SUMMARY

[004a] In a first aspect of the present disclosure, there is provided a composition comprising:

a first portion of a poly(hydroxyalkanoate) and a second portion of the poly(hydroxyalkanoate),

wherein the first portion of the poly(hydroxyalkanoate) has a first weight average molecular weight and the second portion of the poly(hydroxyalkanoate) has a second weight average molecular weight which is at least 50 percent less than the first weight average molecular weight and

wherein the poly(hydroxyalkanoate) comprises at least 10 mole percent monomer repeat units of 3-hydroxypropionate and

wherein the composition is prepared by

polymerizing a first charge of at least one substituted lactone to produce a first portion of a poly(hydroxyalkanoate) having a first weight average molecular weight;

polymerizing a second charge of the at least one substituted lactone to produce a second portion of the poly(hydroxyalkanoate) having a second weight average molecular weight; and

blending the first portion and the second portion to produce a final poly(hydroxyalkanoate),

wherein the at least one substituted lactone comprises beta-propiolactone and the poly(hydroxyalkanoate) comprises monomer repeat units of 3-hydroxypropionate, and

wherein the second weight average molecular weight is at least 50 percent less than the first weight average molecular weight, and

wherein the step of blending the first portion and the second portion is carried out by polymerizing the second charge to form the second portion in the presence of the first portion.

[004b] In another aspect of the present disclosure, there is provided a film comprising the composition as disclosed herein.

[004c] In yet another aspect of the present disclosure, there is provided a fiber comprising the composition as disclosed herein.

[004d] In a further aspect of the present disclosure, there is provided a method for making a composition having a first portion of a poly(hydroxyalkanoate) and a second portion of the poly(hydroxyalkanoate), the method comprising the steps of:

polymerizing a first charge of at least one substituted lactone to produce a first portion of a poly(hydroxyalkanoate) having a first weight average molecular weight;

polymerizing a second charge of the at least one substituted lactone to produce a second portion of the poly(hydroxyalkanoate) having a second weight average molecular weight; and

blending the first portion and the second portion to produce a final poly(hydroxyalkanoate),

wherein the at least one substituted lactone comprises beta-propiolactone and the poly(hydroxyalkanoate) comprises monomer repeat units of 3-hydroxypropionate, and

wherein the second weight average molecular weight is at least 50 percent less than the first weight average molecular weight, and

wherein the step of blending the first portion and the second portion is carried out by polymerizing the second charge to form the second portion in the presence of the first portion.

[005] In response to the above and other needs, the present disclosure provides a poly(hydroxyalkanoate) composition having a bimodal molecular weight distribution. In other words, the molecular weight distribution of the poly(hydroxyalkanoate) in the composition exhibits two distinct molecular weight peaks.

[006] In general, the composition comprises a first portion of a poly(hydroxyalkanoate) and a second portion of the poly(hydroxyalkanoate). Each of the first portion and the second portion has its own distinct weight average molecular weight. Thus, the first portion of the poly(hydroxyalkanoate) has a first weight average molecular weight and the second portion of the poly(hydroxyalkanoate) has a second weight average molecular weight. According to the present disclosure, the second weight average molecular weight which is at least 50 percent less than the first weight average molecular weight.

[007] More particularly, the first weight average molecular weight is typically at least 100,000 daltons, as determined by ASTM D5296. Preferably, the first weight average molecular weight is at least 200,000 daltons, as determined by ASTM D5296. Even more preferably, the first weight average molecular weight is at least 300,000 daltons, as determined by ASTM D5296.

[008] By contrast, the second weight average molecular weight is preferably less than about 25,000 daltons, as determined by ASTM D5296.

[009] With this difference in molecular weights, the composition typically has a polydispersity of at least 1.9, as determined by ASTM D5296. More preferably, the composition typically has a polydispersity from about 1.9 to about 3.5 as determined by ASTM D5296

[010] Typically, the composition includes from about 90 to about 50 weight percent of the first portion of the poly(hydroxyalkanoate) and from about 50 to about 10 weight percent of the second portion of the poly(hydroxyalkanoate). More preferably, the composition includes from about 85 to about 60 weight percent of the first portion of the poly(hydroxyalkanoate) and from about 40 to about 15 weight percent of the second portion of the poly(hydroxyalkanoate).

WHAT IS CLAIMED IS

Claim 1. A composition comprising:

a first portion of a poly(hydroxyalkanoate) and a second portion of the poly(hydroxyalkanoate),

wherein the first portion of the poly(hydroxyalkanoate) has a first weight average molecular weight and the second portion of the poly(hydroxyalkanoate) has a second weight average molecular weight which is at least 50 percent less than the first weight average molecular weight and

wherein the poly(hydroxyalkanoate) comprises at least 10 mole percent monomer repeat units of 3-hydroxypropionate and

wherein the composition is prepared by

polymerizing a first charge of at least one substituted lactone to produce a first portion of a poly(hydroxyalkanoate) having a first weight average molecular weight;

polymerizing a second charge of the at least one substituted lactone to produce a second portion of the poly(hydroxyalkanoate) having a second weight average molecular weight; and

blending the first portion and the second portion to produce a final poly(hydroxyalkanoate),

wherein the at least one substituted lactone comprises beta-propiolactone and the poly(hydroxyalkanoate) comprises monomer repeat units of 3-hydroxypropionate, and

wherein the second weight average molecular weight is at least 50 percent less than the first weight average molecular weight, and

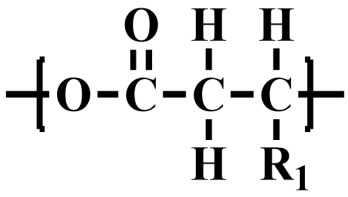
wherein the step of blending the first portion and the second portion is carried out by polymerizing the second charge to form the second portion in the presence of the first portion.

Claim 2. The composition of Claim 1, wherein the poly(hydroxyalkanoate) comprises poly(3-hydroxypropionate) homopolymer.

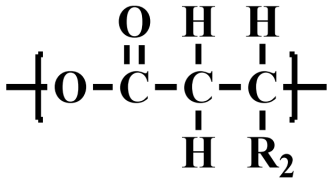
Claim 3. The composition of Claim 1, wherein the poly(hydroxyalkanoate) is a copolymer or a terpolymer which comprises

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

a second repeat unit according to Formula I

	Formula I ; and

optionally, a third repeat unit according to Formula II,

	Formula II

wherein R_1 and R_2 are each independently selected from the group consisting of linear or branched alkyl groups having from 1 to 22 carbon atoms.

Claim 4. The composition of Claim 3, wherein the poly(hydroxyalkanoate) comprises a copolymer and R_1 is methyl.

Claim 5. The composition of Claim 4, wherein the poly(hydroxyalkanoate) copolymer comprises from 10 to 90 mole percent of the first repeat unit and from 90 to 10 mole percent of the second repeat unit.

Claim 6. The composition of Claim 3, wherein the poly(hydroxyalkanoate) comprises a terpolymer, R_1 is methyl, and R_2 is propyl.

Claim 7. The composition of Claim 6, wherein the poly(hydroxyalkanoate) terpolymer comprises from 15 to 75 mole percent of the first repeat unit, from 75 to 15 mole percent of the second repeat unit, and from 1 to 5 mole percent of the third repeat unit.

Claim 8. The composition of Claim 1, wherein the composition comprises from 90 to 50 weight percent of the first portion of the poly(hydroxyalkanoate) and from 50 to 10 weight percent of the second portion of the poly(hydroxyalkanoate).

Claim 9. The composition of Claim 1, wherein the first weight average molecular weight is at least 100,000 daltons, as determined by ASTM D5296 and the second weight average molecular weight is less than 25,000 daltons, as determined by ASTM D5296.

Claim 10. The composition of Claim 1, wherein the composition has a polydispersity of at least 1.9, as determined by ASTM D5296.

Claim 11. The composition of Claim 1, wherein the weight ratio of the first portion of the poly(hydroxyalkanoate) to the second portion of the poly(hydroxyalkanoate) from 1:1 to 9:1.

Claim 12. A film comprising the composition of Claim 1.

Claim 13. A fiber comprising the composition of Claim 1.

Claim 14. A method for making a composition having a first portion of a poly(hydroxyalkanoate) and a second portion of the poly(hydroxyalkanoate), the method comprising the steps of:

polymerizing a first charge of at least one substituted lactone to produce a first portion of a poly(hydroxyalkanoate) having a first weight average molecular weight;

polymerizing a second charge of the at least one substituted lactone to produce a second portion of the poly(hydroxyalkanoate) having a second weight average molecular weight; and

blending the first portion and the second portion to produce a final poly(hydroxyalkanoate),

wherein the at least one substituted lactone comprises beta-propiolactone and the poly(hydroxyalkanoate) comprises monomer repeat units of 3-hydroxypropionate, and

wherein the second weight average molecular weight is at least 50 percent less than the first weight average molecular weight, and

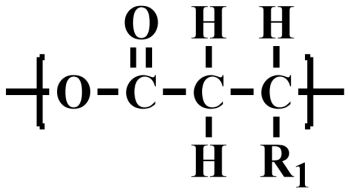
wherein the step of blending the first portion and the second portion is carried out by polymerizing the second charge to form the second portion in the presence of the first portion.

Claim 15. The method of Claim 14, wherein the poly(hydroxyalkanoate) comprises poly(3-hydroxypropionate) homopolymer.

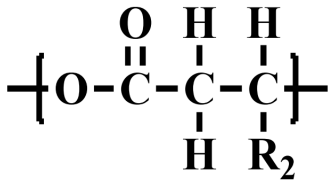
Claim 16. The method of Claim 14, wherein the poly(hydroxyalkanoate) is a copolymer or a terpolymer which comprises

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

a second repeat unit according to Formula I

	Formula I ; and

optionally, a third repeat unit according to Formula II,

	Formula II

wherein R_1 and R_2 are each independently selected from the group consisting of linear or branched alkyl groups having from 1 to 22 carbon atoms.

Claim 17. The method of Claim 14, wherein the first charge is polymerized in a first loop reactor.

Claim 18. The method of Claim 14, wherein the second charge is polymerized in a second loop reactor.