CLAIMS

1. A method for producing a fuel constituent from a bioisoprene composition comprising chemically transforming a substantial portion of the isoprene in the bioisoprene composition to non-isoprene compounds by:

(a) subjecting the bioisoprene composition to heat or catalytic conditions suitable for isoprene dimerization to produce an isoprene dimer and then catalytically hydrogenating the isoprene dimer to form a saturated C10 fuel constituent; or

(b) (i) partially hydrogenating the bioisoprene composition to produce an isoamylene, (ii) dimerizing the isoamylene with a mono-olefin selected from the group consisting of isoamylene, propylene and isobutene to form a dimate and (iii) completely hydrogenating the dimate to produce a fuel constituent.

2. The method of claim 1, wherein at least about 95% of isoprene in the bioisoprene composition is converted to non-isoprene compounds.

3. The method of claim 1, wherein the bioisoprene composition is heated to about 150 °C to about 250 °C to produce an unsaturated cyclic isoprene dimer and the unsaturated cyclic isoprene dimer is hydrogenated catalytically to produce a saturated cyclic isoprene dimer fuel constituent.

4. The method of claim 1, wherein the method comprises: (i) contacting the bioisoprene composition with a catalyst for catalyzing cyclo-dimerization of isoprene to produce an unsaturated cyclic isoprene dimer and the unsaturated cyclic isoprene dimer is hydrogenated catalytically to produce a saturated cyclic isoprene dimer fuel constituent.

5. The method of claim 4, wherein the catalyst for catalyzing cyclo-dimerization of isoprene comprising a catalyst selected from the group consisting of a nickel catalyst, iron catalysts and chromium catalysts.

6. The method of claim 1, wherein the step of partially hydrogenating the bioisoprene composition comprises contacting the bioisoprene composition with hydrogen gas and a catalyst for catalyzing partial hydrogenation of isoprene.

7. The method of claim 6, wherein the catalyst for catalyzing partial hydrogenation of isoprene comprises a palladium catalyst.

8. The method of claim 1, wherein the step of dimerizing the isoamylene with a mono-olefin comprises contacting the isoamylene with the mono-olefin in the presence of a catalyst for catalyzing dimerization of mono-olefin.

9. The method of claim 8, wherein the catalyst for catalyzing dimerization of mono-olefin comprises an acid catalyst.

10. The method of claim 1, further comprising purifying the isoprene from the bioisoprene composition prior to chemically transforming the bioisoprene composition to a fuel constituent.

11. A system for producing a fuel constituent from a bioisoprene composition, wherein a substantial portion of the isoprene in the bioisoprene composition is chemically converted to non-isoprene compounds, the system comprising a bioisoprene composition and :

(a) (i) one or more chemicals capable of dimerizing isoprene in the bioisoprene composition or a source of heat capable of dimerizing isoprene in the bioisoprene composition; and (ii) a catalyst capable of hydrogenating the isoprene dimer to form a saturated C10 fuel constituent; or

(b) (i) a chemical capable of partially hydrogenating isoprene in the bioisoprene composition to produce an isoamylene, (ii) a chemical capable of dimerizing the isoamylene with mono-olefins selected from the group consisting of isoamylene, propylene and isobutene to form a dimate and (iii) a chemical capable of completely hydrogenating the dimate to produce a fuel constituent.

12. The system of claim 11, wherein the bioisoprene composition comprising greater than about 2 mg of isoprene and comprising greater than or about 99.94% isoprene by weight compared to the total weight of all C5 hydrocarbons in the composition.

13. The system of claim 11, wherein the one or more chemicals capable of dimerizing isoprene comprises catalyst for catalyzing cyclo-dimerization of isoprene comprising a catalyst selected from the group consisting of ruthenium catalysts, nickel catalysts, iron catalysts and chromium catalysts.

14. The system of claim 11, wherein the catalyst for hydrogenating the unsaturated isoprene dimers comprises a catalyst selected from the group consisting of palladium catalysts, nickel catalysts, ruthenium catalysts and rhodium catalysts.

15. The system of claim 11, wherein the chemical capable of partially hydrogenating isoprene comprises a palladium catalyst.

16. The system of claim 11, wherein the chemical capable of dimerizing the isoamylene with mono-olefins comprises an acid catalyst.

17. A fuel composition comprising a fuel constituent produced by the method of claim 1.

18. The fuel composition of claim 17, wherein the fuel composition is substantially free of isoprene.

19. The fuel composition of claim 17, wherein the fuel composition has $\delta^{13}C$ value which is greater than -22‰ or within the range of -32‰ to -24‰.

Claims:

1. A method for producing a fuel constituent from a bioisoprene™ composition comprising chemically transforming isoprene in the bioisoprene ™ composition to non-isoprene compounds by:

(a) subjecting the bioisoprene ™ composition to heat or catalytic conditions suitable for isoprene dimerization to produce an isoprene dimer and then catalytically hydrogenating the isoprene dimer to form a saturated C10 fuel constituent; or

(b) (i) partially hydrogenating the bioisoprene ™ composition to produce an isoamylene, (ii) dimerizing the isoamylene with a mono-olefin selected from the group consisting of isoamylene, propylene and isobutene to form a dimate and (iii) completely hydrogenating the dimate to produce a fuel constituent;

wherein the bioisoprene ™ composition is produced by biological means.

2. The method of claim 1, wherein at least 95% of isoprene in the bioisoprene ™ composition is converted to non-isoprene compounds.

3. The method of claim 1, wherein the bioisoprene ™ composition is heated to 150 °C to 250 °C to produce an unsaturated cyclic isoprene dimer and the unsaturated cyclic isoprene dimer is hydrogenated catalytically to produce a saturated cyclic isoprene dimer fuel constituent.

4. The method of claim 1 , wherein the method comprises: (i) contacting the bioisoprene composition with a catalyst for catalyzing cyclo-dimerization of isoprene to produce an unsaturated cyclic isoprene dimer and the unsaturated cyclic isoprene dimer is hydrogenated catalytically to produce a saturated cyclic isoprene dimer fuel constituent.

5. The method of claim 4, wherein the catalyst for catalyzing cyclo-dimerization of isoprene comprising a catalyst selected from the group consisting of a nickel catalyst, iron catalysts and chromium catalysts.

6. The method of claim 1, wherein the step of partially hydrogenating the bioisoprene composition comprises contacting the bioisoprene composition with hydrogen gas and a catalyst for catalyzing partial hydrogenation of isoprene.

7. The method of claim 6, wherein the catalyst for catalyzing partial hydrogenation of isoprene comprises a palladium catalyst.

8. The method of claim 1, wherein the step of dimerizing the isoamylene with a mono-olefin comprises contacting the isoamylene with the mono-olefin in the presence of a catalyst for catalyzing dimerization of mono-olefin.

9. The method of claim 8, wherein the catalyst for catalyzing dimerization of mono-olefin comprises an acid catalyst.

10. The method of claim 1, further comprising purifying the isoprene from the bioisoprene™ composition prior to chemically transforming the bioisoprene™ composition to a fuel constituent.

11. A system for producing a fuel constituent from a bioisoprene™ composition, wherein isoprene in the bioisoprene™ composition is chemically converted to non-isoprene compounds, the system comprising a bioisoprene™ composition and:

(a) (i) one or more chemicals capable of dimerizing isoprene in the bioisoprene™ composition or a source of heat capable of dimerizing isoprene in the bioisoprene™ composition; and (ii) a catalyst capable of hydrogenating the isoprene dimer to form a saturated C10 fuel constituent; or

(b) (i) a chemical capable of partially hydrogenating isoprene in the bioisoprene™ composition to produce an isoamylene, (ii) a chemical capable of dimerizing the isoamylene with mono-olefins selected from the group consisting of isoamylene, propylene and isobutene to form a dimate and (iii) a chemical capable of completely hydrogenating the dimate to produce a fuel constituent;

wherein the bioisoprene™ composition is produced by biological means.

12. The system of claim 11, wherein the bioisoprene™ composition comprising greater than about 2 mg of isoprene and comprising greater than 99.94% isoprene by weight compared to the total weight of all C5 hydrocarbons in the composition.

13. The system of claim 11 , wherein the one or more chemicals capable of dimerizing isoprene comprises catalyst for catalyzing cyclo-dimerization of isoprene comprising a catalyst selected from the group consisting of ruthenium catalysts, nickel catalysts, iron catalysts and chromium catalysts.

14. The system of claim 11, wherein the catalyst for hydrogenating the unsaturated isoprene dimers comprises a catalyst selected from the group consisting of palladium catalysts, nickel catalysts, ruthenium catalysts and rhodium catalysts.

15. The system of claim 11, wherein the chemical capable of partially hydrogenating isoprene comprises a palladium catalyst.

16. The system of claim 11, wherein the chemical capable of dimerizing the isoamylene with mono-olefins comprises an acid catalyst.

17. A fuel composition comprising a fuel constituent produced by the method of claim 1.

18. The fuel composition of claim 17, wherein the fuel composition is substantially free of isoprene.

19. The fuel composition of claim 17, wherein the fuel composition has δ C value which is greater than -22‰ or within the range of -32‰ to -24‰.

20. The method of claim 1, wherein at least 80% of isoprene in the bioisoprene™ composition is converted to non-isoprene compounds.

21. The method of claim 1, wherein the bioisoprene™ composition 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.

22. The method of claim 1, wherein the bioisoprene™ composition comprises one or more 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, and C5 prenyl alcohols.

23. The method of claim 1, wherein the bioisoprene™ composition comprises one or more compounds selected from the group consisting of 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, 3-hexen-1-ol, 3-hexen-1-yl acetate, limonene, geraniol (trans-3,7-dimethyl-2,6-octadien-1-ol), citronellol (3,7-dimethyl-6-octen-1-ol), (E)-3,7-dimethyl-1,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine.

24. The method of claim 1, wherein the isoprene in the bioisoprene™ composition is continuously chemically transformed to the non-isoprene compounds.

25. The system of claim 11, wherein at least 80% of the isoprene in the bioisoprene™ composition is chemically converted to non-isoprene compounds.

26. The system of claim 11, wherein the bioisoprene™ composition 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.

27. The system of claim 11, wherein the bioisoprene™ composition comprises one or more 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, and C5 prenyl alcohols.

28. The system of claim 11, wherein the bioisoprene™ composition comprises one or more compounds selected from the group consisting of 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, 3-hexen-1-ol, 3-hexen-1-yl acetate, limonene, geraniol (trans-3,7-dimethyl-2,6-octadien-1-ol), citronellol (3,7-dimethyl-6-octen-1-ol), (E)-3,7-dimethyl-1,3,6-octatriene, (Z)-3,7-dimethyl-1,3,6-octatriene, and 2,3-cycloheptenolpyridine.