CLAIMS

WHAT IS CLAIMED IS:

1. A system for producing a copolymer of isoprene comprising: (a) an isoprene starting composition derived from renewable resources; and (b) a polymer produced from at least a portion of the isoprene starting material; wherein at least a portion of the isoprene starting composition undergoes polymerization with another non-isoprene molecule to produce a copolymer.

2. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises greater than about 2 mg of isoprene and comprises greater than or about 99.94% isoprene by weight compared to the total weight of all C5 hydrocarbons in the composition.

3. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises greater than about 2 mg of isoprene and comprises one or more compounds selected from the group consisting of ethanol, acetone, C5 prenyl alcohols, and isoprenoid compounds with 10 or more carbon atoms.

4. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises greater than about 2 mg of isoprene and comprises one or more second compounds selected from the group consisting of ethanol, acetone, methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, *cis*- and *trans*-3-methyl-1,3-pentadiene, a C5 prenyl alcohol, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-trimethylpyridine, 2,3,5-trimethylpyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl-3-buten-2-ol, ethyl acetate, 2-methyl-1-propanol, 3-methyl-1-butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-1-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl-3-buten-1-yl acetate, 3-methyl-2-buten-1-yl acetate, (E)-3,7-dimethyl-1,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine; wherein the amount of the second compound relative to the amount of the isoprene is greater than or about 0.01 % (w/w).

5. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises greater than about 2 mg of isoprene and comprises less than or about 0.5 μg/L per compound for any compound in the composition that inhibits the polymerization of isoprene.

6. The system of claim 1 wherein the polymer produced from the isoprene starting material is a polyisoprene polymer which is comprised of repeat units that are derived from isoprene monomer, wherein the polyisoprene polymer has $d^{13}C$ value of greater than -22‰ or which is within the range of -30‰ to -28.5‰.

7. The system of claim 1 wherein the polymer produced from the isoprene starting material is a polymer which is comprised of repeat units that are derived from isoprene monomer and at least one additional monomer, wherein the polymer includes blocks of repeat units that are derived from isoprene, and wherein the blocks of repeat units that are derived from isoprene have a $d^{13}C$ value of greater than -22‰ or which is within the range of -32‰ to -24‰.

8. The system of claim 1 wherein the polymer produced from the isoprene starting material is a polymer which is comprised of repeat units that are derived from isoprene monomer and at least one additional monomer, wherein the polymer includes blocks of repeat units that are derived from isoprene, and wherein the blocks of repeat units that are derived from isoprene have a $d^{13}C$ value of greater than -22‰ or which is within the range of -34‰ to -24‰.

9. The system of claim 8 wherein the polymer is a copolymer selected from the group consisted of (i) copolymers of isoprene and 1,3-butadiene, (ii) copolymers of isoprene and styrene, (iii) copolymers of isoprene, 1,3-butadiene, and styrene, and (iv) copolymers of isoprene and a-methyl styrene.

10. The system of claim 1 wherein the polymer produced from the isoprene starting material is a polyisoprene polymer which is comprised of repeat units that are derived from isoprene monomer, wherein the polyisoprene polymer has f_M value which is greater than 0.9.

11. The system of claim 1, further comprising one or more of: (i) a catalyst for polymerizing isoprene, (ii) a polymerization initiator, (iii) an ionic surfactant, (iv) a suitable organic solvent, and (v) a polymerization chain terminator.

12. A system for producing a polymer of isoprene comprising: (a) an isoprene starting composition derived from renewable resources; and (b) a polymer produced from at least a portion of the isoprene starting material; wherein at least a portion of the isoprene starting composition undergoes polymerization with other isoprene molecules to produce a polymer of isoprene with a molecular weight of about 5,000 to about 100,000.

13. A method for producing a copolymer of isoprene derived from renewable resources comprising: (a) culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; (b) producing the isoprene; and (c) polymerizing the isoprene derived from renewable resources with another non-isoprene molecules to produce a copolymer.

14. The method of claim 13, further comprising recovering the isoprene from the isoprene-producing cell culture prior to polymerization.

15. The method of claim 13 further comprising step (d) recovering the polymer produced.

16. A method for producing a polymer of isoprene derived from renewable resources comprising: (a) culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; (b) producing the isoprene; and (c) polymerizing the isoprene derived from renewable resources with other isoprene molecules to produce a polymer of isoprene with a molecular weight of about 5,000 to about 100,000.

17. A polymer of isoprene derived from renewable resources produced by the method according to claim 13.

18. A polymer of isoprene derived from renewable resources produced by the method according to claim 16.

CLAIMS

1. A system for producing a copolymer of isoprene and at least one non-isoprene monomer comprising:

(a) an isoprene starting composition derived from renewable resources made by culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; and

(b) a polymer produced from at least a portion of the isoprene starting material; wherein at least a portion of the isoprene starting composition undergoes polymerization with another non-isoprene molecule to produce a copolymer

wherein the system further contains a compound selected from the group consisting of ethanol, acetone, a C5 prenyl alcohol, an isoprenoid compound with 10 or more carbon atoms, methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, cis and trans-3-methyl-l,3-pentadiene, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-trimethylpyridine, 2,3,5-trimethyl-pyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl-3-buten-2-ol, ethyl acetate, 2-methyl-1-propanol, 3-methyl-l-butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-l-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl-3-buten-l-yl acetate, 3-methyl-2-buten-l-yl acetate, (E)-3,7-dimethyl-l,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine; and

wherein the isoprene starting composition derived from renewable resources comprised greater than 2 mg of isoprene and comprises less than or 0.5μg/L per compound for any compound in the composition that inhibits the polymerization of isoprene.

2. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises greater than or 99.94% (w/w) isoprene by weight compared to the total weight of all C5 hydrocarbons in the composition.

3. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises one or more compounds selected from the group consisting of ethanol, acetone, C5 prenyl alcohols, and isoprenoid compounds with 10 or more carbon atoms.

4. The system of claim 1, wherein the isoprene starting composition derived from renewable resources comprises one or more second compounds selected from the group consisting of ethanol, acetone, methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, *cis*-

and *tram*-3-methyl-l,3-penta diene, aC5 prenyl alcohol, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-tri- methylpyridine, 2,3,5-trimethylpyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl -3-buten-2-ol, ethyl acetate, 2-methyl-l-propanol, 3-methyl-l- butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-l-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl -3-buten-l-yl acetate, 3-methyl- 2-buten-l-yl acetate, (E)-3,7-di- methyl-1,3,6-octatriene, (Z)-3,7-dimethyl-l,3,6- octatriene, and 2,3-cycloheptenolpyridine; wherein the amount of the second compound relative to the amount of the isoprene is greater than or 0.01 % (w/w).

5. The system of claim 1, wherein the polymer produced from the isoprene starting material is a polyisoprene polymer which is comprised of repeat units that are derived from isoprene monomer, wherein the polyisoprene polymer has $d^{13}C$ value of greater than -22%o or which is within the range of -30%o to -28.5%o.

6. The system of claim 1, wherein the polymer produced from the isoprene starting material is a polymer which is comprised of repeat units that are derived from isoprene monomer and at least one additional monomer, wherein the polymer includes blocks of repeat units that are derived from isoprene, and wherein the blocks of repeat units that are derived from isoprene have a $d^{13}C$ value of greater than -22%o or which is within the range of -32%o to -24‰.

7. The system of claim 1, wherein the polymer produced from the isoprene starting material is a polymer which is comprised of repeat units that are derived from isoprene monomer and at least one additional monomer, wherein the polymer includes blocks of repeat units that are derived from isoprene, and wherein the blocks of repeat units that are derived from isoprene have a $d^{13}C$ value of greater than -22%o or which is within the range of -34%o to -24‰.

8. The system of claim 7, wherein the polymer is a copolymer selected from the group consisted of (i) copolymers of isoprene and 1,3-butadiene, (ii) copolymers of isoprene and styrene, (iii) copolymers of isoprene, 1,3-butadiene, and styrene, and (iv) copolymers of isoprene and a-methyl styrene.

9. The system of claim 1, wherein the polymer produced from the isoprene starting material is a polyisoprene polymer which is comprised of repeat units that are derived from isoprene monomer, wherein the polyisoprene polymer has fM value which is greater than 0.9.

10. The system of claim 1, further comprising one or more of: (i) a catalyst for polymerizing isoprene, (ii) a polymerization initiator, (iii) an ionic surfactant, (iv) a suitable organic solvent, and (v) a polymerization chain terminator.

11. A system for producing a polymer of isoprene and at least one non-isoprene monomer comprising:

(a) an isoprene starting composition derived from renewable resources made by culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; and

(b) a polymer produced from at least a portion of the isoprene starting material; wherein at least a portion of the isoprene starting composition undergoes polymerization with other isoprene molecules to produce a polymer of isoprene with a molecular weight of 5,000 to 100,000

wherein the system further contains a compound selected from the group consisting of ethanol, acetone, a C5 prenyl alcohol, an isoprenoid compound with 10 or more carbon atoms, methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, cis and trans-3-methyl-l,3-pentadiene, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-trimethylpyridine, 2,3,5-trimethyl-pyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl-3-buten-2-ol, ethyl acetate, 2-methyl-1-propanol, 3-methyl-l-butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-l-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl-3-buten-l-yl acetate, 3-methyl-2-buten-l-yl acetate, (E)-3,7-dimethyl-l,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine; and

wherein the isoprene starting composition derived from renewable resources comprised greater than 2 mg of isoprene and comprises less than or 0.5μg/L per compound for any compound in the composition that inhibits the polymerization of isoprene.

12. A method for producing a copolymer of isoprene and at least one non-isoprene monomer derived from renewable resources made by culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; comprising: (a) culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; (b) producing the isoprene; and (c) polymerizing the isoprene derived from renewable resources with another non-isoprene molecules to produce a copolymer

wherein the system further contains a compound selected from the group consisting of ethanol, acetone, a C5 prenyl alcohol, an isoprenoid compound with 10 or more carbon atoms,

methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, cis and trans-3-methyl-l,3-pentadiene, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-trimethylpyridine, 2,3,5-trimethyl-pyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl-3-buten-2-ol, ethyl acetate, 2-methyl-1-propanol, 3-methyl-l-butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-l-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl-3-buten-l-yl acetate, 3-methyl-2-buten-l-yl acetate, (E)-3,7-dimethyl-l,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine; and

wherein the isoprene starting composition derived from renewable resources comprised greater than 2 mg of isoprene and comprises less than or 0.5μg/L per compound for any compound in the composition that inhibits the polymerization of isoprene.

13. The method of claim 12, further comprising recovering the isoprene from the isoprene-producing cell culture prior to polymerization.

14. The method of claim 12, further comprising step (d) recovering the polymer produced.

15. A method for producing a polymer of isoprene and at least one non-isoprene monomer derived from renewable resources made by culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; comprising: (a) culturing cells comprising a heterologous nucleic acid encoding an isoprene synthase polypeptide under suitable culture conditions for the production of the isoprene; (b) producing the isoprene; and (c) polymerizing the isoprene derived from renewable resources with other isoprene molecules to produce a polymer of isoprene with a molecular weight of 5,000 to 100,000

wherein the system further contains a compound selected from the group consisting of ethanol, acetone, a C5 prenyl alcohol, an isoprenoid compound with 10 or more carbon atoms, methanol, acetaldehyde, methacrolein, methyl vinyl ketone, 2-methyl-2-vinyloxirane, cis and trans-3-methyl-l,3-pentadiene, 2-heptanone, 6-methyl-5-hepten-2-one, 2,4,5-trimethylpyridine, 2,3,5-trimethyl-pyrazine, citronellal, acetaldehyde, methanethiol, methyl acetate, 1-propanol, diacetyl, 2-butanone, 2-methyl-3-buten-2-ol, ethyl acetate, 2-methyl-1-propanol, 3-methyl-l-butanal, 3-methyl-2-butanone, 1-butanol, 2-pentanone, 3-methyl-l-butanol, ethyl isobutyrate, 3-methyl-2-butenal, butyl acetate, 3-methylbutyl acetate, 3-methyl-3-buten-l-yl acetate, 3-methyl-2-buten-l-yl acetate, (E)-3,7-dimethyl-l,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine; and

wherein the isoprene starting composition derived from renewable resources comprised greater than 2 mg of isoprene and comprises less than or 0.5μg/L per compound for any compound in the composition that inhibits the polymerization of isoprene.

16. A polymer of isoprene derived from renewable resources produced by the method according to claim 12.

17. A polymer of isoprene derived from renewable resources produced by the method according to claim 15.