93, 92, 91, 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72, 71, 70, 69, 68, 67, 66, 65, 64, 63, 62, 61, 60, 59, 58, 57, 56wt% or less with respect to a total amount of the polymer composition.

In certain embodiments, PLA may be 100% biobased, as measured using ASTM D6866. In some embodiment, PLA may have a biobased carbon content, as measured using ASTM D6866, of about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, or 99% or more, and/or about 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, or 10% or less. In certain embodiments, the biobased compositions comprising an amorphous PHA, a polyester and a pore-forming agent may be at least 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98 or 99% biobased.

In some embodiments, the biobased composition described herein may include a polyester or PLA having a weight-average molecular weight (Mw) in a range from about 10,000, 20,000, 30,000, 40,000, 50,000, 60,000, 70,000, 80,000, 90,000, 100,000, 150,000, 200,000, 250,000, 300,000 or 350,000 g/mol to about 400,000, 350,000, 300,000, 250,000, 200,000, 150,000, 100,000, 90,000, 80,000, 70,000, 60,000, 50,000, 40,000, 30,000, or 20,000 g/mol.

In some embodiments, the biobased composition according to the present disclosure may include the amorphous polyhydroxyalkanoate (PHA), a polyester and a pore-forming agent, and PHA may be a natural thermoplastic polyester polymer that accumulates in microbial cells. Since it may be a biodegradable material, it may be composted and finally decomposed into carbon dioxide, water, and organic waste without generating toxic waste. Since PHA may be biodegradable even in soil and sea, when the biodegradable resin composition and the biodegradable fiber or biodegradable nonwoven fabric prepared using the same comprise a PHA resin, it may have environmentally friendly characteristics. Thus, the biodegradable resin composition and the biodegradable nonwoven fabric prepared using the same may have a great advantage in that it may be used in various fields since it may be biodegradable and environmentally friendly.

In addition, PHA may have physical properties similar to those of conventional petroleum-derived synthetic polymers such as polybutylene adipate terephthalate (PBAT), polybutylene succinate (PBS), polybutylene succinate terephthalate (PBST), and polybutylene succinate adipate (PBSA), may exhibit complete biodegradability, and may be excellent in biocompatibility.

Unlike other environmentally friendly plastic materials such as polybutylene succinate (PBS), polylactic acid (PLA), and polytrimethylene terephthalate (PTT), PHA may be synthesized from more than 150 types of monomers, so that hundreds of types of PHAs may be prepared depending on the types of monomers. Hundreds of different types of PHAs depending on the types of monomers

may have completely different structures and properties.

In some embodiments, an amorphous PHA disclosed herein may exclude a PHA having a single monomer repeating unit. In some embodiments, an amorphous PHA disclosed herein may be formed by polymerizing two or more monomer repeat units. In some embodiments, the amorphous PHA may exclude a homo-polyhydroxyalkanoate resin. In some embodiments, the amorphous PHA may comprise a copolymerized polyhydroxyalkanoate resin. In some embodiments, the amorphous PHA may comprise a copolymer in which different repeat units may be randomly distributed in the polymer chain.

In some embodiments, a total crystallinity of the amorphous PHA disclosed herein may be less than about 5, 4, 3, 2, 1, 0.5 or 0.1%. In certain embodiments, a total crystallinity of the amorphous PHA disclosed herein may be about 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1, 2, 3, or 4% or more. As used herein and unless otherwise indicated, the term "crystallinity" refers to a polymer having a primary transition point or crystal melting point (Tm) determined by differential scanning calorimetry (DSC) or equivalent techniques.

In some embodiments, the amorphous PHA may comprise a copolymer including 3-hydroxybutyrate (3-HB). In some embodiments, the amorphous PHA may comprise a copolymer including 4-hydroxybutyrate (4-HB). In certain embodiments, the amorphous PHA may comprise a copolymer including 3-hydroxypropionate (3-HP). In certain embodiments, the amorphous PHA may comprise a copolymer including 3-hydroxyhexanoate (3-HH). In certain embodiments, the amorphous PHA may comprise a copolymer including 3-hydroxyoctanoate (3-HO). In certain embodiments, the amorphous PHA may comprise a copolymer including 3-hydroxy valerate (3-HV). In certain embodiments, the amorphous PHA may comprise a copolymer including 4-hydroxyvalerate (4-HV). In certain embodiments, the amorphous PHA may comprise a copolymer including 5-hydroxyvalerate (5-HV). In certain embodiments, the amorphous PHA may comprise a copolymer including 6-hydroxyhexanoate (6-HH).

In some embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 4-hydroxybutyrate (4-HB), and a content of 4-HB is in a range from about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 or 44wt% to about 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27 or 26wt% with respect to a total amount of the amorphous PHA. In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxypropionate (3-HP), and a content of 3-HP is in a range from about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43 or 44wt% to about 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27 or

Examples of repeat units that may be contained in the amorphous PHA include 2-hydroxybutyrate, lactic acid, glycolic acid, 3-hydroxybutyrate (hereinafter, referred to as 3-HB), 3-hydroxypropionate (hereinafter, referred to as 3-HP), 3-hydroxyvalerate (hereinafter, referred to as 3-HV), 3-hydroxyhexanoate (hereinafter, referred to as 3-HH), 3-hydroxyheptanoate (hereinafter, referred to as 3-HHep), 3-hydroxyoctanoate (hereinafter, referred to as 3-HO), 3-hydroxynonanoate (hereinafter, referred to as 3-HN), 3-hydroxydecanoate (hereinafter, referred to as 3-HD), 3-hydroxydodecanoate (hereinafter, referred to as 3-HDD), 4-hydroxybutyrate (hereinafter, referred to as 4-HB), 4-hydroxyvalerate (hereinafter, referred to as 4-HV), 5-hydroxyvalerate (hereinafter, referred to as 5-HV), and 6-hydroxyhexanoate (hereinafter, referred to as 6-HH). The amorphous PHA may contain one, two, three, four or more repeat units selected from the above.

The amorphous PHA may comprise one, two, three, four or more repeat units selected from the group consisting of 3-HB, 4-HB, 3-HP, 3-HH, 3-HV, 4-HV, 5-HV, and 6-HH.

In addition, the amorphous PHA may comprise isomers. The amorphous PHA may comprise structural isomers, enantiomers, or geometric isomers. Specifically, the amorphous PHA may comprise structural isomers.

The amorphous PHA may comprise a copolymerized amorphous PHA resin that comprises at least one repeat unit selected from the group consisting of 3-hydroxybutyrate (3-HB), 4-hydroxybutyrate (4-HB), 3-hydroxypropionate (3-HP), 3-hydroxyhexanoate (3-HH), 3-hydroxyoctanoate (3-HO), 3-hydroxyvalerate (3-HV), 4-hydroxyvalerate (4-HV), 5-hydroxyvalerate (5-HV), and 6-hydroxyhexanoate (6-HH).

The copolymerized amorphous PHA resin may comprise a 4-HB repeat unit and further may comprises one or more repeat units selected from the group consisting of a 3-HB repeat unit, a 3-HP repeat unit, a 3-HH repeat unit, a 3-HV repeat unit, a 4-HV repeat unit, a 5-HV repeat unit, and a 6-HH repeat unit. The amorphous PHA resin may comprise a 4-HB repeat unit and a 3-HB repeat unit.

In certain embodiments, the amorphous PHA may comprise: a copolymer comprising or consisting of 3-hydroxybutyrate (3-HB) and 4-hydroxybutyrate (4-HB); a copolymer comprising or consisting of 3-hydroxybutyrate (3-HB) and 3-hydroxypropionate (3-HP); a copolymer comprising or consisting of 3-hydroxybutyrate (3-HB) and 3-hydroxyhexanoate (3-HH); a copolymer comprising or consisting of 3-hydroxybutyrate (3-HB) and 3-hydroxyoctanoate (3-HO); or a copolymer comprising or consisting of 3-hydroxybutyrate (3-HB) and 3-hydroxy valerate (3-HV).

In certain embodiments, the amorphous PHA may comprise 3-hydroxybutyrate (3-HB). In certain embodiments, the amorphous PHA may comprise a copolymer

%, from about 31 to about 41 wt%, from about 31 to about 42 wt%, from about 31 to about 43 wt%, from about 31 to about 44 wt%, from about 31 to about 45 wt%, from about 32 to about 38 wt%, from about 32 to about 39 wt%, from about 32 to about 40 wt%, from about 32 to about 41 wt%, from about 32 to about 42 wt%, from about 32 to about 43 wt%, from about 32 to about 44 wt%, from about 32 to about 45 wt%, from about 33 to about 37 wt%, from about 33 to about 38 wt%, from about 33 to about 39 wt%, from about 33 to about 40 wt%, from about 33 to about 41 wt%, 33 to about 42 wt%, 33 to about 43 wt%, 33 to about 44 wt%, 33 to about 45 wt%, from about 34 to about 36 wt%, from about 34 to about 37 wt%, from about 34 to about 38 wt%, from about 34 to about 39 wt%, from about 34 to about 40 wt%, from about 34 to about 41 wt%, from about 34 to about 42 wt%, from about 34 to about 43 wt%, from about 34 to about 44 wt%, or from about 34 to about 45 wt% with respect to a total amount of the amorphous PHA. In some embodiments, the 3-HV content may be about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 wt% or more, and/or about 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 wt% or less with respect to a total amount of the amorphous PHA.

In certain embodiments, the amorphous PHA may have a 3-HH content in a range from about 25 to about 45 wt%, from about 26 to about 44 wt%, from about 27 to about 43 wt%, from about 28 to about 42 wt%, from about 29 to about 41 wt%, from about 30 to about 40 wt%, from about 30 to about 41 wt%, from about 30 to about 42 wt%, from about 30 to about 43 wt%, from about 30 to about 44 wt%, from about 30 to about 45 wt%, from about 31 to about 39 wt%, from about 31 to about 40 wt%, from about 31 to about 41 wt%, from about 31 to about 42 wt%, from about 31 to about 43 wt%, from about 31 to about 44 wt%, from about 31 to about 45 wt%, from about 32 to about 38 wt%, from about 32 to about 39 wt%, from about 32 to about 40 wt%, from about 32 to about 41 wt%, from about 32 to about 42 wt%, from about 32 to about 43 wt%, from about 32 to about 44 wt%, from about 32 to about 45 wt%, from about 33 to about 37 wt%, from about 33 to about 38 wt%, from about 33 to about 39 wt%, from about 33 to about 40 wt%, from about 33 to about 41 wt%, 33 to about 42 wt%, 33 to about 43 wt%, 33 to about 44 wt%, 33 to about 45 wt%, from about 34 to about 36 wt%, from about 34 to about 37 wt%, from about 34 to about 38 wt%, from about 34 to about 39 wt%, from about 34 to about 40 wt%, from about 34 to about 41 wt%, from about 34 to about 42 wt%, from about 34 to about 43 wt%, from about 34 to about 44 wt%, or from about 34 to about 45 wt% with respect to a total amount of the amorphous PHA. In some embodiments, the 3-HH content may be about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 wt% or more, and/or about 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 wt% or less with respect to a total amount of the amorphous PHA.

In certain embodiments, the amorphous PHA may have a 4-HV content in a range from about 25 to about 45 wt%, from about 26 to about 44 wt%, from about 27 to about 43 wt%, from about 28 to about 42 wt%, from about 29 to about 41 wt%, from about 30 to about 40 wt%, from about 30 to about 41 wt%, from about 30 to about 42 wt%, from about 30 to about 43 wt%, from about 30 to about 44 wt%, from about 30 to about 45 wt%, from about 31 to about 39 wt%, from about 31 to about 40 wt%, from about 31 to about 41 wt%, from about 31 to about 42 wt%, from about 31 to about 43 wt%, from about 31 to about 44 wt%, from about 31 to about 45 wt%, from about 32 to about 38 wt%, from about 32 to about 39 wt%, from about 32 to about 40 wt%, from about 32 to about 41 wt%, from about 32 to about 42 wt%, from about 32 to about 43 wt%, from about 32 to about 44 wt%, from about 32 to about 45 wt%, from about 33 to about 37 wt%, from about 33 to about 38 wt%, from about 33 to about 39 wt%, from about 33 to about 40 wt%, from about 33 to about 41 wt%, 33 to about 42 wt%, 33 to about 43 wt%, 33 to about 44 wt%, 33 to about 45 wt%, from about 34 to about 36 wt%, from about 34 to about 37 wt%, from about 34 to about 38 wt%, from about 34 to about 39 wt%, from about 34 to about 40 wt%, from about 34 to about 41 wt%, from about 34 to about 42 wt%, from about 34 to about 43 wt%, from about 34 to about 44 wt%, or from about 34 to about 45 wt% with respect to a total amount of the amorphous PHA. In some embodiments, the 4-HV content may be about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 wt% or more, and/or about 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 wt% or less with respect to a total amount of the amorphous PHA.

In certain embodiments, the amorphous PHA may have a 5-HH content in a range from about 25 to about 45 wt%, from about 26 to about 44 wt%, from about 27 to about 43 wt%, from about 28 to about 42 wt%, from about 29 to about 41 wt%, from about 30 to about 40 wt%, from about 30 to about 41 wt%, from about 30 to about 42 wt%, from about 30 to about 43 wt%, from about 30 to about 44 wt%, from about 30 to about 45 wt%, from about 31 to about 39 wt%, from about 31 to about 40 wt%, from about 31 to about 41 wt%, from about 31 to about 42 wt%, from about 31 to about 43 wt%, from about 31 to about 44 wt%, from about 31 to about 45 wt%, from about 32 to about 38 wt%, from about 32 to about 39 wt%, from about 32 to about 40 wt%, from about 32 to about 41 wt%, from about 32 to about 42 wt%, from about 32 to about 43 wt%, from about 32 to about 44 wt%, from about 32 to about 45 wt%, from about 33 to about 37 wt%, from about 33 to about 38 wt%, from about 33 to about 39 wt%, from about 33 to about 40 wt%, from about 33 to about 41 wt%, 33 to about 42 wt%, 33 to about 43 wt%, 33 to about 44 wt%, 33 to about 45 wt%, from about 34 to about 36 wt%, from about 34 to about 37 wt%, from about 34 to about 38 wt%, from about 34 to about 39 wt%, from about 34 to about 40 wt%, from about 34 to about 41 wt%, from about 34 to about 42 wt% 34 to about 41 wt%, from about 34 to about 42

wt% 42 wt% 34 to about 41 wt%, from about 34 to about 42 wt%, from about 34 to about 43 wt%, from about 34 to about 44 wt%, or from about 34 to about 45 wt% with respect to a total amount of the amorphous PHA. In some embodiments, the 5-HH content may be about 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 wt% or more, and/or about 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, or 45 wt% or less with respect to a total amount of the amorphous PHA.

In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 4-hydroxybutyrate (4-HB). In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxypropionate (3-HP). In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxyhexanoate (3-HH). In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 6-hydroxyhexanoate (6-HH). In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxyoctanoate (3-HO). In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxy valerate (3-HV).

In certain embodiments, the amorphous PHA may comprise a copolymer of 3-hydroxybutyrate (3-HB) and 4-hydroxybutyrate (4-HB), with a 4-HB content in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxypropionate (3-HP), a content of 3-HP is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxyhexanoate (3-HH), a content of 3-HH is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxyoctanoate (3-HO), a content of 3-HO is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 3-hydroxy valerate (3-HV), a content of 3-HV is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 4-hydroxyvalerate (4-HV), a content of 4-HV is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 5-hydroxyvalerate (5-HV), a content of 5-HV is in a range from 25 to 45%. In certain embodiments, the amorphous PHA comprises a copolymer of 3-hydroxybutyrate (3-HB) and 6-hydroxyhexanoate (6-HH), a content of 6-HH is in a range from 25 to 45%.

The glass transition temperature (Tg) of the amorphous PHA may be in a range from about -45℃ to about -10℃, from about -44℃ to about -11℃, from about -43℃ to about -12℃,

from about -42℃ to about -13℃, from about -41℃ to about -14℃, from about -40℃ to about -15℃, from about -39℃ to about -16℃, from about -38℃

1,200,000, 1,100,000, 1,000,000, 900,000, 800,000, 500,000, 250,000, 200,000, 150,000, 100,000, 90,000, 80,000, 70,000, 60,000, 50,000, 40,000, 30,000, 20,000, or 10,000 g/mole or more.

In some embodiments, the biobased composition may exclude plasticizer for increasing tensile elongation, impact strength or tear strength of a film comprising the biobased composition.

In some embodiments, the biobased composition according to the present disclosure may comprise the amorphous PHA less than about 70, 65, 60, 55, 50, 45, or 40 wt% with respect to a total weight of the biobased composition.

In certain embodiments, the amorphous PHA may be at least 75% or 100% biobased, as measured using ASTM D6866. In some embodiment, the amorphous PHA maybe, as measured using ASTM D6866, at least about 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 91, 92, 93, 94, 95, 96, 97, 98, or 99% or more, and/or about 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, or 10% or less biobased.

In certain embodiments, a weight ratio of the amorphous PHA to PLA in the biobased composition may be 1:99, 5:95, 10:90, 15:85, 20:80, 25:75, 30:70, 35:65, 40:60, 45:55, 50:50, 55:45, 60:40, 65:35, 70:30, 75:25, 80:20, 85:15, 90:10, 95:5 or 99:1. In certain embodiments, a weight ratio of the amorphous PHA to the pore-forming agent in the biobased composition may be 1:99, 5:95, 10:90, 15:85, 20:80, 25:75, 30:70, 35:65, 40:60, 45:55, 50:50, 55:45, 60:40, 65:35, 70:30, 75:25, 80:20, 85:15, 90:10, 95:5 or 99:1. In certain embodiments, a weight ratio of PLA to the pore-forming agent in the biobased composition may be 1:99, 5:95, 10:90, 15:85, 20:80, 25:75, 30:70, 35:65, 40:60, 45:55, 50:50, 55:45, 60:40, 65:35, 70:30, 75:25, 80:20, 85:15, 90:10, 95:5 or 99:1.

In certain embodiments, a biobased composition comprising an amorphous PHA, a polyester and a pore-forming agent may be injection molded, extrusion molded, a blown film extrusion, thermoformed, compression molded, blow molded into an article or a film. In certain embodiments, a biobased composition comprising an amorphous PHA, a polyester and a pore-forming agent may be formed into a film or an oriented film by a blown film extrusion, a cast film extrusion, oriented film extrusion, or combinations thereof.

In certain embodiments, a biobased composition comprising an amorphous PHA, a polyester and a pore-forming agent may be used as film. In some embodiments, a film of the present disclosure may include an amorphous PHA, a polyester and a pore-forming agent. In certain embodiments, a film comprising the biobased composition of the present disclosure may have an impact strength of about 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180 or 190 $kJ/m^2$ or more and/

Embodiment 6. The product of embodiment 5, where the mineral can be calcium carbonate or talc or wallstonite or other.

Embodiment 7. The product of embodiment 1 that is a blend of polylactide (PLA) and a polyhydroxyalkanoate (PHA) copolymer, where ultimate crystallinity of the PHA is less than 5%.

Embodiment 8. The product of embodiment 1 that is a blend of polylactide (PLA), a polyhydroxyalkanoate (PHA) copolymer, and a mineral (any of the mineral choices mentioned in embodiment 6).

Embodiment 9. The product of embodiment 1 that is home compostable.

Embodiment 10. The product of embodiment 1 that displays a higher impact toughness relative to the non-porous control film.

Embodiment 11. The product of embodiment 1 that is composed of multiple layers.

Embodiment 12. The product of embodiment 1 that is at least 75% biobased (according to ASTM D6866).

Embodiment 13. The product of embodiment 1, achieved by making a blown film that is subsequently stretched in one direction only (MDO).

Embodiment 14. The product of embodiment 1 achieved by making a cast film that is subsequently stretched in one direction only (MDO).

Embodiment 15. The product of embodiment 1 achieved by making a cast film that is subsequently stretched in two directions (MD & TD) either simultaneously or in sequence.

Embodiment 16. The product of embodiment 8 where the PHA copolymer is a co-polymer of -3HB and -4HB with -4HB content in the 25-45% range.

Embodiment 17. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight.

Embodiment 18. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight and is a copolymer of 3-hydroxybutanoic acid and 4-hydroxybutanoic acid.

Embodiment 19. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight and is a copolymer of 3-hydroxybutanoic acid and 3-hydroxypropionic acid.

Embodiment 20. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight and is a copolymer of 3-hydroxybutanoic acid and 3-hydroxyhexanoate.

Embodiment 21. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight and is a copolymer of 3-hydroxybutanoic acid and 3-hydroxyoctanoate.

Embodiment 22. The product of embodiment 8, where the PHA copolymer has a crystallinity of less than 5% by weight and is a copolymer of 3-hydroxybutanoic acid and 3-hydroxyvalerate.