SUMMARY

[0006] The above and other needs are met by a method for extruding high moisture polyhydroxyalkanoates, according to the present disclosure. In one example, the method of the present disclosure includes a step of mixing at least one polyhydroxyalkanoate in powder form with at least one resin additive at a temperature from about 120 to about 190 °C to form an extrusion mixture. This mixture is then extruded through an extrusion die to form a resin extrudate comprising the at least one polyhydroxyalkanoate and the at least one resin additive.

[0007] According to the present disclosure, the at least one polyhydroxyalkanoate in powder form has an initial (i.e., prior to mixing) moisture content of at least 0.10 weight percent, as determined in accordance with ASTM D7191-05, when mixed with the at least one resin additive. In certain examples, the polyhydroxyalkanoate powder may have an even higher moisture content. In some instances, the least one polyhydroxyalkanoate in powder form may have an initial moisture content of at least 1 weight percent, at least 5 weight percent, at least 10 weight percent, at least 15 weight percent, or even greater, as determined in accordance with ASTM D7191-05, when mixed with the at least one resin additive.

[0008] According to certain examples, the mixing step and the extruding steps are preferably carried out in different devices or in different chambers of the same device. In some instances, the mixing step is preferably carried out in a low-shear continuous mixer. In some examples, it is also preferred that the extruding step is carried out in a screw extruder.

[0009] In some instances, the at least one polyhydroxyalkanoate preferably has an initial weight average molecular weight before the mixing step and a final weight average molecular weight after the extruding step, which is at least 40 percent of the initial weight average molecular weight, wherein all weight average molecular weights are determined in accordance with ASTM D5296-05. More preferably, the final weight average molecular weight of the at least one polyhydroxyalkanoate is at least 70 percent of the initial weight average molecular weight, still more preferably at least 80 percent of the initial weight

average molecular weight, and even more preferably at least 85 percent of the initial weight average molecular weight.

[0009a] In one aspect, the present disclosure refers to a method for extruding a resin which includes polyhydroxyalkanoates, the method comprising the steps of:

mixing at least one polyhydroxyalkanoate in powder form at a temperature from 120 to 190 ℃ to form an extrusion mixture consisting of the at least one polyhydroxyalkanoate; and

extruding the mixture through an extrusion die to form a resin extrudate consisting of the at least one polyhydroxyalkanoate,

wherein the least one polyhydroxyalkanoate in powder form has an initial moisture content, prior to mixing, of at least 1 weight percent, as determined in accordance with ASTM D7191-05, when mixed;

wherein the least one polyhydroxyalkanoate has an initial weight average molecular weight before the mixing step and a final weight average molecular weight after the extruding step, which is at least 80 percent of the initial weight average molecular weight, wherein all weight average molecular weights are determined in accordance with ASTM D5296-05.

[0010] A variety of different forms of polyhydroxyalkanoate may be used in the method of the present disclosure. In certain examples, the at least one polyhydroxyalkanoate is made up of poly-3-hydroxybutyrate-co-3-hydroxyhexanoate ("P(3HB-co-3HHx)"). In some examples, this P(3HB-co-3HHx) is preferably made up of from about 75 to about 99 mole percent hydroxybutyrate and from about 1 to about 25 mole percent hydroxyhexanoate.

[0011] In other examples, the at least one polyhydroxyalkanoate is preferably made up of from about 1 to about 25 weight percent of at least one polyhydroxyalkanoate comprising from about 25 to about 50 mole percent of hydroxyvalerate, hydroxyhexanoate, hydroxyoctanoate, and/or hydroxydecanoate. In some examples, the at least one polyhydroxyalkanoate preferably includes a terpolymer made up from about 75 to

about 99.9 mole percent monomer residues of 3-hydroxybutyrate, from about 0.1 to about 25 mole percent monomer residues of 3-hydroxyhexanoate, and from about 0.1 to about 25 mole percent monomer residues of a third 3-hydroxyalkanoate having from 5 to 12 carbon atoms.

[0012] In some instances, the at least one poly(hydroxyalkanoate) preferably has an initial weight average molecular weight from about 50,000 Daltons to about 2.5 million Daltons, as determined by ASTM D5296-05.

[0013] According to certain examples, the at least one resin additive preferably includes at least one rheology modifier selected from the group consisting of vinyl acetate homopolymers or copolymers, peroxides, epoxides, isocyanates, carbodiimides, and mixtures thereof.

[0014] In some examples, the at least one resin additive preferably includes at least one nucleating agent from the group consisting of pentaerythritol, boron nitride, poly(hydroxybutyrate), inositol, clays, dipentaerythritol, sorbitol, and mixtures thereof.

[0015] In some instances, the at least one resin additive preferably includes at least one filler selected from the group consisting of aragonite, clays, calcium carbonate, cellulose,

nano-cellulose, talc, kaolinite, montmorillonite, bentonite, silica, chitin, starches, diatomaceous earth, titanium dioxide, nano clay, mica, and mixtures thereof.

[0016] Moreover, in certain examples, the mixing step may also include mixing the at least one polyhydroxyalkanoate in powder form with at least one biopolymer selected from the group consisting of biodegradable polymer selected from the group consisting of polybutylene succinate, polycaprolactone, polybutylene succinate-co-butylene adipate, polybutylene adipate-co-terephthalate, polylactic acid, cellulose acetate, and mixtures thereof.