Description
A Composite And A Method Of Preparing The Same

References to Related Applications

This application claims priority to Singapore application number 10201902068U filed on 7 March 2019, the disclosure of which is hereby incorporated by reference.

Technical Field

The present invention relates to a composite, a method of preparing the same and uses thereof.

Background Art

Microbial infections and the development of antimicrobial resistance have received attention as one of the most critical issues facing the public health and security. The creation of clean antimicrobial surfaces with long-term stabilities and activities have tremendous applications involving almost all aspects of daily life, such as medical devices, hospital surfaces, textiles, packaging, electrical appliances, marine antifouling, filters and public surfaces.

Inorganic antimicrobial materials, especially semiconductor antimicrobial materials, are less prone to chemical contamination and possess long-term stability. Some metal or metal oxides, such as silver, zinc oxide and titanium oxide particles, have been used as antimicrobial ingredients in various products or in antimicrobial surface coatings. However, these materials have various limitations, such as heavy metal contamination/ toxicity for silver-based materials and low antimicrobial efficacies due to dependence on photo irradiation and uncertain nano-toxicity for zinc oxide and titanium oxide materials. Redox active Zn/ZnO, Zn/ZnS and Zn/ZnS_xO_{1-x} composite materials have been developed and possess excellent antimicrobial property. However, these types of inorganic composites have difficulties in formulation and dispersion into various matrices.

Therefore, there is a need to provide a process and a composite material for antimicrobial activity that overcome or ameliorate one or more of the disadvantages mentioned above.

Summary

~~In one aspect, t~~The present disclosure relates to a composite comprising an inorganic metal or alloy core at least partially covered by a protection layer comprising a carboxylate salt, a metal oxide, a metal oxide salt or a metal-amino acid complex.

In one aspect, the present disclosure relates to a comprising an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

Advantageously, the composite may demonstrate an antimicrobial activity in the form of antibacterial and antifungal effects. Thus, the composite may be used on its own as a general antimicrobial agent or antimicrobial surface coating or mixed in other systems as an antimicrobial additive.
Further advantageously, the composite may be highly active and stable and may exhibit long-term activity.

Still further advantageously, the composite may be easily synthesized, enabling scale-up manufacturing. The composite may also be readily formulated and dispersed into various matrices, thus it may be provided in different forms, such as films, plates and particles.

~~In another aspect, t~~The present disclosure relates to a method of preparing the composite comprising an inorganic metal or alloy core at least partially covered by a protection layer comprising a carboxylate salt, a metal oxide, or a metal oxide salt or a metal-amino acid complex, comprising the step of mixing a metal or alloy with an acid, at elevated temperature for a time duration, optionally in the presence of a solvent.

In another aspect, the present disclosure relates to a method of preparing a composite comprising an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell,

the method comprising the step of mixing a metal or alloy with an acid, at elevated temperature for a time duration, optionally in the presence of a solvent.

Advantageously, the method of preparing the composite may be applied on various metal or alloy surfaces to generate activated surfaces and impose antimicrobial effect.

~~In another aspect, t~~The present disclosure relates to use of a composite as an antimicrobial agent, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection layer comprising a carboxylate salt, a metal oxide, a metal oxide salt or a metal-amino acid complex.

In another aspect, the present disclosure relates to a use of a composite as an antimicrobial agent, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

Advantageously, the use of the composite may cause a 5-log reduction of gram-positive bacteria, gram-negative bacteria or fungi population within 18 hours.

~~In another aspect, t~~The present disclosure relates to a composite for use in the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection layer comprising a carboxylate salt, a metal oxide, a metal oxide salt or a metal-amino acid complex.

In another aspect, the present disclosure relates to a composite for use in the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids;

(ii) a metal oxide salt;

(iii) or a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

~~In another aspect, t~~The present disclosure relates to use of a composite in the manufacture of a medicament for the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection layer comprising a carboxylate salt, a metal oxide, a metal oxide salt or a metal-amino acid complex.

In another aspect, the present disclosure relates to a use of a composite in the manufacture of a medicament for the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids;

(ii) a metal oxide salt;

(iii) or a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer

~~In another aspect, t~~The present disclosure relates to a method of inhibiting microbial activity or treating a microbial infection or disease comprising administering an antimicrobial composition comprising the composite as disclosed herein to a subject or applying the antimicrobial composition on a surface.

Definitions

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

The term “composite” as used herein refers to a material made of two or more constituent components that are of different physical and/or chemical properties such that when combined, the resulting material has characteristics different from the constituent components and the individual components remain separate and distinct within the finished structure.

The term “antimicrobial” as used herein refers to the capability to cause cell inhibition, cell injury, cell death or to control the growth of target bacteria and fungi microorganisms.

The term “additive” as used herein refers to a substance that is added to another substance or product in minor quantities to impart or improve certain desired performance properties.

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 composite comprising an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ~~salt, a metal oxide,~~;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

2. The composite of claim 1, wherein said ~~core comprises a~~ metal is selected from the group consisting of Group 2, Group 4, Group 7, Group 8, Group 12 or Group 13 of the Periodic Table of Elements, combinations thereof and alloys thereof.

3. The composite of claim 1 or 2, wherein said metal is selected from the group consisting of zinc, iron, aluminium, titanium, magnesium, and manganese.

4. The composite of any one of claims 1 to 3, wherein in (ii) said metal oxide salt is formed from an ~~acid is selected from the group consisting of organic acids,~~ inorganic acid~~s, and mixtures thereof~~.

~~5. The composite of claim 4, wherein said organic acid is selected from the group consisting of carboxylic acids, amino acids, and mixtures thereof.~~

~~6. The composite of claim 5, wherein said carboxylic acid is a saturated monocarboxylic acid of the formula $CH_3(CH_2)_nCOOH$, wherein n is an integer from 0 to 20.~~

~~7. The composite of claim 5, wherein said carboxylic acid is selected from the group consisting of saturated fatty acids, unsaturated fatty acids, aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids, α-hydroxyl acids and divinylether fatty acids.~~

~~8~~5. The composite of any one of claim~~s~~ 1 to 3~~-5~~, wherein in (iii) said metal-amino acid complex is formed from an ~~said~~ amino acid ~~is~~ selected from the group consisting of proteinogenic amino acids, non-proteinogenic amino acids, and mixtures thereof.

~~9~~6. The composite of claim 4, wherein said inorganic acid is selected from the group consisting of phosphoric acid, polyphosphoric acids, tungstic acids, vanadic acid, molybdic acid, and heteropolyacids.

7. The composite of claim 5, wherein said proteinogenic amino acid is selected from the group consisting of arginine, histidine, lysine, phenylalanine, tryptophan, glutamic acid, aspartic acid and tyrosine; and said non-proteinogenic amino acid is selected from levothyroxine, hydroxyproline, γ-aminobutyric acid, selenomethionine and carnitine.

~~10~~8. The composite of any of claims 1 to ~~9~~7, wherein said protection shell layer is polymeric or non-polymeric.

~~11~~9. The composite of any one of claims 1 to ~~10~~8, wherein said protection shell layer is porous or non-porous.

~~12~~10. The composite of any one of claims 1 to ~~11~~9, wherein said inorganic metal or alloy core is of a size in the range of 0.01 µm to 100 µm or said protection shell layer is of a thickness in the range of 5 nm to 1,000 nm.

~~13~~11. The composite of any one of claims 1 to ~~12~~10, wherein said protection shell layer is in a mass weight percentage range of 0.1 % to 20 % by weight of the inorganic core.

~~14~~12. The composite of any one of claims 1 to ~~13~~11, wherein said composite is in the size range of 100 nm to 500,000 nm.

~~15~~13. A method of preparing ~~the~~ a composite comprising an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ~~salt, a metal oxide,~~;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell,

the method comprising the step of mixing a metal or alloy with an acid, at elevated temperature for a time duration, optionally in the presence of a solvent.

~~16~~14. The method according to claim ~~15~~13, wherein said elevated temperature is in the range of 50 °C to 180 °C, or wherein said time duration is in the range of 1 hour to 50 hours.

~~17~~15. Use of a composite as an antimicrobial agent, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ~~salt, a metal oxide,~~;

(ii) a metal oxide salt; or

(iii) a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

~~18~~16. A composite for use in the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ~~salt, a metal oxide,~~;

(ii) a metal oxide salt;

(iii) or a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

~~19~~17. Use of a composite in the manufacture of a medicament for the treatment or prophylaxis of microbial infection, wherein said composite comprises an inorganic metal or alloy core at least partially covered by a protection shell layer comprising:

(i) a metal carboxylate formed from a carboxylic acid selected from the group consisting of aromatic carboxylic acids, dicarboxylic acids, tricarboxylic acids, keto acids and α-hydroxyl acids ~~salt, a metal oxide,~~;

(ii) a metal oxide salt;

(iii) or a metal-amino acid complex,

wherein the metal of the inorganic metal core is the same as the metal in the metal carboxylate, metal oxide salt or metal-amino acid complex of the protection shell layer.

~~20. A method of inhibiting microbial activity or treating a microbial infection or disease comprising administering an antimicrobial composition comprising said composite of claim 1 to a subject or applying the antimicrobial composition on a surface.~~