WE CLAIM:

1. A method for suppressing isomerization of an olefin metathesis product produced in a metathesis reaction, the method comprising:

adding an isomerization suppression agent to a mixture that comprises the olefin metathesis product and residual metathesis catalyst from the metathesis reaction under conditions that are sufficient to passivate at least a portion of the residual metathesis catalyst;

wherein the isomerization suppression agent is selected from the group consisting of phosphorous acid, phosphinic acid, and a combination thereof.

2. The invention of claim 1 wherein the olefin metathesis product comprises a terminal double bond.

3. The invention of claim 2 wherein the isomerization comprises conversion of the terminal double bond to an internal double bond.

4. The invention of claim 1 wherein the olefin metathesis product comprises an internal double bond.

5. The invention of claim 4 wherein the isomerization comprises conversion of the internal double bond to a different internal double bond.

6. The invention of claim 4 wherein the isomerization comprises conversion of the internal double bond to a terminal double bond.

7. The invention of claim 1 wherein the olefin metathesis product is α,ω-di-functionalized.

8. The invention of claim 1 wherein the olefin metathesis product comprises a carboxylic acid moiety or a derivative thereof.

9. The invention of claim 1 wherein the olefin metathesis product comprises a carboxylic ester moiety.

10. The invention of claim 1 wherein the olefin metathesis product is selected from the group consisting of 9-decenoic acid, an ester of 9-decenoic acid, 9-undecenoic acid, an ester of 9-undecenoic acid, 9-dodecenoic acid, an ester of 9-dodecenoic acid, 1-decene, 2-dodecene, 3-dodecene, and combinations thereof.

11. The invention of claim 1 wherein the olefin metathesis product is derived from a natural oil.

12. The invention of claim 11 wherein the natural oil is selected from the group consisting of canola oil, rapeseed oil, coconut oil, corn oil, cottonseed oil, olive oil, palm oil, peanut oil, safflower oil, sesame oil, soybean oil, sunflower oil, linseed oil, palm kernel oil, tung oil, jatropha oil, mustard oil, camelina oil, pennycress oil, hemp oil, algal oil, castor oil, lard, tallow, poultry fat, yellow grease, fish oil, tall oils, and combinations thereof.

13. The invention of claim 1 wherein the metathesis reaction comprises self-metathesis of a natural oil.

14. The invention of claim 1 wherein the metathesis reaction comprises cross-metathesis between a natural oil and a low-molecular-weight olefin.

15. The invention of claim 1 wherein the metathesis reaction comprises cross-metathesis between a natural oil and a C_2-C_{14} olefin that comprises a terminal double bond.

16. The invention of claim 15 wherein the natural oil is selected from the group consisting of canola oil, rapeseed oil, coconut oil, corn oil, cottonseed oil, olive oil, palm oil, peanut oil, safflower oil, sesame oil, soybean oil, sunflower oil, linseed oil, palm kernel oil, tung oil, jatropha oil, mustard oil, camelina oil, pennycress oil, hemp

oil, algal oil, castor oil, lard, tallow, poultry fat, yellow grease, fish oil, tall oils, and combinations thereof.

17. The invention of claim 1 wherein the residual metathesis catalyst comprises a transition metal selected from the group consisting of ruthenium, rhenium, tantalum, nickel, tungsten, molybdenum, and combinations thereof.

18. The invention of claim 1 wherein the residual metathesis catalyst comprises ruthenium.

19. The invention of claim 18 wherein the olefin metathesis product is produced in a metathesis reaction catalyzed by a ruthenium carbene complex.

20. The invention of claim 19 wherein the ruthenium carbene complex comprises a phosphine ligand.

21. The invention of claim 19 wherein the ruthenium carbene complex comprises an imidazolidine ligand.

22. The invention of claim 19 wherein the ruthenium carbene complex comprises an isopropyloxy group attached to a benzene ring.

23. The invention of claim 1 wherein the isomerization suppression agent comprises phosphorous acid.

24. The invention of claim 23 wherein neat phosphorous acid is added to the mixture.

25. The invention of claim 1 wherein the isomerization suppression agent comprises phosphorous acid, which is provided in an aqueous solution having a concentration of between about 1 wt% and about 70 wt%.

26. The invention of claim 25 wherein the concentration is between about 5 wt% and about 50 wt%.

27. The invention of claim 25 wherein the concentration is between about 7 wt% and about 15 wt%.

28. The invention of claim 25 wherein the concentration is about 10 wt%.

29. The invention of claim 1 wherein the isomerization suppression agent comprises phosphinic acid.

30. The invention of claim 1 wherein the isomerization suppression agent comprises phosphinic acid, which is provided in an aqueous solution having a concentration of between about 1 wt% and about 50 wt%.

31. The invention of claim 1 wherein the isomerization suppression agent is added in a molar excess relative to the residual metathesis catalyst.

32. The invention of claim 31 wherein the molar excess is at least about 15 to 1.

33. The invention of claim 31 wherein the molar excess is at least about 25 to 1.

34. The invention of claim 32 wherein the molar excess is at least about 35 to 1.

35. The invention of claim 31 wherein the molar excess is at least about 50 to 1.

36. The invention of claim 1 wherein the conditions comprise high shear mixing.

37. The invention of claim 1 wherein the conditions comprise high shear mixing and heating.

38. The invention of claim 1 further comprising extracting the mixture with a polar solvent.

39. The invention of claim 38 wherein the polar solvent is selected from the group consisting of water, methanol, ethanol, ethylene glycol, glycerol, DMF, polyethylene glycols, glymes, and combinations thereof.

40. The invention of claim 38 wherein the polar solvent comprises water.

41. The invention of claim 40 further comprising separating an organic phase from an aqueous phase.

42. The invention of claim 40 wherein the metathesis reaction comprises cross-metathesis between a natural oil and a C_2-C_{14} olefin that comprises a terminal double bond.

43. The invention of claim 42 further comprising separating an organic phase from an aqueous phase, wherein a majority of the isomerization suppression agent is distributed in the aqueous phase and wherein a majority of the olefin metathesis product is distributed in the organic phase.

44. The invention of claim 43 further comprising separating the olefin metathesis product into a triacylglyceride fraction and an olefinic fraction.

45. The invention of claim 44 further comprising transesterifying the triacylglyceride fraction to produce one or a plurality of transesterification products.

46. The invention of claim 45 further comprising separating the transesterification products from a glycerol-containing phase.

47. The invention of claim 46 wherein the residual metathesis catalyst comprises ruthenium, and wherein a majority of the ruthenium is distributed between the glycerol-containing phase and the transesterification products.

48. The invention of claim 45 wherein the transesterification products comprise fatty acid methyl esters.

49. The invention of claim 1 wherein the isomerization is reduced to less than about 1% by weight of the olefin metathesis product.

50. The invention of claim 1 wherein the isomerization suppression agent is attached to a solid support.

51. The invention of claim 1 further comprising adsorbing at least a portion of the isomerization suppression agent onto an adsorbent.

52. The invention of claim 51 further comprising physically separating the adsorbent from the mixture.

53. The invention of claim 51 wherein the adsorbent is selected from the group consisting of carbon, silica, silica-alumina, alumina, clay, magnesium silicates, TRISYL synthetic silica, diatomaceous earth, and the like, and combinations thereof.

54. A method for suppressing isomerization of an olefin metathesis product produced in a metathesis reaction, the method comprising:

adding an isomerization suppression agent to a mixture that comprises the olefin metathesis product and residual metathesis catalyst from the metathesis reaction under conditions that are sufficient to passivate at least a portion of the residual metathesis catalyst;

washing the mixture with a polar solvent; and

separating a phase comprising a majority of the isomerization suppression agent from a phase comprising a majority of the olefin metathesis product;

wherein the isomerization suppression agent is selected from the group consisting of phosphorous acid, phosphinic acid, and a combination thereof.

55. The invention of claim 54 wherein the phase comprising the majority of the isomerization suppression agent further comprises a majority of the polar solvent.

56. The invention of claim 54 wherein the residual metathesis catalyst comprises ruthenium.

57. A method of refining a natural oil comprising:

providing a feedstock comprising a natural oil;

reacting the feedstock in the presence of a metathesis catalyst to form a metathesized product comprising olefins and esters;

passivating residual metathesis catalyst with an agent selected from the group consisting of phosphorous acid, phosphinic acid, and a combination thereof;

separating the olefins in the metathesized product from the esters in the metathesized product; and

transesterifying the esters in the presence of an alcohol to form a transesterified product and/or hydrogenating the olefins to form a fully or partially saturated hydrogenated product.

58. The invention of claim 57 wherein the natural oil is selected from the group consisting of canola oil, rapeseed oil, coconut oil, corn oil, cottonseed oil, olive oil, palm oil, peanut oil, safflower oil, sesame oil, soybean oil, sunflower oil, linseed oil, palm kernel oil, tung oil, jatropha oil, mustard oil, camelina oil, pennycress oil, hemp oil, algal oil, castor oil, lard, tallow, poultry fat, yellow grease, fish oil, tall oils, and combinations thereof.

59. The invention of claim 57 wherein the residual metathesis catalyst comprises ruthenium.

60. The invention of claim 57 wherein the isomerization suppression agent comprises phosphorous acid.

61. The invention of claim 60 wherein neat phosphorous acid is added to the mixture.

62. The invention of claim 57 wherein the isomerization suppression agent comprises phosphorous acid, which is provided in an aqueous solution having a concentration of between about 1 wt% and about 70 wt%.

63. The invention of claim 57 wherein the isomerization suppression agent comprises phosphinic acid.

64. The invention of claim 57 wherein the isomerization suppression agent comprises phosphinic acid, which is provided in an aqueous solution having a concentration of between about 1 wt% and about 50 wt%.

65. The invention of claim 57 wherein the isomerization suppression agent is added in a molar excess relative to the residual metathesis catalyst.

66. The invention of claim 65 wherein the molar excess is at least about 15 to 1.

67. The invention of claim 57 further comprising treating the feedstock, prior to reacting the feedstock in the presence of the metathesis catalyst, under conditions sufficient to diminish catalyst poisons in the feedstock.

68. The invention of claim 67 wherein the feedstock is chemically treated through a chemical reaction to diminish the catalyst poisons.

69. The invention of claim 67 wherein the feedstock is heated to a temperature greater than 100 °C in an absence of oxygen and held at the temperature for a time sufficient to diminish the catalyst poisons.

70. The invention of claim 57 wherein the metathesis catalyst is dissolved in a solvent.

71. The invention of claim 70 wherein the solvent comprises toluene.

72. The invention of claim 57, further comprising hydrogenating the olefins to form a fuel composition that comprises (a) a jet fuel composition having a carbon number distribution between 5 and 16 and/or (b) a diesel fuel composition having a carbon number distribution between 8 and 25.

73. The invention of claim 57 further comprising oligomerizing the olefins to form a material selected from the group consisting of poly-alpha-olefins, poly-internal-olefins, mineral oil replacements, biodiesel, and combinations thereof.

74. The invention of claim 57, further comprising:

separating glycerin from the transesterified product through a liquid-liquid separation;

washing the transesterified product with water after separating the glycerin to further remove the glycerin; and

drying the transesterified product after the washing to separate the water from the transesterified product.

75. The invention of claim 74 further comprising distilling the transesterified product to separate a specialty chemical selected from the group consisting of an ester of 9-decenoic acid, an ester of 9-undecenoic acid, an ester of 9-dodecenoic acid, and combinations thereof.

76. The invention of claim 75 further comprising hydrolyzing the specialty chemical, thereby forming an acid selected from the group consisting of: 9-decenoic acid, 9-undecenoic acid, 9-dodecenonic acid, alkali metal salts thereof, alkaline metal salts thereof, and combinations thereof.

77. The invention of claim 57 further comprising reacting the transesterified product with itself to form a dimer.

78. The invention of claim 57 wherein the reacting comprises self-metathesis of the natural oil.

79. The invention of claim 57 further comprising providing a low-molecular-weight olefin.

80. The invention of claim 79 wherein the reacting comprises cross-metathesis between the natural oil and the low-molecular-weight olefin.

81. The invention of claim 80 wherein the low-molecular-weight olefin comprises a C_2-C_{14} olefin that comprises a terminal double bond.

82. The invention of claim 80 wherein the low-molecular-weight olefin comprises a material selected from the group consisting of ethylene, propylene, 1-butene, 2-butene, and combinations thereof.

83. The invention of claim 80 wherein the low-molecular-weight olefin comprises at least one branched olefin having a carbon number between 4 and 10.

84. A method of producing a fuel composition comprising:

providing a feedstock comprising a natural oil;

reacting the feedstock in the presence of a metathesis catalyst to form a metathesized product comprising olefins and esters;

passivating residual metathesis catalyst with an agent selected from the group consisting of phosphorous acid, phosphinic acid, and a combination thereof;

separating the olefins in the metathesized product from the esters in the metathesized product; and

hydrogenating the olefins to form a fuel composition.

85. The invention of claim 84 wherein the fuel composition is (a) a kerosene-type jet fuel having a carbon number distribution between 8 and 16, a flash point between about 38 °C and about 66 °C, an auto ignition temperature of about 210 °C, and a freeze point between about -47 °C and about -40 °C; (b) a naphtha-type jet fuel having a carbon number distribution between 5 and 15, a flash point between about -23 °C and about 0 °C, an auto ignition temperature of about 250 °C; and a freeze point of about -65°C; or (c) a diesel fuel having a carbon number distribution between 8 and 25, a specific gravity of between about 0.82 and about 1.08 at about 15.6 °C, a cetane number of greater than about 40, and a distillation range between about 180 °C and about 340 °C.

86. The invention of claim 84 further comprising flash-separating a light end stream from the metathesized product prior to separating the olefins from the esters, the light end stream having a majority of hydrocarbons with carbon number between 2 and 4.

87. The invention of claim 84 further comprising separating a light end stream from the olefins prior to hydrogenating the olefins, the light end stream having a majority of hydrocarbons with carbon numbers between 3 and 8.

88. The invention of claim 84 further comprising separating a C_{18+} heavy end stream from the olefins prior to hydrogenating the olefins, the heavy end stream having a majority of hydrocarbons with carbon numbers of at least 18.

89. The invention of claim 84 further comprising separating a C_{18+} heavy end stream from the fuel composition, the heavy end stream having a majority of hydrocarbons with carbon numbers of at least 18.

90. The invention of claim 84 further comprising isomerizing the fuel composition, wherein a fraction of normal-paraffin compounds in the fuel composition are isomerized into *iso*-paraffin compounds.

91. The invention of claim 84 wherein the reacting comprises self-metathesis of the natural oil.

92. The invention of claim 84 further comprising providing a low-molecular-weight olefin, wherein the reacting comprises cross-metathesis between the natural oil and the low-molecular-weight olefin.

93. A method of producing a fuel composition comprising:

providing a feedstock comprising a natural oil;

reacting the feedstock in the presence of a metathesis catalyst under conditions sufficient to form a metathesized product comprising olefins and esters;

passivating residual metathesis catalyst with an agent selected from the group consisting of phosphorous acid, phosphinic acid, and a combination thereof;

hydrogenating the metathesized product to form a fuel composition and at least partially saturated esters;

separating the fuel composition from the at least partially saturated esters.

94. The invention of claim 93 further comprising isomerizing the fuel composition, wherein a fraction of normal-paraffin compounds in the fuel composition are isomerized into *iso*-paraffin compounds.

95. The method of claim 93 further comprising separating a C_{18+} heavy end stream from the fuel composition, the heavy end stream having a majority of hydrocarbons with carbon numbers of at least 18.

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