflectance of solar radiation.

The polymer matrix may be any suitable solvent-based
10 organic resin matrix or any suitable water-based acrylic resin matrix.

In one embodiment, the solvent-based organic resin matrix may be an oil-based organic alkyd resin matrix. In one embodiment, the organic alkyd resin is an oil-
15 modified alkyd resin.

Advantageously, the organic alkyd resin matrix and acrylic resin matrix are resistant to exposure to weathering and normal wear and tear. Accordingly, the coating may be used to coat external surfaces that are
20 exposed to the atmosphere.

Further advantageously, the coating comprising the organic alkyd resin matrix or the acrylic resin matrix may be applied on surfaces at ambient conditions and is thus easy to use.

25 The dispersant may be any suitable dispersant adapted to aid the dispersion of the polymer matrix and the microparticles in the coating. The dispersant may comprise of a lower alcohol such as a C_2 to C_6 alcohol. In one embodiment, the dispersant comprises butanol.

30 The microparticles having a particle size of from about 0.5 μm to about 50 μm may be present in the coating in an amount from about 10 wt% to about 40 wt% of the total weight of the coating. The microparticles may be present in an amount selected from the group consisting

of about 10 wt% to about 40 wt%, about 10 wt% to about 35 wt%, from about 10 wt% to about 30 wt%, from about 10 wt% to about 25 wt%, from about 10 wt% to about 20 wt%, from about 10 wt% to about 15 wt%, from about 15 wt% to about 40 wt%, from about 20 wt% to about 40 wt%, from about 25 wt% to about 40 wt%, from about 30 wt% to about 40 wt%, and from about 35 wt% to about 40 wt%. In one embodiment, the microparticles are present in an amount of about 25 wt% of the total weight of the coating.

10 The polymer matrix may be present in the coating in an amount from about 50 wt% to about 80 wt% of the total weight of the coating. The polymer matrix may be present in an amount selected from the group consisting of about 50 wt% to about 80 wt%, from about 55 wt% to about 80 wt%, from about 60 wt% to about 80 wt%, from about 65 wt% to about 80 wt%, from about 70 wt% to about 80 wt%, from about 75 wt% to about 80 wt%, from about 50 wt% to about 75 wt%, from about 50 wt% to about 70 wt%, from about 50 wt% to about 65 wt%, from about 50 wt% to about 60 wt%, and from about 50 wt% to about 55 wt%. In one embodiment, the polymer matrix is present in an amount of about 65 wt% of the total weight of the coating.

25 The dispersant may be present in the coating in an amount from about 5 wt% to about 20 wt% of the total weight of the coating. The dispersant may be present in an amount selected from the group consisting of about 5 wt% to about 20 wt%, from about 10 wt% to about 20 wt%, and from about 5 wt% to about 10 wt%. In one embodiment, the dispersant is present in an amount of about 10 wt% of the total weight of the coating.

30 The coating may be used as a paint.

 The coating may be substantially organic. Advantageously, the substantially organic coating may easily be applied onto surfaces.

The coating may be applied in any suitable way onto surfaces. For example, the coating may be brushed onto surfaces or may be sprayed onto surfaces. Advantageously, the coating may be applied onto surfaces at ambient
5 temperature.

Advantageously, the microparticles have a particle size of from about 0.5 μm to about 50 μm , thereby conferring low reflectance values of less than about 20% reflectance of solar radiation on the disclosed coating.
10 Accordingly, the disclosed coating may advantageously be capable of absorbing a high amount of heat energy from the solar radiation. Further, the disclosed coating may also be capable of transferring the absorbed heat.

The heat transferability of the coating may be
15 measured from the increase in temperature of the coating. In one embodiment, the temperature of the coating increases about 5°C when the concentration of the heat absorbing coating is from about 0.015 g/cm² to about 0.03 g/cm². In other words, when compared with a prior art
20 coating at concentrations of 0.015 g/cm² to 0.03 g/cm², the temperature of the disclosed heat absorbing coating at the same concentrations is about 5°C higher than the prior art coating.

The coating may have less than about 20% reflectance
25 of solar radiation. In one embodiment, the coating possesses from about 10% to about 20% reflectance of solar radiation. In one embodiment, the coating possesses about 10% reflectance of solar radiation. In this embodiment, the solar reflectance is measured according
30 to the ASTM C1549-09 standard.

Exemplary, non-limiting embodiments of a method of producing microparticles will now be disclosed.

In one embodiment, there is provided a method of producing a coating having less than 20% reflectance of

solar radiation, the method comprising the steps of: a. providing particles having an initial particle size of from about 0.5 μm to about 150 μm ; b. mixing the particles having an initial particle size of from about
5 0.5 μm to about 150 μm with a polymer matrix and a dispersant to obtain a substantially homogenous mixture; and c. comminuting the particles in said homogenous mixture to obtain the coating, wherein the coating comprises comminuted microparticles having a particle
10 size of from about 0.5 μm to about 50 μm .

In one embodiment, the particles having an initial particle size of from about 0.5 μm to about 150 μm are comprised of a ceramic material.

In another embodiment, the particles having an
15 initial particle size of from about 0.5 μm to about 150 μm are comprised of a material selected from the group consisting of silicates, silicon oxides, aluminates, aluminum oxides, zirconium oxides and mixtures thereof.

The disclosed particles having a particle size of
20 from about 0.5 μm to about 150 μm may be derived from any suitable source. It may be appreciated that the particles having a particle size of from about 0.5 μm to about 150 μm may have a particle size distribution which differs from source to source.

25 In one embodiment, the mixing step comprises high shearing mechanical blending. The step of mixing may be undertaken for a duration of time suitable to obtain a homogenous mixture. The step of mixing may also be undertaken at ambient temperature and pressure.

30 In one embodiment, the comminuting step comprises a high shear process step.

The high shear process step may be a ball-milling step. The balls used in the ball-milling step may have a diameter of between about 8 mm and about 10 mm. In one

embodiment, the diameter of the balls used is about 10 mm.

The number of balls that may be used for about 30 grams to about 160 grams of the mixture is about 9 to about 27 balls. In one embodiment, 27 balls are used for about 100 grams of the mixture.

The high shear process step may be undertaken for a duration of about 30 minutes to about 120 minutes. In one embodiment, the high shear process step is undertaken for 60 minutes.

The high shear process step may be undertaken at atmospheric temperature and pressure. Hence, the disclosed method advantageously may not require high temperature or high pressure conditions.

The comminuting step may comminute the particles having a particle size of from about 0.5 μm to about 150 μm to a particle size of from about 0.5 μm to about 50 μm . The comminuting step may also produce nano-sized pores on the comminuted microparticles. Hence, in one embodiment, the comminuted particles having a particle size of from about 0.5 μm to about 50 μm comprise nano-sized pores.

The comminuting step may narrow the particle size distribution of the particles. In one embodiment, the comminuted microparticles have a particle size of from about 5 μm to about 15 μm .

Advantageously, the substantially uneven surface arising from the nano-sized pores present on the surface of the comminuted microparticles prevents a high amount of solar radiation from being reflected. Accordingly, the comminuted microparticles comprising the nano-sized pores made by the disclosed method may be able to absorb large amounts of heat.

Exemplary, non-limiting embodiments of a heat exchanging system will now be disclosed.

In one embodiment, there is provided a heat exchanging system comprising at least one substrate coated with the coating as defined above, wherein said at least one substrate is in thermal communication with a fluid.

The heat exchanging system may comprise of opposite-facing substrates having the external surfaces coated with the coating as defined above. The heat exchanging system may further comprise of a tube between the opposite-facing substrates, wherein the tube substantially extends along the longitudinal axis of the heat exchanging system.

In one embodiment, the tube comprises of an inlet and an outlet in fluid connection with each other. The fluid may be pumped into the tube from the inlet and exit the tube via the outlet. The pump may be any suitable pump known in the art.

The fluid may be a fluid having high specific heat capacity, i.e. a heat sink. In one embodiment, the fluid is a heat exchange fluid adapted to absorb heat transferred from the at least one substrate. In one embodiment, the fluid is water. The water may be fed from a water circulation system in a building.

In one embodiment, the inlet and outlet are on opposite longitudinal sides of the heat exchanging system. In another embodiment, the inlet and outlet are on the same longitudinal side of the heat exchanging system. In this embodiment, the tube is substantially U-shaped. It is to be appreciated that the term "U-shaped" is used to describe the shape of the tube figuratively and is not to be construed literally.

In one embodiment, the fluid is introduced into the heat exchanging system at ambient temperature. Ambient temperature is about 25°C to 30°C.

5 The heat exchanging system may be adapted to receive heat energy from solar radiation. When exposed to the sun, the coating coated on the substrates absorbs and stores the solar energy. The solar heat energy stored in the coating may be transferred through the substrate and to the fluid, thereby increasing the temperature of the
10 fluid in the tube to give rise to heated fluid. The temperature of the fluid may increase from ambient temperature to about 45°C to 55°C. In one embodiment, the temperature of the fluid in the tube increases to above 50°C.

15 The heated fluid may then exit via the outlet of the tube, thereby removing the heat from the heat exchanging system and lowering the temperature of the heat exchanging system.

The heat exchanging system may be mounted or
20 installed on any external surface exposed to solar radiation, such as on the exterior wall or the roof of buildings or on the external surface of outdoor industrial plant equipment. Advantageously, the heat exchanging system may be installed on the external
25 surface of the buildings so as to maximize exposure to the sun, thereby increasing the amount of heat absorbed from the solar or infrared radiation. Further advantageously, the absorbed heat energy may be stored for further uses.

30 The at least one substrate may be made of a heat conductor. In one embodiment, the at least one substrate is made of metal. Accordingly, the at least one substrate may advantageously be capable of conducting heat from the coating coated thereon to the fluid.

In the embodiment where the fluid is water, the heated water may be supplied as warm water for residential use. The heated fluid may also be used for industrial purposes.

5

Brief Description of Drawings

The accompanying drawings illustrate a disclosed embodiment and serves to explain the principles of the disclosed embodiment. It is to be understood, however, 10 that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention.

Figs. 1a and 1b show schematic diagrams of heat exchanging systems according to embodiments of the 15 invention.

Fig. 2 shows a graph of temperature against time for a coating according to an embodiment of the invention and a comparative coating.

Fig. 3 shows a graph of reflectance against 20 wavelength for a coating according to an embodiment of the invention and a comparative coating.

In the drawings, like numerals denote like parts.

EXAMPLES

25

Example 1

20 weight% of solar heat absorbent microparticles comprised of silicates, silicon oxides, aluminates, aluminum oxides, zirconium oxides and mixtures thereof were added to 75 weight% of alkyd resin based matrix.

30

The microparticles possessed particle sizes between 0.5 μ m to 150 μ m.

1 weight% of nonyl phenol ethoxylate and 4 weight% of butanol were then added as a dispersant to the mixture.

5 The resultant mixture was transferred to a stainless steel reactor with stainless steel balls for a high shearing process. The high shearing process step was carried out at a rotation speed of 150 rpm for a duration of 30 minutes.

10 After the high shearing process, the solar heat absorbent microparticles had particle sizes between $0.5\mu\text{m}$ to $50\mu\text{m}$ and were dispersed homogeneously in the alkyd resin matrix to obtain solar heat absorbing paint.

Example 2

15 Two layers of the solar heat absorbing paint obtained in Example 1 were applied onto the external surface of a heat exchanging system 100 shown in Fig. 1a and allowed to dry at ambient condition for two hours.

20 An alternate configuration of heat exchanging system 100 is shown in Fig. 1b. Like numerals in Fig. 1b denote like parts of the system shown in Fig. 1a.

The heat exchanging system coated with the paint obtained in Example 1 is referred to as coating 108 in Figs. 1a, 2 and 3.

25 Referring to Fig. 1a, system 100 comprises a passageway for fluid to enter through inlet 114 and exit from outlet 116. In this example, 15kg of tap water was pumped in stream 104 into system 100 at ambient temperature through inlet 114. The pump is not shown in
30 Fig. 1. System 100 was exposed to sunlight 102 with the surface coated with coating 108 thereon directed towards sunlight 102. The stored heat energy within coating 108 was transmitted through system 100 to heat up tap water

stream 104. The heated stream 106 then exited system 100 via outlet 116.

The temperature of stream 106 was measured by thermal couple meters and temperature readings were collected every 5 minutes. The results of the water temperature readings are shown in Fig. 2.

As a comparison, two layers of the alkyd resin based paint matrix (containing no solar heat absorbent microparticles) were applied onto the external surface of an identical heat exchanging system and subject to the same conditions as above. This blank coating is referred to as coating 208 in Figs. 2 and 3.

As seen in Fig. 2, coating 108 increased from about 30°C to a maximum of about 52.5°C after about 16 hours of exposure to sunlight 102. In comparison, coating 208 increased from about 27°C to a maximum of only about 43°C after the same duration of exposure. Accordingly, it is evident that coating 108 is capable of absorbing more heat than coating 208.

The percentage reflectance of coating 108 and coating 208 is shown in Fig. 3. It can be seen in Fig. 3 that the percentage reflectance of coating 108 is distinctly lower than that of coating 208 between the wavelengths of about 800 nm and about 2300 nm, i.e. within the infrared region. Accordingly, it is evident that coating 108 is especially capable of absorbing infrared radiation.

Applications

The disclosed heat absorbing coating is advantageously able to absorb and store solar heat more efficiently than prior art coatings.

5 The disclosed heat absorbing coating may be used as a paint for coating on surfaces. Thus, the disclosed heat absorbing coating may be used as a solar heat collector.

Advantageously, the disclosed solar heat absorbing coating is easy to use and does not require high
10 temperature and/or pressure conditions for use.

The disclosed installation having the solar heat absorbing coating coated thereon is able to effectively utilize the stored solar heat. In one embodiment, the stored solar heat is advantageously capable of being used
15 to provide heated fluids for domestic and industrial applications.

It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing
20 disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Claims

1. A coating composition comprising a polymer matrix, comminuted
microparticles comprising a mixture of silicates, silicon
5 oxides, aluminates, aluminum oxides and zirconium oxides, said
comminuted microparticles having a particle size of from 0.5
 μm to 50 μm and a dispersant to disperse said comminuted
microparticles in said polymer matrix, wherein the comminuted
microparticles comprise nano-sized pores, wherein the
10 comminuted microparticles are present in an amount from 10 wt%
to 40 wt% of the total weight of the coating composition, and
wherein said coating composition has less than 20% reflectance
of solar radiation.
- 15 2. The coating composition of claim 1, wherein the polymer matrix
is selected from the group consisting of a solvent-based
organic polymer matrix and a water-based acrylic polymer
matrix.
- 20 3. The coating composition of any one of the preceding claims,
wherein the dispersant comprises butanol.
4. The coating composition of any one of the preceding claims,
wherein the polymer matrix is present in an amount from 50 wt%
25 to 80 wt% of the total weight of the coating composition.
5. The coating composition of any one of the preceding claims,
wherein the dispersant is present in an amount from 5 wt% to
20 wt% of the total weight of the coating composition.
- 30 6. The coating composition of any one of the preceding claims,
wherein the nano-sized pores have a pore size of from 1 nm to
500 nm.

7. The coating composition of any one of the preceding claims when used to prepare a coating having less than 20% reflectance of solar radiation.

5 8. A method of producing a coating composition having less than 20% reflectance of solar radiation, the method comprising the steps of:

a. providing particles having an initial particle size of from 0.5 μm to 150 μm ;

10 b. mixing the particles having an initial particle size of from 0.5 μm to 150 μm with a polymer matrix and a dispersant to obtain a substantially homogenous mixture, wherein the particles are selected to be present in an amount from 10 wt% to 40 wt% of the
15 total weight of the mixture; and

c. comminuting the particles in said homogenous mixture to obtain the coating composition, wherein the coating composition comprises comminuted microparticles having a particle size of from 0.5 μm to 50 μm and wherein

the comminuted microparticles comprise nano-sized pores.

9. The method of claim 8, wherein the comminuting step
5 comprises a high shear process step.

10. The method of claim 9, wherein the high shear process
step is undertaken for a duration of 30 minutes to 120
minutes.

10 11. The method of any one of claims 9-10, wherein the high
shear process step is undertaken at atmospheric temperature
and pressure.

15 12. The method of any one of claims 8-11, wherein the
particles having an initial particle size of from 0.5 μm to
150 μm are comprised of a material selected from the group
consisting of silicates, silicon oxides, aluminates,
aluminum oxides, zirconium oxides and mixtures thereof.

20 13. A heat exchanging system comprising at least one
substrate coated with the coating composition of any one of
claims 1-7, wherein said at least one substrate is in
thermal communication with a fluid.

25 14. The heat exchanging system of claim 13, wherein the
fluid is a heat exchange fluid adapted to absorb heat
transferred from said at least one substrate.

30 15. The heat exchanging system of any one of claims 13-14,
wherein said system is adapted to receive heat energy from
solar radiation.

16. Paint comprising a coating composition of any one of claims 1-7.