SUMMARY

[0007] In response to the foregoing and other needs, the present disclosure provides a biodegradable aqueous mixture for coating substrates. According to one example, this aqueous mixture is made up of from about 35 to about 75 weight percent water and from about 25 to about 65 weight percent solids. The solids, in turn, are made up of from about 40 to about 99 weight percent of a first poly(hydroxyalkanoate) based on the total dry weight of the solids.

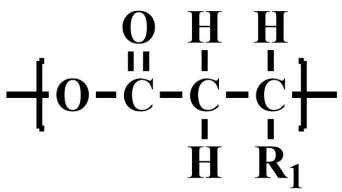
[0008] This first poly(hydroxyalkanoate) is made up of at least 1 mole percent monomer repeat units of 3-hydroxypropionate. Preferably, the first poly(hydroxyalkanoate) is made up of at least 50 mole percent monomer repeat units of 3-hydroxypropionate and, even more preferably, 75 mole percent monomer repeat units of 3-hydroxypropionate.

[0009] In certain examples, the first poly(hydroxyalkanoate) in the aqueous mixture is preferably made up of poly(3-hydroxypropionate).

[0010] In other examples, the first poly(hydroxyalkanoate) in the aqueous mixture is preferably a copolymer or a terpolymer. This copolymer or terpolymer is made up of

[0011] a first repeat unit which is (3-hydroxypropionate),

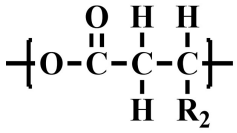
[0012] a second repeat unit according to Formula I



Formula I

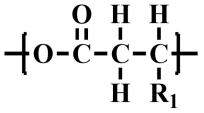
; and

[0013] optionally, a third repeat unit according to Formula II,

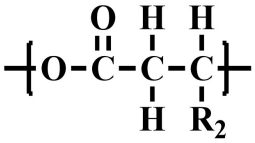
	Formula II

[0014] wherein R1 and R2 are each independently selected from the group consisting of linear or branched alkyl groups having from 1 to 22 carbon atoms.

[0014a] In one aspect, the present disclosure refers to a biodegradable aqueous mixture for coating substrates, the mixture comprising: from 35 to 75 weight percent water and from 25 to 65 weight percent solids, wherein the solids comprise from 40 to 99 weight percent of a first poly(hydroxyalkanoate) based on the total dry weight of the solids, and wherein the first poly(hydroxyalkanoate) comprises at least 1 mole percent monomer repeat units of 3-hydroxypropionate; wherein the first poly(hydroxyalkanoate) is a terpolymer which comprises a first repeat unit which is (3-hydroxypropionate), a second repeat unit according to Formula I

	Formula I ; and

a third repeat unit according to Formula II,

	Formula II

wherein R_1 is methyl, and R_2 is propyl.

[0015] In some examples, the first poly(hydroxyalkanoate) is preferably a copolymer, and R_1 is methyl. In some instances, this poly(hydroxyalkanoate) copolymer is preferably made of from about 10 to about 90 mole percent of the first repeat unit and from about 90 to about 10 mole percent of the second repeat unit. More preferably, the poly(hydroxyalkanoate) copolymer is made of from about 30 to about 70 mole percent of the first repeat unit and from about 70 to about 30 mole percent of the second repeat unit.

[0016] In other examples, the first poly(hydroxyalkanoate) is preferably a terpolymer in which R_1 is methyl and R_2 is propyl. In some instances, this poly(hydroxyalkanoate) terpolymer is preferably made of from about 15 to about 75 mole percent of the first repeat unit, from about 75 to about 15 mole percent of the second repeat unit, and from about 1 to about 5 mole percent of the third repeat unit. More preferably, the terpolymer is preferably made of from about 30 to about 60 mole percent of the first repeat unit, from about 60 to about 30 mole percent of the second repeat unit, and from about 1 to about 5 mole percent of the third repeat unit.

[0017] According to certain examples, the first poly(hydroxyalkanoate) preferably has a weight average molecular weight, as determined by ASTM D4001-20, of at least 50,000 Daltons. More preferably, the first poly(hydroxyalkanoate) has a weight average molecular weight, as determined by ASTM D4001-20, from about 50,000 to about 1,000,000 Daltons.

[0018] In some examples, according to the present disclosure, the solids of the aqueous mixture may include a second poly(hydroxyalkanoate) and the first

poly(hydroxyalkanoate). This second poly(hydroxyalkanoate) does not include monomer repeat units of 3-hydroxypropionate.

[0019] In other examples, the solids of the aqueous mixture may also include at least one biodegradable polymer selected from the group consisting of polybutylene succinate, polybutylene succinate co butylene adipate, polybutylene adipate co butylene terephthalate, polycaprolactone, polylactic acid, poly(vinyl alcohol), polyglycolic acid, polyglycolic acid/ polylactic acid copolymer, cellulose acetate, nano-cellulose, isosorbide esters, and mixtures thereof.

[0020] In some examples, the mixture preferably also includes from about 0.01 weight percent to about 5.0 weight percent of at least one surfactant selected from the group consisting of polysorbates, aromatic polyethylene oxides, sorbitan derivatives, block copolymers of poly(ethylene oxide) and poly(propylene oxide), poly(glycol ethers), poly(vinyl alcohol), alkyl sulfates, alkyl phosphates, stearates, and mixtures thereof.

[0021] According to certain examples, the mixture preferably also includes from about 0.01 weight percent to about 5.0 weight percent of at least one rheology modifier selected from the group consisting of polysaccharides, acrylate-based emulsion copolymers, viscosity depressants, and viscosity enhancers.

[0022] In some instances, the mixture preferably also includes from about 0.01 weight percent to about 2.5 weight percent of at least one wetting and dispersing agent.

[0023] In accordance with certain examples, the mixture preferably also includes from about 0.01 weight percent to about 0.5 weight percent of at least one biocide or biostatic agent.

[0024] In certain examples, the mixture preferably also includes from about 0.1 weight percent to about 5.0 weight percent of at least one coalescing agent selected from the group consisting of bio-succinic acid-based coalescing solvent, 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate, dimethyl carbonate, methanol, ethanol, ketones, acetates, and or mixtures thereof.

[0025] In some examples, the mixture also preferably from about 0.05 to about 1 weight percent of at least one defoamer selected from the group consisting of polyether siloxanes, polyamide particles, and mixtures thereof.

[0026] In some examples, the mixture preferably also includes from about 1 weight percent to about 35 weight percent of at least one filler selected from the group consisting of clays, calcium carbonate, talc, kaolinite, montmorillonite, bentonite, silica, chitin, titanium dioxide, nano clay, or mixtures thereof.

[0027] In certain examples, the mixture includes poly(hydroxyalkanoate) particles having a Dv (90) particle size of no more than about 20 microns and, more preferably, no more than about 10 microns, as determined using ISO 8130-13:201.

[0028] According to certain examples, the mixture, when applied as a substrate coating, preferably has an oxygen transmission rate of less than 50 $cc/m^2/24$ h, as determined according to ASTM D3985. In some instances, the mixture, when applied as a substrate coating, has an oxygen transmission rate from 10 to 50 $cc/m^2/24$ h, as determined according to ASTM D3985.

[0029] In certain examples, the mixture, when applied as a substrate coating, has a water vapor transmission rate of less than 50 $g/m^2/24$ h, according to ASTM F1249. In some instances, the mixture, when applied as a substrate coating, has a water vapor transmission rate from 10 to 50 $g/m^2/24$ h, according to ASTM F1249.

[0030] In a further example, the present disclosure also provides a coated substrate. This coated substrate includes a paperboard substrate having at least a first surface and a second surface; and a coating layer over at least the first surface, wherein the coating is formed by applying the aforementioned biodegradable aqueous mixture.

[0030a] In one aspect, the present disclosure refers to a coated substrate comprising:

a paperboard substrate having at least a first surface and a second surface; and

a coating layer over at least the first surface, wherein the coating is formed by applying the biodegradable aqueous mixture as disclosed herein.