SUMMARY

[0005a] In a first aspect, the present disclosure refers to a polymer composition comprising:

a first biodegradable copolymer, the first biodegradable copolymer comprising

from about 84 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate,

from about 0.1 to about 1.0 mole percent monomer residues of a secondary monomer selected from the group consisting of 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and

monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms,

wherein the monomer residues of the secondary monomer and the tertiary monomer combined comprise from about 1 to about 35 mole percent of the first biodegradable copolymer.

[0005b] In another aspect, the present disclosure refers to a molded article comprising at least 50 weight percent of the polymer composition disclosed herein.

[0005c] In yet another aspect, the present disclosure refers to a fiber or filament comprising at least 50 weight percent of the polymer composition disclosed herein.

[0005d] In a further aspect, the present disclosure refers to a polymeric film comprising at least 50 weight percent of the polymer composition disclosed herein.

[0005e] In another aspect, the present disclosure refers to a dispersion comprising at least 50 weight percent of the polymer composition disclosed herein.

[0006] The above and other needs are met by a polymer composition in accordance with the current disclosure. According to one example, this polymer composition includes at least a first biodegradable copolymer. This first biodegradable copolymer is itself made up of: (1) from about 55 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate, (2) monomer residues of a secondary monomer selected from the group consisting of 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and (3)

monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms.

[0007] In certain examples, the secondary monomer is preferably 3-hydroxyvalerate. In other examples, however, the secondary monomer is preferably 4-hydroxybutyrate. In still other examples, the secondary monomer is preferably 4-hydroxyvalerate or 5-hydroxyvalerate.

[0008] In certain examples, the tertiary monomer is preferably 3-hydroxyhexanoate. In some other examples, the tertiary monomer is preferably 3-hydroxyoctanoate. In still other examples, the tertiary monomer is preferably 3-hydroxydecanoate.

[0009] In certain examples, the first biodegradable copolymer is preferably made up of from about 0.01 to about 20 mole percent (preferably 0.01 to 5 mole percent) monomer residues of the secondary monomer, and from about 1 to about 35 mole percent monomer residues of the tertiary monomer. According to certain examples, the first biodegradable copolymer is more preferably made up of: (1) from about 84 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate, (2) from about 0.1 to about 1.0 mole percent monomer residues of a secondary monomer selected from the group consisting of 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and (3) from about 0.4 to about 15 mole percent monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms.

[0010] In other examples however, the first biodegradable copolymer is preferably made up of from about 1 to about 35 mole percent monomer residues of the secondary

monomer, and from about 0.01 to about 20 mole percent (preferably 0.01 to 5 mole percent) monomer residues of the tertiary monomer. In some instances, the first biodegradable copolymer is more preferably made up of: (1) from about 84 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate, (2) from about 0.4 to about 15 mole percent monomer residues of a secondary monomer selected from the group consisting 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and (3) from about 0.1 to about 1.0 mole percent monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms.

[0011] In certain examples, the first biodegradable copolymer preferably has a weight average molecular weight from about 50,000 to about 7.5 million Daltons. More preferably, the first biodegradable copolymer has a weight average molecular weight from about 450,000 to about 3.0 million Daltons. Most preferably, the first biodegradable copolymer has a weight average molecular weight from about 350,000 to about 1.5 million Daltons.

[0012] In certain examples, the polymer composition includes from about 50 weight percent to about 95 weight percent of the first biodegradable copolymer. Moreover, the polymer composition also preferably includes from about 5 weight percent to about 50 weight percent of a second biodegradable polymer selected from the group consisting of polybutylene adipate terephthalate, polybutylene succinate, polybutylene succinate-co-butylene adipate, polylactic acid, mesolactide, polycaprolactone, polyglycolide, starches, cellulose esters, polysaccharides, polyvinyl alcohol, polyvinyl acetate, polymaleic acid, copolyesters of diols having 2 to 18 carbon atoms and diacids having 2 to 18 carbon atoms, and mixtures thereof.

[0013] In some instances, the first biodegradable copolymer is preferably blended or reactively extruded with the second biodegradable polymer.

[0014] In other instances, the first biodegradable copolymer is preferably blended or reactively extruded with additional polyhydroxyalkanoates.

[0015] In certain examples, the polymer composition includes from about 50 weight percent to about 95 weight percent of the first biodegradable copolymer. Moreover, the polymer composition also preferably includes from about 5 weight percent to about 50 weight percent of a nonbiodegradable polymer selected from the group consisting of polyvinyl chloride, polypropylene, polyethylene, polyethylene terephthalate, and mixtures thereof.

[0016] In certain examples, the polymer composition also includes from about 0.01 weight percent to about 20 weight percent of a nucleating agent selected from the group consisting of (1) compounds having an orthorhombic crystal structure, (2) compounds having a hexagonal crystal structure, (3) compounds having a tetragonal crystal structure, (4) allotrophic elements having at least one crystalline form which is orthorhombic, hexagonal, or tetragonal, (5) polymorphic compounds having at least one crystalline form which is orthorhombic, hexagonal, or tetragonal, and (6) mixtures thereof. For instance, the nucleating agent may, in some examples, be selected from the group consisting of artificial sweeteners, boron nitride, thymine, pentaerythritol, dipentaerythritol, anatase, wulfenite, aragonite, sulfur, selenium, phosphorous, and benzamide.

[0017] In some examples, the polymer composition also includes from about 1.0 weight percent to about 40 weight percent of a filler selected from the group consisting of clays, calcium carbonate, talc, kaolinite, montmorillonite, bentonite, silica, chitin, titanium dioxide, nano clay, nanocellulose, or mixtures thereof.

[0018] In certain examples, the polymer composition also includes from about 0.5 weight percent to about 25 weight percent of a plasticizer selected from the group consisting of sebacates, citrates, fatty esters of adipic, succinic, and glutaric acids, lactates, alkyl diesters having a having a main carbon chain of from about 2 to about 12 carbon atoms, alkyl methyl esters, dibenzoates, propylene carbonate, caprolactone diols having a weight average molecular weight from about 200 to about 10,000, polyethylene glycols diols having a weight average molecular weight from about 400 to about 10,000, esters of vegetable oils (such as soybean, canola, corn, cottonseed, sunflower, and peanut oils), long chain alkyl acids having from about 10 to about 20 carbon atoms, glycerol, isosorbide derivatives and mixtures thereof.

[0019] A variety of articles may be formed from the polymer composition of the present disclosure. For instance, in one example of the present disclosure, a molded article is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

[0020] In a different example of the present disclosure, an extruded article is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

[0021] In another example of the present disclosure, a fiber or filament is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

[0022] In yet another example of the present disclosure, a polymeric film is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

[0023] In still another example of the present disclosure, a foamed article is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

[0024] In a further example of the present disclosure, a dispersion, generally an aqueous dispersion, is provided which made up of at least 50 weight percent of the aforementioned polymer composition.

WHAT IS CLAIMED IS

Claim 1. A polymer composition comprising:

a first biodegradable copolymer, the first biodegradable copolymer comprising

from about 84 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate,

from about 0.1 to about 1.0 mole percent monomer residues of a secondary monomer selected from the group consisting of 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and

monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms,

wherein the monomer residues of the secondary monomer and the tertiary monomer combined comprise from about 1 to about 35 mole percent of the first biodegradable copolymer.

Claim 2. The polymer composition of Claim 1, wherein the secondary monomer comprises 3-hydroxyvalerate.

Claim 3. The polymer composition of Claim 1, wherein the secondary monomer comprises 4-hydroxyvalerate.

Claim 4. The polymer composition of Claim 1, wherein the secondary monomer comprises 5-hydroxyvalerate.

Claim 5. The polymer composition of Claim 1, wherein the tertiary monomer comprises 3-hydroxyhexanoate.

Claim 6. The polymer composition of Claim 1, wherein the tertiary monomer comprises 3-hydroxyoctanoate.

Claim 7. The polymer composition of Claim 1, wherein the tertiary monomer comprises 3-hydroxydecanoate

Claim 8. The polymer composition of Claim 1, wherein the first biodegradable copolymer comprises

from about 84 to about 99.5 mole percent monomer residues of 3-hydroxybutyrate,

from about 0.4 to about 15 mole percent monomer residues of a secondary monomer selected from the group consisting of 4-hydroxybutyrate, 3-hydroxyvalerate, 4-hydroxyvalerate, and 5-hydroxyvalerate, and

from about 0.1 to about 1.0 mole percent monomer residues of a tertiary monomer selected from the group consisting of hydroxyalkanoate monomers having from 6 to 22 carbon atoms.

Claim 9. The polymer composition of Claim 1, wherein the first biodegradable copolymer has a weight average molecular weight from about 50,000 to about 7.5 million Daltons.

Claim 10. The polymer composition of Claim 1, wherein the polymer composition comprises from about 50 weight percent to about 95 weight percent of the first biodegradable copolymer and further comprises from about 5 weight percent to about 50 weight percent of a second biodegradable polymer selected from the group consisting of polybutylene adipate terephthalate, polybutylene succinate, polybutylene succinate-co-adipate, polylactic acid, mesolactide, polycaprolactone, polyglycolide, starches, cellulose esters, polysaccharides, polyvinyl alcohol, polyvinyl acetate, polymaleic acid, copolyesters of diols having 2 to 18 carbon atoms and diacids having 2 to 18 carbon atoms, and mixtures thereof.

Claim 11. The polymer composition of Claim 1, wherein the first biodegradable copolymer is blended or reactively extruded with the second biodegradable polymer

Claim 12. The polymer composition of Claim 1, wherein the first biodegradable copolymer is blended or reactively extruded with additional polyhydroxyalkanoates.

Claim 13. The polymer composition of Claim 1, wherein the polymer composition comprises from about 50 weight percent to about 95 weight percent of the first biodegradable copolymer and further comprises from about 5 weight percent to about 50 weight percent of a nonbiodegradable polymer selected from the group consisting of polyvinyl chloride, polypropylene, polyethylene, polyethylene terephthalate, and mixtures thereof.

Claim 14. The polymer composition of Claim 1, wherein the polymer composition further comprises from about 1.0 weight percent to about 40 weight percent of a filler selected from the group consisting of clays, calcium carbonate, talc, kaolinite, montmorillonite, bentonite, silica, chitin, titanium dioxide, nano clay, nanocellulose, or mixtures thereof.

Claim 15. The polymer composition of Claim 1, wherein the polymer composition further comprises from about 0.5 weight percent to about 25 weight percent of a plasticizer selected from the group consisting of sebacates, citrates, fatty esters of adipic, succinic, and

glucaric acids, lactates, alkyl diesters having a having a main carbon chain of from about 2 to about 12 carbon atoms, alkyl methyl esters, dibenzoates, propylene carbonate, caprolactone diols having a weight average molecular weight from about 200 to about 10,000, polyethylene glycols diols having a weight average molecular weight from about 400 to about 10,000, esters of vegetable oils, long chain alkyl acids having from about 10 to about 20 carbon atoms, glycerol, isosorbide derivatives and mixtures thereof.

Claim 16. A molded article comprising at least 50 weight percent of the polymer composition of Claim 1.

Claim 17. A fiber or filament comprising at least 50 weight percent of the polymer composition of Claim 1.

Claim 18. A polymeric film comprising at least 50 weight percent of the polymer composition of Claim 1.

Claim 19. A dispersion comprising at least 50 weight percent of the polymer composition of Claim 1.