[0005] There is therefore a need for a UV blocking compound with effective blocking properties across a wide range of UV wavelenths. The compound is preferably readily dispersible in film forming materials. The resulting films are preferably transparent to visible light.

OBJECT OF THE INVENTION

[0006] It is an object of the present invention to at least partially satisfy the above need. It is a further object to at least partially overcome, or at least ameliorate, one or more of the above disadvantages of prior art materials.

SUMMARY

[0007] In the present disclosure, there is provided a coating composition comprising a metal complex comprising an organic acid or anion thereof coordinated to a metal ion; and a polymer. There may be no covalent bond between said metal complex and the polymer. In the present context, the term "metal complex" should be understood to include salts of a metal ion.

[0007a] In a first aspect, there is provided a coating composition comprising an iron complex comprising a carboxylic acid or anion thereof coordinated to an iron ion and a water-soluble polymer, wherein the iron complex and the polymer are both in solution in an aqueous solvent; wherein there is no covalent bond between said iron complex and the polymer and wherein the ratio of polymer to the iron content is in the range of 40:1 to 2:1 by weight.

[0008] The following options may be used either individually or in any suitable combination.

[0009] In some embodiments the metal complex and the polymer are both in solution in a solvent. This solvent may be aqueous. It may contain no organic solvent. In other embodiments, the coating composition as described above comprises less than about 1% solvent by weight. The metal complex and the polymer may be distributed substantially homogenously through the composition.

[0010] The metal of the metal complex may be a group 8 element, or may be a group 9 element or may be a group 10 element. In particular, the metal may be iron, nickel, cobalt or ruthenium. Optionally, the metal is iron. The oxidation state of the metal may be 3+.

may be no less than 70% (or no less than 80 or 90%) for any wavelength in the range of 500 nm to 700 nm. The coating composition may be colourless. It may be optically clear. It may be non-cloudy. For these visible light wavelengths, the metal complex may have a molar extinction coefficient of no more than about $5*10^4 M^{-1}m^{-1}$, or no more than about 10^4 or no more than about $5*10^3$ or no more than about 10^3 or no more than about 10^2 $M^{-1}m^{-1}$.

[0015] The oxygen transmission rate of the coating composition as described herein may be lower than 10cc/[m^2.day]. The water vapor transmission rate of the said coating composition may be lower than 10 gm/[m^2.day].

[0016] In a specific embodiment, there is provided a coating composition comprising a metal complex comprising an organic acid, e.g. a carboxylic acid or anion thereof, coordinated to an Fe^{3+} ion; and a polymer, wherein there is no covalent bond between said metal complex and the polymer, and wherein the complex is substantially homogeneously distributed through the polymer. This coating composition may have less than about 1% solvent by weight.

[0017] In another specific embodiment, there is provided a coating composition comprising a metal complex comprising a carboxylic acid or anion thereof coordinated to a metal ion; and a polymer which is either polyvinyl alcohol or a partially hydrolysed polyvinyl acetate and wherein the complex is substantially homogeneously distributed through the polymer. There may be no covalent bond between said metal complex and the polymer. This coating composition may have less than about 1% solvent by weight.

[0018] In another specific embodiment, there is provided a coating composition comprising a metal complex comprising a carboxylic acid or anion thereof coordinated to an Fe^{3+} ion; and a polymer which is either polyvinyl alcohol or a partially hydrolysed polyvinyl acetate, wherein the carboxylic acid or anion of the complex has a second functional group, optionally a second carboxylic acid or a hydroxyl group, which is also coordinated to the Fe^{3+} ion and wherein the complex is substantially homogeneously distributed through the polymer. This coating composition may have less than about 1% solvent by weight.

[0018a] In another aspect, there is provided a non-cloudy coating composition comprising less than about 1% solvent by weight obtained from the coating composition as defined herein, after evaporating the solvent from said solution.

[0019] In the present disclosure, there is provided an article comprising a substrate and a coating composition as described herein in the form of a layer on a surface of the substrate.

[0019a] In another aspect, there is provided an article comprising a substrate and a coating composition as described herein in the form of a layer on a surface of said substrate.

metal ion. There may be no covalent bond formed between the metal complex and said polymer in the process.

[0030a] In another aspect, there is provided a process for making a coating composition as described herein, comprising combining a solution of an iron complex with a solution of a water-soluble polymer.

[0031] The following options may be used either individually or in any suitable combination.

[0032] The metal complex may be as described above.

[0033] The process may comprise a first step of combining a solution of a metal ion (i.e. a salt of the metal ion) with a solution of an organic acid or salt thereof so as to produce the solution of the metal complex.

[0034] After obtaining the solution of the metal complex and the polymer, the process may further comprise the step of drying the coating composition. The process may further comprise the step of applying a film of the coating composition onto a surface of a substrate prior to the step of drying.

[0035] In a specific embodiment, the process comprises combining an Fe^{3+} ion with a carboxylic acid in an aqueous solvent to produce a solution of a Fe^{3+} complex with the carboxylic acid and combining the solution of the complex with an aqueous solution of a polymer (e.g. polyvinyl alcohol or a partially hydrolysed polyvinyl acetate) to form a coating composition. This embodiment may also comprise drying the coating composition, optionally to a solvent content of less than about 1% by weight. It may comprise applying a film of the coating composition onto a surface of a substrate and drying the coating composition on said surface. In this embodiment the carboxylic acid may have a second functional group, e.g. a second carboxylic acid or a hydroxyl group. The second functional group may also complex with the Fe^{3+} ion.

[0036] The process as described herein may make the coating composition as described herein. The coating composition as described herein may be made by the process as described herein.

[0037] In another aspect, there is provided a process for making an article, comprising the step of applying a coating composition as described herein, or a coating composition made by the process as described herein, to a surface of a substrate.

[0045] In another aspect, there is provided a coating composition made by the process as described herein.

[0046] In another aspect, there is provided an article made by the process as described herein.

[0046a] In another aspect, there is provided the use of a coating composition as described herein in food packaging, windows, windshields, prescription glasses or sun screens.

[0047] The coating composition as described herein may be used for reducing exposure of a substrate to ultraviolet radiation, said composition being disposed on said substrate. For example, it might be used in food packaging, windows, windshields, prescription glasses or sun screens.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048] Specific embodiments of the present invention will now be described, by way of examples only, with reference to the accompanying drawings, wherein:

[0049] Figure 1 shows UV-Vis spectra of potassium ferric oxalate complex in H_2O. (a) 0.01wt% Fe^{3+}; (b) 0.02wt% Fe^{3+}; (c) 0.05wt% Fe^{3+}; (d) 0.10wt% Fe^{3+}.

[0050] Figure 2 shows UV-Vis spectra of ferric citrate complex in H_2O. (a) 0.01wt% Fe^{3+}; (b) 0.02wt% Fe^{3+}; (c) 0.05wt% Fe^{3+}; (d) 0.10wt% Fe^{3+}; (e) 0.20wt% of Fe^{3+}; (f) 0.50wt% of Fe^{3+}; (g) 1.00wt% of Fe^{3+}.

[0051] Figure 3 shows UV-Vis spectra of sodium ferric citrate complex in H_2O. (a) 0.01wt% Fe^{3+}; (b) 0.02wt% Fe^{3+}; (c) 0.05wt% Fe^{3+}; (d) 0.10wt% Fe^{3+}; (e) 0.20wt% of Fe^{3+}; (f) 0.50wt% of Fe^{3+}; (g) 1.00wt% of Fe^{3+}.

[0052] Figure 4 shows UV-Vis spectra of ferric tartrate complex in H_2O. (a) 0.01wt% Fe^{3+}; (b) 0.02wt% Fe^{3+}; (c) 0.05wt% Fe^{3+}; (d) 0.10wt% Fe^{3+}; (e) 0.20wt% of Fe^{3+}; (f) 0.50wt% of Fe^{3+}; (g) 1.00wt% of Fe^{3+}.

[0053] Figure 5 shows UV-Vis spectra of ferric malonate complex in H_2O. (a) 0.01wt% Fe^{3+}; (b) 0.02wt% Fe^{3+}; (c) 0.05wt% Fe^{3+}; (d) 0.10wt% Fe^{3+}; (e) 0.20wt% of Fe^{3+}; (f) 0.50wt% of Fe^{3+}; (g) 1.00wt% of Fe^{3+}.

CLAIMS

1. A coating composition comprising
   a) an iron complex comprising a carboxylic acid or anion thereof coordinated to an iron ion; and
   b) a water-soluble polymer,
   wherein the iron complex and the polymer are both in solution in an aqueous solvent; wherein there is no covalent bond between said iron complex and the polymer; and wherein the ratio of polymer to the iron content is in the range of 40:1 to 2:1 by weight.

2. The coating composition of claim 1, wherein the carboxylic acid, or anion thereof, comprises a second functional group coordinated with the iron ion.

3. The coating composition of claim 2, wherein the second functional group is a carboxyl group, or a hydroxyl group or a thiol group or anion of any one of these.

4. The coating composition of any one of claims 1 to 3, wherein the iron content of the composition is in the range of 0.0005wt% to 10.0wt%.

5. The coating composition of any one of claims 1 to 4, wherein the polymer is selected from the group consisting of polyvinyl alcohol, a partially hydrolyzed polyvinyl alcohol ester and any derivatives and copolymers thereof.

6. A non-cloudy coating composition comprising less than about 1% solvent by weight obtained from the coating composition of any one of claims 1 to 5, after evaporating the solvent from said solution.

7. The coating composition according to any one of claims 1 to 6, wherein the transmission of UVA, UVB and UVC radiation is at least 90% blocked by a thickness of 10 microns of said composition, optionally by a thickness of 5 microns or of 1 micron thereof.

8. The coating composition of any one of claims 1 to 7, wherein at least 70% of visible light in the range of 500 nm to 700 nm is transmitted through a thickness of 10 microns of said composition, optionally by a thickness of 5 microns or of 1 micron thereof.
9. The composition of any one of claims 1 to 8, wherein the oxygen transmission rate of the coating composition is less than 10cc/[m^2.day].
10. The composition of any one of claims 1 to 9, wherein the water vapor transmission rate of the coating composition is less than 10 gm/[m^2.day].
11. An article comprising;
    a) a substrate; and
    b) a coating composition of any one of claims 1 to 10 in the form of a layer on a surface of said substrate.
12. The article of claim 11, wherein the coating composition has a thickness in the range of 1 μm to 250 μm, optionally in the range of 1 μm to 10 μm.

13. The article of claim 11 or claim 12, wherein the substrate is selected from materials in the group consisting of polymer, glass, wood, silicon, metal, metal alloy and any mixture thereof.

14. The article of any one of claims 11 to 13, further comprising a laminate layer bonded to the coating composition layer whereby the coating composition is disposed between the substrate and the laminate layer.

15. The article of claim 14, wherein the laminate layer comprises a material selected from the group consisting of polymer, glass, and any mixture thereof.

16. The article of claim 15, wherein the laminate layer comprises polypropylene.

17. The article of any one of claims 11 to 16, wherein the film is substantially non-toxic or has no toxic extractables.

18. A process for making a coating composition of any one of claims 1 to 10, comprising combining a solution of an iron complex with a solution of a water-soluble polymer.

19. The process of claim 18 comprising combining a solution of an iron ion with a solution of a carboxylic acid or salt thereof so as to produce the solution of the iron complex.
20. The process of claim 18 or claim 19, further comprising the step of drying the coating composition.
21. A process for making an article according to any one of claims 11 to 17, comprising the step of applying a coating composition according to any one of claims 1 to 5 to a surface of a substrate.
22. The process of claim 21, further comprising a step of drying the coating composition after said applying.
23. The process of claim 22, wherein the drying comprises air flash drying at room temperature.
24. The process of any one of claims 21 to 23, further comprising the step of laminating the article with a laminate layer after said applying.
25. A coating composition made by the process of any one of claims 18 to 20.
26. An article made by the process of any one of claims 21 to 24.
27. The use of a coating composition according to any one of claims 1 to 10 for reducing exposure of a substrate to ultraviolet radiation, said composition being disposed on said substrate.
28. Use of a coating composition according to claim 6 in food packaging, windows, windshields, prescription glasses or sun screens.