

Claims:

We claim:

1. A method for preparing supported alumoxane comprising contacting in an aliphatic solvent at a temperature of from less than 0°C to -60°C at least one support material having
5 absorbed water and at least one hydrocarbyl aluminum compound.
2. The method of claim 1, wherein the at least one support material contains absorbed water in an amount ranging from 0.5 to 30 mmol of water per one gram of support material.
- 10 3. The method of claim 1 or 2, wherein the at least one support material contains absorbed water in a ratio of from 1:0.95 to 1:100 mol water:mol hydrocarbyl aluminum.
4. The method of any of claims 1 to 3, wherein the temperature is less than -10°C.
- 15 5. The method of any of claims 1 to 3, wherein the temperature is less than -20°C.
6. The method of any of claims 1 to 5, wherein the aliphatic solvent is one or more of non-cyclic alkanes with formula $C_nH_{(n+2)}$ where n is 4 to 30, cycloalkanes with formula C_nH_n where n is 5 to 30 and mixtures thereof.
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7. The method of claims 1 to 6, wherein the amount of hydrocarbyl aluminum compound on the support material is from 1.0 mmol aluminum per gram of support material to 30 mmol aluminum per gram of support material.
- 25 8. The method of claims 1 to 7, wherein the support material comprises a solid oxide optionally treated with an electron-withdrawing anion, wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and the electron-withdrawing anion is selected from fluoride, chloride, bromide,
30 phosphate, triflate, bisulfate, sulfate, and any combination thereof.
9. The method of claims 1 to 8, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum, triethylaluminum, tripropylaluminum, tri-n-butylaluminum, tri-

isobutyl-aluminum, tri(2-methylpentyl)aluminum, trihexylaluminum, tri-n-octylaluminum, and tri-n-decylaluminum.

10. The method of any of claims 1 to 9, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum and tri-n-octylaluminum.

11. The method of any of claims 1 to 10, wherein the support material is silica and the hydrocarbyl aluminum compound is trimethylaluminum.

12. A continuous process for preparing supported alumoxane comprising contacting in an aliphatic solvent at a temperature of from less than 0°C to -60°C at least one support material having absorbed water and at least one hydrocarbyl aluminum compound to produce a silica supported alumoxane, separating the silica supported alumoxane from the aliphatic solvent and recycling the aliphatic solvent and any excess hydrocarbyl aluminum.

13. The method of claim 12, wherein the temperature is less than -10°C.

14. The method of claim 12, wherein the temperature is less than -20°C.

15. The method of claims 12 to 14, wherein the amount of hydrocarbyl aluminum compound on the support material is from 1.0 mmol aluminum per gram of support material to 30 mmol aluminum per gram of support material.

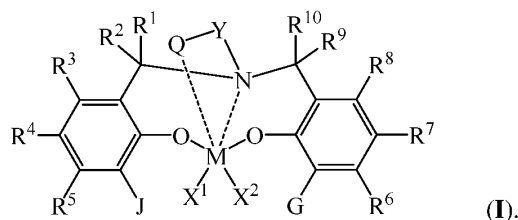
16. The method of claims 12 to 15, wherein the support material is silica, alumina or mixtures thereof.

17. The method of claims 12 to 16, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum, triethylaluminum, tripropylaluminum, tri-n-butylaluminum, tri-isobutyl-aluminum, tri(2-methylpentyl)aluminum, trihexylaluminum, tri-n-octylaluminum, and tri-n-decylaluminum.

18. The method of any of claims 12 to 17, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum and tri-n-octylaluminum.

19. The method of any of claims 12 to 18, wherein the support material is silica and the hydrocarbyl aluminum compound is trimethylaluminum.
- 5 20. A method for preparing a catalyst system comprising contacting in an aliphatic solvent at a temperature of from less than 0°C to -60°C at least one support material having absorbed water and at least one hydrocarbyl aluminum compound to form a supported alumoxane and contacting the supported alumoxane with at least one catalyst compound having a Group 3 through Group 12 metal atom or lanthanide metal atom.
- 10 21. The method of claim 20, wherein the temperature is less than -10°C.
22. The method of claim 20, wherein the temperature is less than -20°C.
- 15 23. The method of any of claims 20 to 22, wherein the amount of hydrocarbyl aluminum compound on the support material is from 1.0 mmol aluminum per gram of support material to 30 mmol aluminum per gram of support material.
24. The method of claims 20 to 23, wherein the support material is silica, alumina or
20 mixtures thereof.
25. The method of any of claims 20 to 24, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum, triethylaluminum, tripropylaluminum, tri-n-butylaluminum, tri-isobutyl-aluminum, tri(2-methylpentyl)aluminum, trihexylaluminum, tri-
25 n-octylaluminum, and tri-n-decylaluminum.
26. The method of any of claims 20 to 25, wherein the hydrocarbyl aluminum compound is one or more of trimethylaluminum and tri-n-octylaluminum.
- 30 27. The method of any of claims 20 to 26, wherein the support material is silica and the hydrocarbyl aluminum compound is trimethylaluminum.

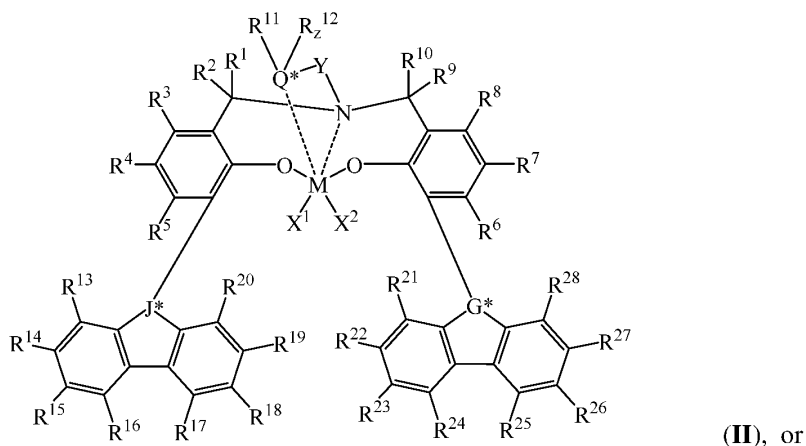
28. The method of any of claims 20 to 27, wherein the catalyst compound is a metallocene catalyst compound comprising a Group 4 metal.
29. The method of any of claims 20 to 28, wherein the catalyst compound is a metallocene catalyst compound selected from the group consisting of:
- 5 bis(1-methyl, 3-n-butyl cyclopentadienyl) zirconium dichloride;
 bis(1-methyl, 3-n-butyl cyclopentadienyl) zirconium dimethyl;
 dimethylsilyl bis(tetrahydroindenyl) zirconium dichloride;
 dimethylsilyl bis(tetrahydroindenyl) zirconium dimethyl;
- 10 bis(n-propylcyclopentadienyl) hafnium dichloride;
 bis(n-propylcyclopentadienyl) hafnium dimethyl;
 dimethylsilyl (tetramethylcyclopentadienyl)(cyclododecylamido)titanium dimethyl;
 dimethylsilyl (tetramethylcyclopentadienyl)(cyclododecylamido)titanium dichloride;
 dimethylsilyl (tetramethylcyclopentadienyl)(t-butylamido)titanium dimethyl;
- 15 dimethylsilyl (tetramethylcyclopentadienyl)(t-butylamido)titanium dichloride;
 μ -(CH₃)₂Si(cyclopentadienyl)(1-adamantylamido)M(R)₂;
 μ -(CH₃)₂Si(3-tertbutylcyclopentadienyl)(1-adamantylamido)M(R)₂;
 μ -(CH₃)₂(tetramethylcyclopentadienyl)(1-adamantylamido)M(R)₂;
 μ -(CH₃)₂Si(tetramethylcyclopentadienyl)(1-adamantylamido)M(R)₂;
- 20 μ -(CH₃)₂C(tetramethylcyclopentadienyl)(1-adamantylamido)M(R)₂;
 μ -(CH₃)₂Si(tetramethylcyclopentadienyl)(1-tertbutylamido)M(R)₂;
 μ -(CH₃)₂Si(fluorenyl)(1-tertbutylamido)M(R)₂;
 μ -(CH₃)₂Si(tetramethylcyclopentadienyl)(1-cyclododecylamido)M(R)₂;
 μ -(C₆H₅)₂C(tetramethylcyclopentadienyl)(1-cyclododecylamido)M(R)₂; and
- 25 μ -(CH₃)₂Si(η^5 -2,6,6-trimethyl-1,5,6,7-tetrahydro-s-indacen-1-yl)(tertbutylamido)M(R)₂;
 where M is Ti, Zr, or Hf; and R is halogen or C₁ to C₅ alkyl.
30. The method of any of claims 20 to 27, wherein the catalyst compound comprises one or more of L_nL'_mMR_o wherein L is a neutral ligand, n = 0 – 4, L' is an anionic ligand, m = 0 –
- 30 2, M is titanium, zirconium, or hafnium, o = 2 – 4, with the constraint that o + m = 4.
31. The method of any of claims 20 to 27, wherein the catalyst compound is a bis(phenolate) catalyst compound represented by Formula (I):

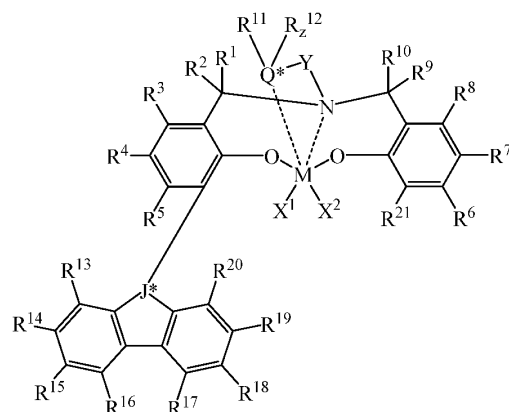


M is a Group 4 metal. X^1 and X^2 are independently a univalent C_1 - C_{20} hydrocarbyl, C_1 - C_{20} substituted hydrocarbyl, a heteroatom or a heteroatom-containing group, or X^1 and X^2 join together to form a C_4 - C_{62} cyclic or polycyclic ring structure; R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 , R^8 , R^9 , and R^{10} is independently hydrogen, C_1 - C_{40} hydrocarbyl, C_1 - C_{40} substituted hydrocarbyl, a heteroatom or a heteroatom-containing group, or two or more of R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 , R^8 , R^9 , or R^{10} are joined together to form a C_4 - C_{62} cyclic or polycyclic ring structure, or a combination thereof; Q is a neutral donor group; J is heterocycle, a substituted or unsubstituted C_7 - C_{60} fused polycyclic group, where at least one ring is aromatic and where at least one ring, which may or may not be aromatic, has at least five ring atoms; G is as defined for J or may be hydrogen, C_2 - C_{60} hydrocarbyl, C_1 - C_{60} substituted hydrocarbyl, or may independently form a C_4 - C_{60} cyclic or polycyclic ring structure with R^6 , R^7 , or R^8 or a combination thereof; and Y is divalent C_1 - C_{20} hydrocarbyl or divalent C_1 - C_{20} substituted hydrocarbyl or $(-Q^*-Y-)$ together form a heterocycle.

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32. The method of 31, wherein the catalyst compound is represented by Formula (II) or Formula (III):

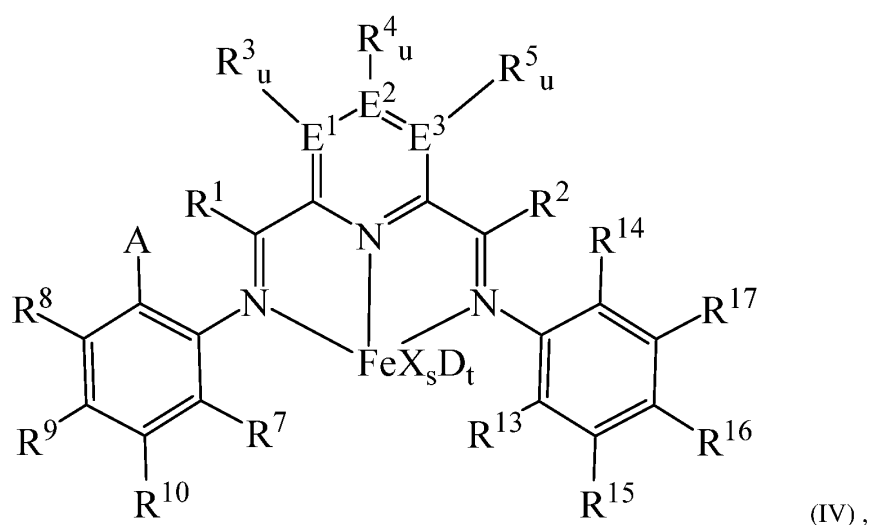




(III),

- wherein M is Hf, Zr, or Ti. X^1 , X^2 , R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 , R^8 , R^9 , R^{10} , and Y are as defined for Formula (I). R^{11} , R^{12} , R^{13} , R^{14} , R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , and R^{28} is independently a hydrogen, C_1 - C_{40} hydrocarbyl, C_1 - C_{40} substituted hydrocarbyl, a functional group comprising elements from Groups 13 to 17, or two or more of R^1 , R^2 , R^3 , R^4 , R^5 , R^6 , R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , R^{14} , R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{20} , R^{21} , R^{22} , R^{23} , R^{24} , R^{25} , R^{26} , R^{27} , and R^{28} may independently join together to form a C_4 - C_{62} cyclic or polycyclic ring structure, or a combination thereof; R^{11} and R^{12} may join together to form a five- to eight-membered heterocycle; Q^* is a group 15 or 16 atom; z is 0 or 1; J^* is CR'' or N, and G^* is CR'' or N, where R'' is C_1 - C_{20} hydrocarbyl or carbonyl-containing C_1 - C_{20} hydrocarbyl; and z = 0 if Q^* is a group 16 atom, and z = 1 if Q^* is a group 15 atom.

33. The method of any of claims 20 to 27, wherein the catalyst compound is an iron complex represented by formula (IV):



wherein:

A is chlorine, bromine, iodine, -CF₃ or -OR¹¹;

each of R¹ and R² is independently hydrogen, C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, C₆-C₂₂-aryl,
 5 arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6 to 20 carbon atoms,
 or five-, six- or seven-membered heterocyclyl comprising at least one atom selected from the
 group consisting of N, P, O and S;

wherein each of R¹ and R² is optionally substituted by halogen, -NR¹¹₂, -OR¹¹ or -SiR¹²₃;

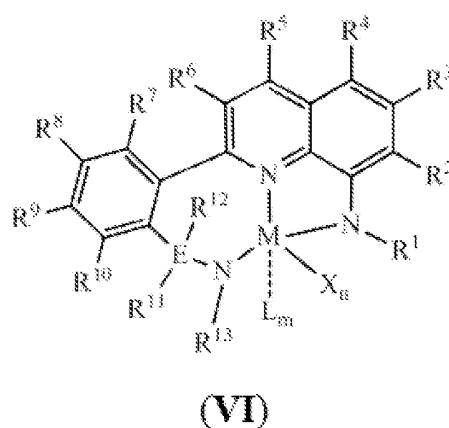
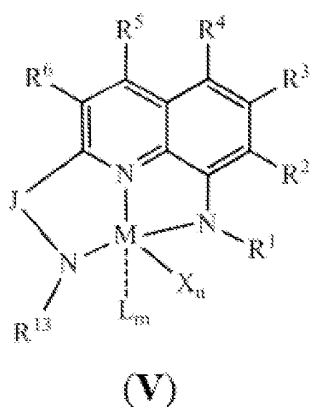
wherein R¹ optionally bonds with R³, and R² optionally bonds with R⁵, in each case to
 10 independently form a five-, six- or seven-membered ring;

R⁷ is a C₁-C₂₀ alkyl;

each of R³, R⁴, R⁵, R⁸, R⁹, R¹⁰, R¹⁵, R¹⁶, and R¹⁷ is independently hydrogen, C₁-C₂₂-alkyl,
 C₂-C₂₂-alkenyl, C₆-C₂₂-aryl, arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has
 from 6 to 20 carbon atoms, -NR¹¹₂, -OR¹¹, halogen, -SiR¹²₃ or five-, six- or seven-membered
 15 heterocyclyl comprising at least one atom selected from the group consisting of N, P, O and S;
 wherein R³, R⁴, R⁵, R⁷, R⁸, R⁹, R¹⁰, R¹⁵, R¹⁶, and R¹⁷ are optionally substituted by
 halogen, -NR¹¹₂, -OR¹¹ or -SiR¹²₃;

wherein R³ optionally bonds with R⁴, R⁴ optionally bonds with R⁵, R⁷ optionally bonds with
 R¹⁰, R¹⁰ optionally bonds with R⁹, R⁹ optionally bonds with R⁸, R¹⁷ optionally bonds with R¹⁶,
 20 and R¹⁶ optionally bonds with R¹⁵, in each case to independently form a five-, six- or seven-
 membered carbocyclic or heterocyclic ring, the heterocyclic ring comprising at least one atom
 from the group consisting of N, P, O and S;

- R¹³ is C₁-C₂₀-alkyl bonded with the aryl ring via a primary or secondary carbon atom;
- R¹⁴ is chlorine, bromine, iodine, -CF₃ or -OR¹¹, or C₁-C₂₀-alkyl bonded with the aryl ring;
- each R¹¹ is independently hydrogen, C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, C₆-C₂₂-aryl, arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6 to 20 carbon atoms, or -SiR¹²₃, wherein
- 5 R¹¹ is optionally substituted by halogen, or two R¹¹ radicals optionally bond to form a five- or six-membered ring;
- each R¹² is independently hydrogen, C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, C₆-C₂₂-aryl, arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6 to 20 carbon atoms, or two R¹² radicals optionally bond to form a five- or six-membered ring;
- 10 each of E¹, E², and E³ is independently carbon, nitrogen or phosphorus;
- each u is independently 0 if E¹, E², and E³ is nitrogen or phosphorus and is 1 if E¹, E², and E³ is carbon;
- each X is independently fluorine, chlorine, bromine, iodine, hydrogen, C₁-C₂₀-alkyl, C₂-C₁₀-alkenyl, C₆-C₂₀-aryl, arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6
- 15 to 20 carbon atoms, -NR¹⁸₂, -OR¹⁸, -SR¹⁸, -SO₃R¹⁸, -OC(O)R¹⁸, -CN, -SCN, β-diketonate, -CO, -BF₄⁻, -PF₆⁻ or bulky non-coordinating anions, and the radicals X can be bonded with one another;
- each R¹⁸ is independently hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl, arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6 to 20 carbon atoms, or -SiR¹⁹₃, wherein
- 20 R¹⁸ can be substituted by halogen or nitrogen- or oxygen-containing groups and two R¹⁸ radicals optionally bond to form a five- or six-membered ring;
- each R¹⁹ is independently hydrogen, C₁-C₂₀-alkyl, C₂-C₂₀-alkenyl, C₆-C₂₀-aryl or arylalkyl where alkyl has from 1 to 10 carbon atoms and aryl has from 6 to 20 carbon atoms, wherein R¹⁹ can be substituted by halogen or nitrogen- or oxygen-containing groups or two R¹⁹ radicals
- 25 optionally bond to form a five- or six-membered ring;
- s is 1, 2, or 3;
- D is a neutral donor; and
- t is 0 to 2.
- 30 34. The method of any of claims 20 to 27, wherein the catalyst is a quinolinylidamido transition metal complex represented by formulas (V) and (VI):



wherein:

M is a Group 3-12 metal;

J is a three-atom-length bridge between the quinoline and the amido nitrogen;

5 E is selected from carbon, silicon, or germanium;

X is an anionic leaving group;

L is a neutral Lewis base;

R¹ and R¹³ are independently selected from the group consisting of hydrocarbyls, substituted hydrocarbyls, and silyl groups;

10 R² through R¹² are independently selected from the group consisting of hydrogen, hydrocarbyls, alkoxy, silyl, amino, aryloxy, substituted hydrocarbyls, halogen, and phosphino;
n is 1 or 2;

m is 0, 1, or 2;

n+m is not greater than 4;

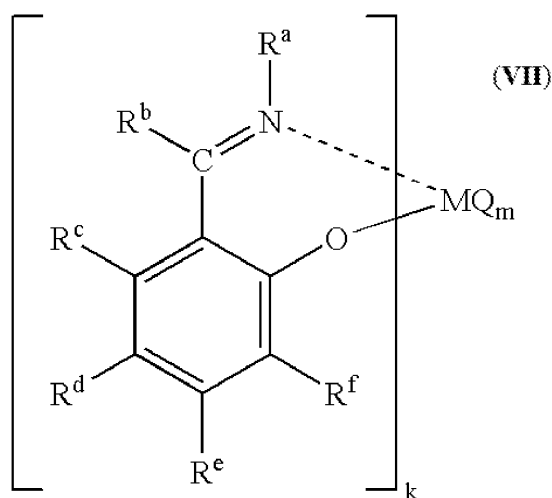
15 any two adjacent R groups (e.g. R¹ & R², R² & R³, etc.) may be joined to form a substituted or unsubstituted hydrocarbyl or heterocyclic ring, where the ring has 5, 6, 7, or 8 ring atoms and where substitutions on the ring can join to form additional rings;

any two X groups may be joined together to form a dianionic group;

any two L groups may be joined together to form a bidentate Lewis base; and

20 an X group may be joined to an L group to form a monoanionic bidentate group.

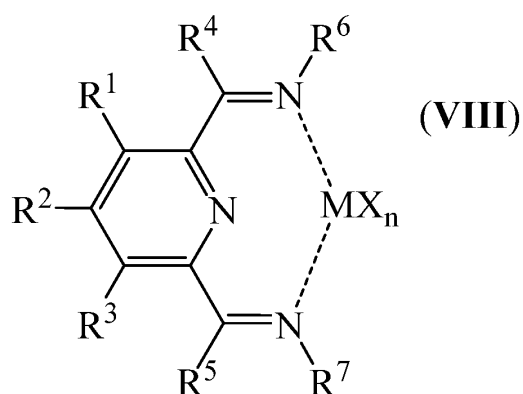
35. The method of any of claims 20 to 27, wherein the catalyst compound comprises a phenoxyimine compound represented by the formula (VII):



wherein M represents a transition metal atom selected from the groups 3 to 11 metals in the periodic table; k is an integer of 1 to 6; m is an integer of 1 to 6; R^a to R^f may be the same or different from one another and each represent a hydrogen atom, a halogen atom, a hydrocarbon group, a heterocyclic compound residue, an oxygen-containing group, a nitrogen-containing group, a boron-containing group, a sulfur-containing group, a phosphorus-containing group, a silicon-containing group, a germanium-containing group or a tin-containing group, among which 2 or more groups may be bound to each other to form a ring; when k is 2 or more, R^a groups, R^b groups, R^c groups, R^d groups, R^e groups, or R^f groups may be the same or different from one another, one group of R^a to R^f contained in one ligand and one group of R^a to R^f contained in another ligand may form a linking group or a single bond, and a heteroatom contained in R^a to R^f may coordinate with or bind to M; m is a number satisfying the valence of M; Q represents a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a tin-containing group; when m is 2 or more, a plurality of groups represented by Q may be the same or different from one another, and a plurality of groups represented by Q may be mutually bound to form a ring.

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36. The method of claims 20 to 27, wherein the catalyst compound comprises a bis(imino)pyridyl compound of the formula (VIII):

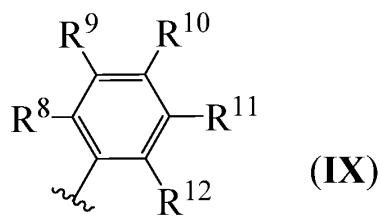


wherein :

M is Co or Fe; each X is an anion; n is 1, 2 or 3, so that the total number of negative charges on said anion or anions is equal to the oxidation state of a Fe or Co atom present in (II);

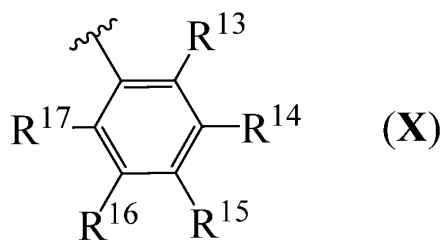
- 5 R^1 , R^2 and R^3 are each independently hydrogen, hydrocarbyl, substituted hydrocarbyl, or an inert functional group;

R^4 and R^5 are each independently hydrogen, hydrocarbyl, an inert functional group or substituted hydrocarbyl;



R^6 is formula IX:

- 10 and R^7 is formula X:



R^8 and R^{13} are each independently hydrocarbyl, substituted hydrocarbyl or an inert functional group;

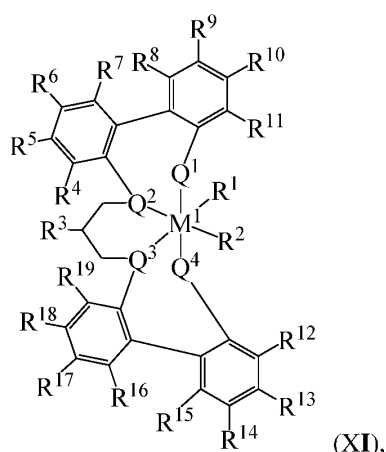
- 15 R^9 , R^{10} , R^{11} , R^{14} , R^{15} and R^{16} are each independently hydrogen, hydrocarbyl, substituted hydrocarbyl or an inert functional group;

R^{12} and R^{17} are each independently hydrogen, hydrocarbyl, substituted hydrocarbyl or an inert functional group; and

provided that any two of R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , R^{14} , R^{15} , R^{16} and R^{17} that are adjacent to one another, together may form a ring.

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37. The method of claims 20 to 27, wherein the catalyst compound is represented by the formula (XI):



M^1 is selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum and tungsten;

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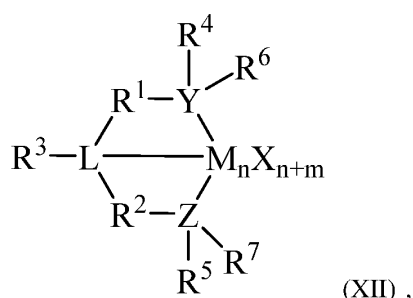
each of Q^1 , Q^2 , Q^3 , and Q^4 is independently oxygen or sulfur;

at least one of Q^1 , Q^2 , Q^3 , and Q^4 is oxygen, alternately all of Q^1 , Q^2 , Q^3 , and Q^4 are oxygen; and

R^1 – R^{19} are independently hydrogen, halogen, hydroxyl, hydrocarbyl, or substituted hydrocarbyl (such as C_1 – C_{10} alkyl, C_1 – C_{10} alkoxy, C_6 – C_{20} aryl, C_6 – C_{10} aryloxy, C_2 – C_{10} alkenyl, C_2 – C_{40} alkenyl, C_7 – C_{40} arylalkyl, C_7 – C_{40} alkylaryl, C_8 – C_{40} arylalkenyl, or conjugated diene which is optionally substituted with one or more hydrocarbyl, tri(hydrocarbyl) silyl or tri(hydrocarbyl) silylhydrocarbyl, the diene having up to 30 atoms other than hydrogen).

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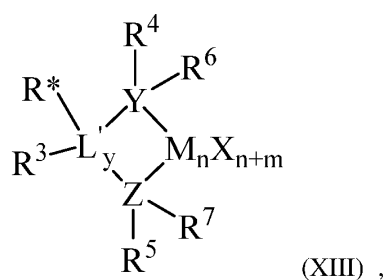
20 38. A method according to any of claims 20 to 27, wherein the catalyst is represented by Formula (XII):



wherein M is a Group 3 to 12 transition metal or a Group 13 or 14 main group metal; each X is independently an anionic leaving group; y is 0 or 1; n is the oxidation state of M; m is the formal charge of the ligand represented by YZL or YZL'; L is a Group 15 or 16 element; L' is a group 15 or 16 element or Group 14 containing group; Y is a Group 15 element; Z is a Group 15 element; R¹ and R² are independently a C₁ to C₂₀ hydrocarbon group, a heteroatom containing group having up to twenty carbon atoms, silicon, germanium, tin, lead, or phosphorus; R¹ and R² may be interconnected to each other; R³ is absent, a hydrocarbon group, hydrogen, a halogen, or a heteroatom containing group; R⁴ and R⁵ are independently an alkyl group, an aryl group, a substituted aryl group, a cyclic alkyl group, a substituted cyclic alkyl group, a cyclic aralkyl group, a substituted cyclic aralkyl group, or a multiple ring system; R⁴ and R⁵ may be interconnected to each other; R⁶ and R⁷ are independently absent, hydrogen, an alkyl group, a halogen, a heteroatom, or a hydrocarbyl group; and R* is absent, hydrogen, a Group 14 atom containing group, a halogen, or a heteroatom containing group.

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39. A method according to any of claims 20 to 27, wherein the catalyst is represented by Formula (XIII):



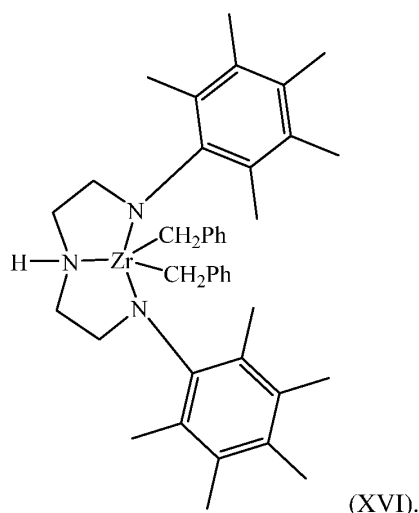
wherein M is a Group 3 to 12 transition metal or a Group 13 or 14 main group metal; each X is independently an anionic leaving group; y is 0 or 1; n is the oxidation state of M; m is the formal charge of the ligand represented by YZL or YZL'; L is a Group 15 or 16 element; L' is a group 15 or 16 element or Group 14 containing group; Y is a Group 15 element; Z is a Group 15 element; R¹ and R² are independently a C₁ to C₂₀ hydrocarbon group, a heteroatom containing group having up to twenty carbon atoms, silicon, germanium, tin, lead, or phosphorus; R¹ and R² may be interconnected to each other; R³ is absent, a hydrocarbon group, hydrogen, a halogen, or a heteroatom containing group; R⁴ and R⁵ are independently an alkyl group, an aryl group, a substituted aryl group, a cyclic alkyl group, a substituted cyclic alkyl group, a cyclic aralkyl group, a substituted cyclic aralkyl group, or a multiple ring system; R⁴ and R⁵ may be interconnected to each other; R⁶ and R⁷ are independently absent, hydrogen, an alkyl group, a halogen, a heteroatom, or a hydrocarbyl group; and R* is absent, hydrogen, a Group 14 atom containing group, a halogen, or a heteroatom containing group.

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- 15 element; R^1 and R^2 are independently a C_1 to C_{20} hydrocarbon group, a heteroatom containing group having up to twenty carbon atoms, silicon, germanium, tin, lead, or phosphorus; R^1 and R^2 may be interconnected to each other; R^3 is absent, a hydrocarbon group, hydrogen, a halogen, or a heteroatom containing group; R^4 and R^5 are independently an alkyl group, an aryl group, a substituted aryl group, a cyclic alkyl group, a substituted cyclic alkyl group, a cyclic aralkyl group, a substituted cyclic aralkyl group, or a multiple ring system; R^4 and R^5 may be interconnected to each other; R^6 and R^7 are independently absent, hydrogen, an alkyl group, a halogen, a heteroatom, or a hydrocarbyl group; and R^* is absent, hydrogen, a Group 14 atom containing group, a halogen, or a heteroatom containing group.

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40. A method according to any of claims 20 to 27, wherein the catalyst comprises a catalyst of Formula (XVI):



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41. A method of polymerizing olefins to produce a polyolefin composition comprising contacting at least one olefin with a catalyst system prepared by the method of any of claims 20 to 37 and obtaining a polyolefin having no detectable aromatic hydrocarbon solvent.
42. A method for preparing a catalyst system comprising contacting in an aliphatic solvent at a temperature of from less than 0°C to -60°C at least one support material having absorbed water and at least one hydrocarbyl aluminum compound to form a supported alumoxane, heating the supported alumoxane to at least 60°C up to 140°C and contacting the heated

supported alumoxane with at least one catalyst compound having a Group 3 through Group 12 metal atom or lanthanide metal atom.

43. A method for preparing a catalyst system comprising contacting in an aliphatic solvent at a temperature of from less than 0°C to -60°C at least one support material having absorbed water and at least one hydrocarbyl aluminum compound to form a supported alumoxane, contacting the supported alumoxane with at least one catalyst compound having a Group 3 through Group 12 metal atom or lanthanide metal atom to form a supported catalyst system and heating the supported catalyst system to at least 60°C up to 140°C.
44. A process of making a supported aluminoxane free of aromatic solvent comprising adding at least one support material having absorbed water as a solid form to a hydrocarbyl aluminum aliphatic solvent solution at a temperature of from less than 0°C to about -60°C.
45. A process of making a supported aluminoxane free of aromatic solvent comprising adding an aliphatic solution of at least one support material having absorbed water to hydrocarbyl aluminum aliphatic solvent solution at a temperature of from about less than 0°C to about -60°C.
46. The process of claims 44 or 45, wherein the hydrocarbyl aluminum solution concentration is 0.1 to 40 wt%.
47. The process of claims 44 or 45, wherein the hydrocarbyl aluminum solution concentration is 1.0 to 20 wt%.
48. The process of any of claims 43 to 47, wherein the process is a batch process or a continuous process.
49. The process of claims 43 to 47, wherein the process is continuous and comprises isolating the solid supported aluminoxane product and recycling any excess hydrocarbyl aluminum.

50. The method of any of claims 20 to 37, wherein the supported alumoxane composition is further heat-treated at a temperature selected from 60°C to 200°C for 0.5 to 24 hours prior to contact with the catalyst compound.