SUMMARY

[0004a] In one aspect, the present disclosure refers to a granular composition for agricultural use comprising:

a plurality of granulates having a biodegradable coating applied over the granulates,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides,

wherein the biodegradable coating comprises from about 5 to about 75 weight percent polylactic acid and from about 25 to about 95 weight percent polyhydroxyalkanoates, and

wherein the biodegradable coating comprises a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogeneously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 micron.

[0004b] In another aspect, the present disclosure refers to a method for making a coated granular composition disclosed herein, comprising the steps of:

mixing polylactic acid and a polyhydroxyalkanoate, optionally in the presence of a solvent, at a temperature from about 25 °C to about 180 °C to provide a coating mixture;

applying the coating mixture over outer surfaces of a plurality of granulates; and

solidifying the coating mixture to create a biodegradable coating over the outer surfaces of the plurality of granulates,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides, and

wherein the biodegradable coating comprises a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogeneously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 micron.

[0004c] In yet another aspect, the present disclosure refers to a method for controlled release of a granular material, comprising the steps of:

providing a granular composition comprising a plurality of granulates having a biodegradable coating applied over the granulates, wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides, and wherein the biodegradable coating comprises from about 10 to about 30 weight percent polylactic acid and from about 70 to about 90 weight percent polyhydroxyalkanoates;

dispersing the granular composition over a plot of soil;

dissolving at least the polyhydroxyalkanoates in the biodegradable coating by exposing the plot of soil, and the granular composition dispersed therein, to moisture,

wherein dissolution of the polyhydroxyalkanoates forms a plurality of channels in the biodegradable coating through which the granulate material may be released into the soil.

[0005] The above and other needs are met by a granular composition for agricultural use in accordance with the current disclosure. According to one example, this granular composition is made up of a plurality of granulates having a biodegradable coating applied over the granulates. These granulates, in turn, are made up of a material selected from the group consisting of seeds, fertilizers, and pesticides. The biodegradable coating is made up of from about 5 to about 75 weight percent polylactic acid and from about 25 to about 95 weight percent polyhydroxyalkanoates.

[0006] In certain examples, the granulates of the composition are preferably made up of seeds. In other examples, the granulates of the composition are preferably made up of fertilizer, more preferably a urea-based fertilizer.

[0007] As noted, the biodegradable coating includes both polylactic acid (PLA) and a polyhydroxyalkanoate (PHA). In certain examples, the biodegradable coating preferably includes polylactic acid having a weight average molecular weight from about 10,000 to about 250,000 Daltons. Also, in certain examples, the biodegradable coating preferably includes polyhydroxyalkanoates having a weight average molecular weight from about 50,000 to about 2.5 million Daltons.

[0008] In a more preferred example, the biodegradable coating is preferably made up of from about 10 to about 50 weight percent polylactic acid and from about 50 to about 90 weight percent polyhydroxyalkanoates.

[0009] In certain examples, the polyhydroxyalkanoates within the biodegradable coating are preferably made up of from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate and from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

[0010] In some examples, the polyhydroxyalkanoates within the biodegradable coating may be made up of three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

[0011] In a preferred example, the granulates preferably have an average particle size, before coating, from about 1 to about 25 mm.

[0012] Further, in certain examples, the biodegradable coating preferably includes a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogenously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 microns.

[0013] In another example, the present disclosure provides a method for making a coated granular composition. In one example, the method includes a step of mixing polylactic acid, a polyhydroxyalkanoate, and optionally a solvent, at a temperature from about 25°C to about 180 °C to provide a coating mixture. This coating mixture is then applied over outer surfaces of a plurality of granulates. The method also includes a step of solidifying the coating mixture to create a biodegradable coating over the outer surfaces of the plurality of granulates. The granulates coated according to the method made up of a material selected from the group consisting of seeds, fertilizers, and pesticides. Once solidified, the biodegradable coating is made up of a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogenously dispersed therein. These globules have an average size of from about 2 nm to about 10 microns.

[0014] In certain examples of the method, the biodegradable coating is annealed briefly after application at 150 – 170 °C for a few seconds or the biodegradable coating is exposed to solvent vapors after coating.

[0015] In certain examples of the method, the granulates of the composition are preferably made up of seeds. In other examples of the method, the granulates of the compositions are preferably made up of fertilizer, more preferably a urea-based fertilizer.

[0016] In certain examples of the method, the biodegradable coating preferably includes polylactic acid having a weight average molecular weight from about 10,000 to about 250,000 Daltons. Also, in certain examples of the method, the biodegradable coating preferably includes polyhydroxyalkanoates having a weight average molecular weight from about 50,000 to about 2.5 million Daltons.

[0017] In a more preferred example of the method, the biodegradable coating is preferably made up of from about 10 to about 50 weight percent polylactic acid and from about 50 to about 90 weight percent polyhydroxyalkanoates.

[0018] In certain examples of the method, the polyhydroxyalkanoates within the biodegradable coating is preferably made up of from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate and from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

[0019] In some examples of the method, the polyhydroxyalkanoates within the biodegradable coating may be made up of three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

[0020] In a preferred example of the method, the granulates preferably have an average particle size, before coating, from about 1 to about 25 mm.

[0021] In a further example, the present disclosure provides a method for controlled release of a granular material. According to one example, the method includes an initial step of providing a granular composition made up of a plurality of granulates having a biodegradable coating applied over the granulates. These granulates in turn are made up of a material selected from the group consisting of seeds, fertilizers, and pesticides. The biodegradable coating is made up of from about 5 to about 75 weight percent polylactic acid and from about 25 to about 95 weight percent polyhydroxyalkanoates.

[0022] In a second step, the granular composition is dispersed over a plot of soil.

[0023] At least the polyhydroxyalkanoates in the biodegradable coating are then dissolved by exposing the plot of soil, and the granular composition dispersed therein, to moisture. The dissolution of the polyhydroxyalkanoates leads to formation of a plurality of channels in the biodegradable coating through which the granulate material may be released into the soil.

[0024] In a more preferred example of the method, the biodegradable coating is preferably made up of from about 10 to about 50 weight percent polylactic acid and from about 50 to about 90 weight percent polyhydroxyalkanoates.

[0025] In certain examples of the method, the polyhydroxyalkanoates within the biodegradable coating is preferably made up of from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate and from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

[0026] In some examples of the method, the polyhydroxyalkanoates within the biodegradable coating may be made up of three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms. For instance, the polyhydroxyalkanoates may in some instances be made up of monomer residues of 3-hydroxybutyrate, monomer residues of 3-hydroxyvalerate, and monomer residues of 3-hydroxyhexanoate.

[0027] In other instances, the polyhydroxyalkanoates may be made up of at least three different type of monomer residues selected from the group consisting of monomer residues of 3-hydroxybutyrate, monomer residues of 4-hydroxybutyrate, monomer residues of 3-hydroxyvalerate, monomer residues of 3-hydroxyhexanoate, monomer residues of 3-hydroxyoctanoate, and monomer residues of 3-hydroxydecanoate.

[0028] In certain examples of the method, the biodegradable coating preferably includes a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogeneously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 microns.

[0029] In certain examples of the method, at least about 10 to 50 percent of the polyhydroxyalkanoates in the biodegradable coating has started to degrade or has degraded after about 21 days exposure to moisture in the plot of soil.

WHAT IS CLAIMED IS

Claim 1. A granular composition for agricultural use comprising:

a plurality of granulates having a biodegradable coating applied over the granulates,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides,

wherein the biodegradable coating comprises from about 5 to about 75 weight percent polylactic acid and from about 25 to about 95 weight percent polyhydroxyalkanoates, and

wherein the biodegradable coating comprises a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogeneously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 micron.

Claim 2. The granular composition of Claim 1, wherein the granulates comprise seeds.

Claim 3. The granular composition of Claim 1, wherein the granulates comprise fertilizer.

Claim 4. The granular composition of Claim 1, wherein the granulates comprise pesticide.

Claim 5. The granular composition of Claim 1, wherein the biodegradable coating comprises polylactic acid having a weight average molecular weight from about 10,000 to about 250,000 Daltons.

Claim 6. The granular composition of Claim 1, wherein the biodegradable coating comprises polyhydroxyalkanoates having a weight average molecular weight from about 50,000 to about 2.5 million Daltons.

Claim 7. The granular composition of Claim 1, wherein the granulates have an average particle size, before coating, from about 1 to about 25 mm.

Claim 8. The granular composition of Claim 1, wherein the biodegradable coating comprises from about 10 to about 50 weight percent polylactic acid and from about 50 to about 90 weight percent polyhydroxyalkanoates.

Claim 9. The granular composition of Claim 1, wherein the polyhydroxyalkanoates comprise from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate and from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

Claim 10. The granular composition of Claim 1, wherein the polyhydroxyalkanoates comprise three or more different types of hydroxyalkanoate monomer residues, each having from 5 to 22 carbon atoms.

Claim 11. A method for making a coated granular composition according to any of Claims 1-10, comprising the steps of:

mixing polylactic acid and a polyhydroxyalkanoate, optionally in the presence of a solvent, at a temperature from about 25 °C to about 180 °C to provide a coating mixture;

applying the coating mixture over outer surfaces of a plurality of granulates; and

solidifying the coating mixture to create a biodegradable coating over the outer surfaces of the plurality of granulates,

wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides, and

wherein the biodegradable coating comprises a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates homogeneously dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 micron.

Claim 12. The method of Claim 11, wherein the biodegradable coating is annealed briefly after application at 150-170 °C for a few seconds or the biodegradable coating is exposed to solvent vapors after coating.

Claim 13. A method for controlled release of a granular material, comprising the steps of:

providing a granular composition comprising a plurality of granulates having a biodegradable coating applied over the granulates, wherein the granulates comprise a material selected from the group consisting of seeds, fertilizers, and pesticides, and wherein the biodegradable coating comprises from about 10 to about 30 weight percent polylactic acid and from about 70 to about 90 weight percent polyhydroxyalkanoates;

dispersing the granular composition over a plot of soil;

dissolving at least the polyhydroxyalkanoates in the biodegradable coating by exposing the plot of soil, and the granular composition dispersed therein, to moisture,

wherein dissolution of the polyhydroxyalkanoates forms a plurality of channels in the biodegradable coating through which the granulate material may be released into the soil.

Claim 14. The method of Claim 13, wherein the biodegradable coating comprises from about 10 to about 30 weight percent polylactic acid and from about 70 to about 90 weight percent polyhydroxyalkanoates.

Claim 15. The method of Claim 13, wherein the polyhydroxyalkanoates comprise from about 70 to about 99 mole percent monomer residues of 3-hydroxybutyrate and from about 1 to about 30 mole percent monomer residues of 3-hydroxyhexanoate.

Claim 16. The method of Claim 13, wherein the biodegradable coating comprises a continuous phase of polylactic acid having globules of the polyhydroxyalkanoates stably dispersed therein, wherein the globules have an average size of from about 2 nm to about 10 micron.

Claim 17. The method of Claim 13, wherein at least about 50 percent of the polyhydroxyalkanoates in the biodegradable coating are dissolved after about 21 days exposure to moisture in the plot of soil.