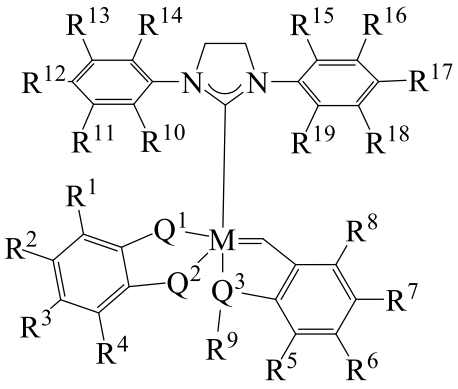
CLAIMS:

What is claimed is:

1. A method for forming a polyolefin having 60% or greater cis carbon-carbon double bonds and a melting point of from -40°C to 20°C, the method comprising:

contacting, at a temperature of about 20°C to about 100°C, a C_5 cyclic olefin monomer selected from cyclopentene and cyclopentadiene, with a catalyst represented by Formula (I):



(**I**)

wherein:

M is a group 8 metal;

Q^1, Q^2, and Q^3 are independently oxygen or sulfur;

each of R^1 and R^4 is a halogen;

R^9 is C_1-C_{40} hydrocarbyl or C_1-C_{40} substituted hydrocarbyl; and

each of R^2, R^3, R^5, R^6, R^7, R^8, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, and R^{19} is independently hydrogen, halogen, C_1-C_{40} hydrocarbyl or C_1-C_{40} substituted hydrocarbyl.

2. The method of claim 1, further comprising contacting the catalyst with a second cyclic hydrocarbyl monomer different than the C5 cyclic olefin monomer to form a polyolefin copolymer.

3. The method of claim 2, wherein the second cyclic hydrocarbyl monomer is one or more of cyclopropene, cyclobutene, cyclohexene, methylcyclohexene, cycloheptene, cyclooctadiene, cyclooctene, norbornadiene, norbornene, cyclobutadiene, cyclohexadiene, cycloheptadiene, cyclooctatetraene, 1,5-cyclooctadiene, 1,5-dimethyl-1,5-cyclooctadiene, dicyclopentadiene, and isomers thereof.

4. The method of any of claims 1 to 3, wherein M is ruthenium or osmium.

5. The method of any of claims 1 to 4, wherein M is ruthenium.

6. The method of any of claims 1 to 5, wherein Q^1 and Q^2 are sulfur and Q^3 is oxygen.

7. The method of any of claims 1 to 6, wherein each of R^{10}, R^{12}, R^{14}, R^{15}, R^{17}, and R^{19} is independently C_1-C_{40} hydrocarbyl.

8. The method of any of claims 1 to 7, wherein each of R^{10}, R^{12}, R^{14}, R^{15}, R^{17}, and R^{19} is independently selected from methyl, ethyl, and propyl.

9. The method of any of claims 1 to 8, wherein each of R^{11}, R^{13}, R^{16}, and R^{18} is hydrogen.

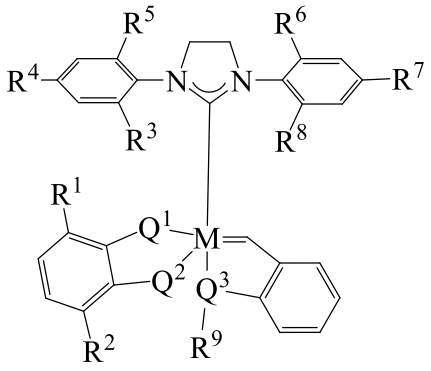
10. The method of any of claims 1 to 9, wherein each of R^2, R^3, R^5, R^6, R^7, and R^8 is independently hydrogen or C_1-C_{40} hydrocarbyl.

11. The method of any of claims 1 to 10, wherein each of R^2, R^3, R^5, R^6, R^7, and R^8 is hydrogen.

12. The method of any of claims 1 to 11, wherein R^9 is selected from methyl, ethyl, n-propyl, isopropyl, butyl, isobutyl, tert-butyl, sec-butyl, pentyl, isopentyl, sec-pentyl, hexyl, isohexyl, heptyl, isoheptyl, octyl, isooctyl, nonyl, isononyl, decyl, and isodecyl.

13. The method of any of claims 1 to 12, wherein R^1 and R^4 are chlorine.

14. The method of claim 1, wherein the catalyst is represented by Formula (II):



(**II**)

wherein:

M is a group 8 metal;

Q^1, Q^2, and Q^3 are independently oxygen or sulfur;

each of R^1 and R^2 is halogen;

R^9 is C_1-C_{40} hydrocarbyl or C_1-C_{40} substituted hydrocarbyl; and

each of R^3, R^4, R^5, R^6, R^7, and R^8 is independently hydrogen, halogen, C_1-C_{40} hydrocarbyl, or C_1-C_{40} substituted hydrocarbyl.

15. The method of claim 14, wherein M is ruthenium.

16. The method of claim 14 or 15, wherein Q^1 and Q^2 are sulfur and Q^3 is oxygen.

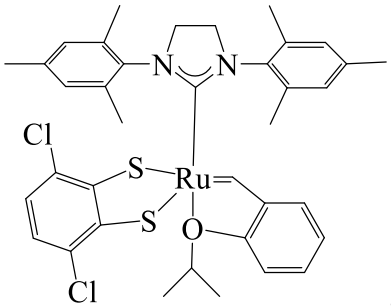
17. The method of any of claims 14 to 16, wherein each of R^3, R^4, R^5, R^6, R^7, and R^8 is independently C_1-C_{40} hydrocarbyl.

18. The method of any of claims 14 to 17, wherein each of R^3, R^4, R^5, R^6, R^7, and R^8 is a C_1-C_{40} independently selected from methyl, ethyl, and propyl.

19. The method of any of claims 14 to 18, wherein R^9 is selected from methyl, ethyl, n-propyl, isopropyl, butyl, isobutyl, tert-butyl, sec-butyl, pentyl, isopentyl, sec-pentyl, hexyl, isohexyl, heptyl, isoheptyl, octyl, isooctyl, nonyl, isononyl, decyl, and isodecyl.

20. The method of any of claims 14 to 19, wherein R^1 and R^4 are chlorine.

21. The method of any of claims 1 to 20, wherein the catalyst is:



.

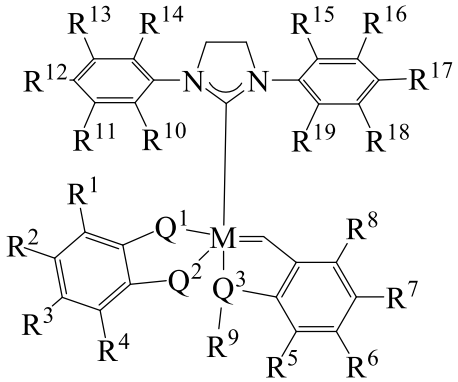
22. The method of any of claims 1 to 21, wherein the polyolefin has a melting point of from -40°C to - 25°C.

23. The method of any of claims 1 to 22, wherein the polyolefin has a glass transition temperature from -100°C to -115°C.

24. The method of any of claims 1 to 23, wherein the polyolefin is a polycyclopentene having 90% or greater cis carbon-carbon double bonds.

25. A method for forming a olefin block copolymer having 50% or greater cis carbon-carbon double bonds, the method comprising:

contacting a first cyclic hydrocarbyl monomer with a catalyst represented by Formula (**I**) to form a polyolefin having 50% or greater cis carbon-carbon double bonds, wherein Formula (**I**) is:



(**I**),

wherein:

M is a group 8 metal;

Q^1, Q^2, and Q^3 are independently oxygen or sulfur;

each of R^1 and R^4 is a first halogen;

R^9 is a first C_1-C_{40} hydrocarbyl or, a first C_1-C_{40} substituted hydrocarbyl; and

each of R^2, R^3, R^5, R^6, R^7, R^8, R^{10}, R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, R^{16}, R^{17}, R^{18}, and R^{19} is independently hydrogen, a second halogen, a second C_1-C_{40} hydrocarbyl, or a second C_1-C_{40} substituted hydrocarbyl; and

contacting the polyolefin and the catalyst with a second monomer to form the block copolymer.

26. The process of claim 1 wherein the turnover number for the polymerization is from about 500 to about 50,000, where turnover number is defined to be [micromoles of metathesis product]/([micromoles of catalyst included in the reaction mixture].

27. The process of claim 1 wherein the process is a continuous process.