[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 there is no covalent bond between said iron complex and the polymer and wherein the ratio of polymer to the iron 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.

[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 a second 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, wherein said coating composition contains less than about 1%w/v solvent.

[0020] The following options may be used either individually or in any suitable combination.

[0021] The coating composition may contain less than about 1% w/v solvent by weight. It may cover substantially all of said surface, e.g. at least about 90, 95 or 99% thereof.

[0022] The coating composition may adhere to the substrate. The adhesive strength between the substrate and the coating composition may be greater than the cohesive strength of the coating composition. Thus if sufficient force is applied, the coating composition may fail within the body of the composition rather than at the adhesive interface between the composition and the substrate.

[0023] The coating composition may have a thickness in the range of about 1 μm to about 250 μm, for example in the range of 1 μm to 20 μm, optionally in the range of 1 to 10 μm.

[0024] The substrate may be for example polymer, glass, wood, silicon, metal, metal alloy or any mixture thereof, or may be some other suitable substrate. The substrate may be degradable by any one, or more, optionally all, of UVA, UVB or UVC radiation. The substrate may be a polymer. It may be a polymer film. In particular, the polymer film may comprise, or may be, a polyester. The polyester may be optionally substituted polyglycolide, optionally substituted polylactic acid, optionally substituted polycaprolactone, optionally substituted polyhydroxyalkanoate, optionally substituted polyhydroxybutyrate, optionally substituted polyethylene adipate, optionally substituted polybutylene succinate, optionally substituted polyethylene terephthalate, optionally substituted polybutylene terephthalate, optionally substituted polytrimethylene tetraphthalate, optionally substituted polyethylene naphthalate or optionally substituted aromatic polyesters produced from a 4-hydroxybenzoic acid and a 6-hydroxynaphthalene-2-carboxylic acid. It may be a blend of any two or more of these.

[0025] The article may further comprise a laminate layer bonded to the coating composition layer, whereby the coating composition is disposed between the substrate and the laminate layer. In other words, the laminate layer may be on top of the coating composition, which may be on top of the substrate. The laminate layer may be, or may comprise, a polymer, glass, a mixture thereof or some other material or mixture of materials. For instance, the laminate layer may comprise polypropylene. The polypropylene may be

biaxially oriented polypropylene (BOPP). The laminate layer may provide additional barrier properties to inhibit access of undesirable substances to the surface of the substrate.

[0026] The oxygen transmission rate of the article as described herein may be lower than 10cc/[m^2.day]. The water vapor transmission rate of the said article may be lower than 10 gm/[m^2.day]. The film of the article as described herein may be substantially non-toxic. It may have no toxic extractables. Any extractables may have an LD50 towards humans of greater than about 1000mg/kg body weight, or of greater than about 2000, 3000, 4000 or 5000mg/kg body weight.

[0027] In a specific embodiment, 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, said layer having a thickness of about 1 to about 250 microns and having a solvent content of less than about 1% by weight.

[0028] In another specific embodiment there is provided an article comprising:

- a substrate and
- a coating composition comprising (i) a metal complex comprising an organic acid, e.g. a carboxylic acid, or anion thereof coordinated to a metal ion; and (ii) either polyvinyl alcohol or a partially hydrolysed polyvinyl acetate, said composition being in the form of a layer on a surface of the substrate, said layer having a thickness of about 1 to about 250 microns and having a solvent content of less than about 1% by weight.

[0029] In yet another specific embodiment 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, said layer having a thickness of about 1 to about 250 microns and having a solvent content of less than about 1% by weight and
- a laminate layer bonded to the coating composition layer, whereby the coating composition is disposed between the substrate and the laminate layer.

[0030] In the present disclosure, there is provided a process for making a coating composition, which comprises combining a solution of a metal complex with a solution of a polymer, wherein the metal complex comprises an organic acid, or anion thereof, coordinated to a

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

[0030a] In a third 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, wherein the iron complex comprises a carboxylic acid or anion thereof coordinated to an iron ion and wherein the iron complex does not bond covalently to the polymer, and wherein the ratio of polymer to the iron is in the range of 40:1 to 2:1 by weight.

[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 a fourth 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.

[0038] The following options may be used either individually or in any suitable combination.

[0039] The step of applying the coating composition to the substrate may be performed by blade deposition.

[0040] The process may further comprise a step of drying the coating composition after said applying. The drying may comprise air flash drying, for example at room temperature. Alternatively, the step of drying may comprise vacuum drying, for example at a temperature in the range of 40°C to 60°C.

[0041] The process may further comprise the step of laminating the article with a laminate layer after said applying. The step of laminating may be performed at a temperature in the range of 100°C to 150°C. The laminating step may be performed at a roll pressure in the range of 0.8 to 2.5 bars. The step of laminating may comprise applying a laminating layer to a coating composition on the surface of the substrate.

[0042] In a specific embodiment, there is provided a process for making an article comprising applying a coating composition as described herein, or a coating composition made by the process as described herein, to a substrate by blade deposition and applying a laminating layer to a coating composition on the surface of the substrate. The substrate may be a polymer, e.g. a polyester.

[0043] In another embodiment there is provided a process for making an article comprising applying a coating composition to a substrate by blade deposition and applying a laminating layer to a coating composition on the surface of the substrate, wherein the coating composition comprises a metal complex comprising an organic acid, e.g. a carboxylic acid, or anion thereof coordinated to an Fe^{3+} ion; and either polyvinyl alcohol or a partially hydrolysed polyvinyl acetate, wherein the organic acid or anion thereof has a second functional group, optionally a carboxylic acid or a hydroxyl group, which is also coordinated to the Fe^{3+} ion. The substrate may be a polymer, e.g. a polyester.

[0044] The process as described herein may make an article as described herein. The article as described herein may be made by the process as described herein.

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

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

[0046a] In a seventh 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+}.