quality of eggs and extending shelf life. Among the coating materials, mineral oil chitosan have shown to be very promising and is currently used to preserve the internal quality of eggs. However, there are problems associated with oil coating such as the long period of time required for the drying process (which can take more than one day for each layer of coating), formation of thick coatings from the mineral oil, and greasy surfaces that are not suitable for handling.

There is a need to provide a polymer composite that overcomes, or at least ameliorates, one or more of the disadvantages described above. There is also a need to provide a multi-layered structure that is able to function as a coating that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

There is provided a polymer composite comprising: (a) a clay modified with a coupling agent; and (b) a plant protein polymeric matrix, wherein said coupling agent couples said modified clay to said plant protein polymeric matrix.

According to a first aspect, there is provided a polymer composite comprising: a) a clay modified with a silane coupling agent; and b) a plant protein polymeric matrix, wherein said silane coupling agent couples said modified clay to said plant protein polymeric matrix.

Advantageously, the polymer composite may be able to act as a barrier layer against a gas for coating and packaging applications. The coating may also enhance the mechanical strength of the coated substrates or packaged food. The coating may also act as a barrier against moisture or water vapour.

There is provided a method of forming a polymer composite coating on a substrate comprising the step of applying a polymer composite composition on the substrate under conditions to form the coating thereon.

According to a second aspect, there is provided a method of forming a polymer composite coating on a substrate comprising the step of applying a polymer composite composition on said substrate under conditions to form said coating thereon, wherein said polymer composite composition comprises a clay modified with a silane coupling agent and a plant protein.

There is provided a multi-layered structure comprising: (a) a polymer composite layer; and (b) a polymer substrate layer, wherein the polymer composite layer is a layer comprised of: (i) a clay modified with a coupling agent; and (ii) a plant protein polymeric matrix.

According to a third aspect, there is provided a multi-layered structure comprising: (a) a polymer composite layer; and (b) a polymer substrate layer, wherein the polymer composite layer is a layer comprised of: (i) a clay modified with a silane coupling agent; and (ii) a plant protein polymeric matrix.

There is provided a polymer composite composition comprising a liquid medium of (a) a clay modified with a coupling agent; and (b) a plant protein.

According to a fourth aspect, there is provided a polymer composite composition comprising a liquid medium of (a) a clay modified with a silane coupling agent; and (b) a plant protein.

Definitions

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

The term “clay” as used herein refers to a naturally occurring material composed primarily of fine-grained minerals, which depending on the water content, can deform when a stress is applied on the clay, and become harder and non-deformable when heat is applied to the clay. Clay can be generally divided into four groups depending on their structures and contents, such as kaolinite, montmorillonite-smectite, illite, or chlorite. Clay is made of clay minerals that are structured within the clay as planes of cations, arranged in sheets, which may be tetrahedrally or octahedrally coordinated (with oxygen), which in turn are arranged into layers of tetrahedral and/or octahedral sheets. As such, it is possible to introduce additives into the clay by intercalating such additives into the region between the sheets. Where the clay is coupled with a coupling agent, the clay can be termed as modified

Claims

1. A polymer composite comprising:

    a) a clay modified with a silane coupling agent; and

    b) a plant protein polymeric matrix,

    wherein said silane coupling agent couples said modified clay to said plant protein polymeric matrix.

2. The polymer composite according to claim 1, further comprising an antimicrobial agent coupled to said silane coupling agent.

3. The polymer composite according to claim 1 or 2, wherein said silane coupling agent is an organosilane coupling agent.

4. The polymer composite according to claim 3, wherein said organosilane coupling agent is selected from the group consisting of amino functional silane coupling agent, an epoxy functional silane coupling agent, a vinyl functional silane coupling agent.

5. The polymer composite according to claim 3 or 4, wherein said organosilane coupling agent is selected from the group consisting of N-β(aminoethyl)-γ-aminopropylmethyldimethoxysilane, N-β(aminoethyl)-γ-aminopropyltrimethoxysilane, γ-aminopropyltriethoxysilane, aminopropyltrimethoxysilane, aminopropylmethyldiethoxysilane, diethylmethyltriethoxysilane, bis(triethoxysilylpropyl)tetrasulfide, bis(triethoxycilylpropyl)disulphide, 3-glycidoxypropyltriethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, 2-(3,4-epoxycyclohexyl)-ethyltrimethoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, ethenyltriethoxysilane, vinyl(2-methoxyethoxy)silane, N-propyltrimethoxysilane, γ-methacryloxy-propyl trimethoxysilane, γ-mercaptopropyl trimethoxy silane, mercaptopropyltriethoxysilane, triethoxysilylpropylmercaptan, mercaptopropylmethyldimethoxysilane, 3-ureidopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane, methyltrimethoxy silane, N-octyltriethoxy-silane and combinations thereof.

6. The polymer composite according to any one of the preceding claims, wherein said plant protein is a prolamine protein, a derivative thereof or mixtures thereof.

7. The polymer composite according to claim 6, wherein said prolamine protein is selected from the group consisting of zein, gliadin, hordein, secalin, kafirin and avenin.

8. The polymer composite according to any one of claims 2 to 7, wherein said antimicrobial agent is selected from the group consisting of chitosan, a chitosan derivative compound, a transition metal, an inorganic oxide and combinations thereof.

9. The polymer composite according to claim 8, wherein said chitosan derivative compound is a chitosan-arginine compound, a chitosan-guanidine compound, a

methyl-thiocarbamoyl chitosan derivative, a phenylthiocarbamoyl chitosan derivative and a chitosan-lysine compound.

10. The polymer composite according to claim 8, wherein said transition metal is selected from the group containing of copper, cobalt, nickel, zinc, silver, ruthenium, platinum, rhodium, iridium, palladium, osmium, manganese and combinations thereof.

11. The polymer composite according to claim 8, wherein said inorganic oxide is selected from the group consisting of magnesium oxide, zinc oxide, silver oxide, titanium oxide, copper oxide and calcium oxide.

12. The polymer composite according to any one of the preceding claims, wherein the concentration of said modified clay in the polymer composite is at least 50 wt%, based on the weight of said plant protein polymeric matrix.

13. A method of forming a polymer composite coating on a substrate comprising the step of applying a polymer composite composition on said substrate under conditions to form said coating thereon, wherein said polymer composite composition comprises a clay modified with a silane coupling agent and a plant protein.

14. The method according to claim 13, further comprising the step of, before said applying step, providing said polymer composite composition, wherein said polymer composite composition comprises a clay modified with a coupling agent and a plant protein.

15. The method according to claim 13 or 14, further comprising the step of heating said coated substrate.

16. The method according to any one of claims 13 to 15, further comprising the step of drying said coated substrate.

17. A multi-layered structure comprising:

    a. a polymer composite layer; and

    b. a polymer substrate layer,

    wherein said polymer composite layer is a layer comprised of:

        i. a clay modified with a silane coupling agent; and

        ii. a plant protein polymeric matrix.

18. The multi-layered structure according to claim 17, further comprising an adhesive layer.

19. The multi-layered structure according to claim 17 or 18, wherein said polymer substrate is selected from the group consisting of polyethylene terephthalate, polypropylene and polyethylene.

20. A polymer composite composition comprising a liquid medium of

    a. clay modified with a silane coupling agent; and

b. a plant protein.

21. The polymer composite composition according to claim 20, further comprising an antimicrobial agent.

22. The polymer composite composition according to claim 20 or 21, wherein said liquid medium is an aqueous solution.

23. The polymer composite composition according to any one of claims 20 to 22, wherein the concentration of said modified clay is in the range of 0.1 wt% to 5 wt%, based on the weight of modified clay in the polymer composites suspension.

24. The polymer composite composition according to any one of claims 20 to 23, wherein the concentration of said plant protein is in the range of 0.1 wt% to 2 wt%, based on the weight of plant protein in the polymer composite suspension.

25. The polymer composite composition according to any one of claims 21 to 24, wherein the concentration of said antimicrobial agent is in the range of 0.01 wt% to 5 wt%, based on the weight of antibacterial agent in the polymer composite suspension.