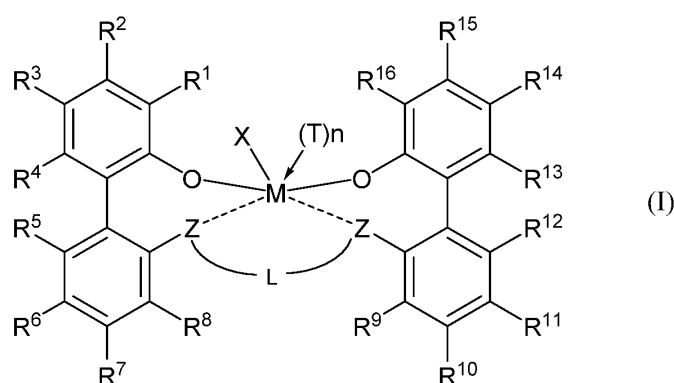


CLAIMS

1. A metal–ligand complex according to formula (I):



where:

M is scandium, yttrium, or a lanthanide metal having an oxidation state of +3;

X is a ligand chosen from (C₁–C₄₀)hydrocarbyl,

(C₁–C₄₀)heterohydrocarbyl, –CH₂Si(R^C)_{3-Q}(OR^C)_Q,
 –Si(R^C)_{3-Q}(OR^C)_Q, –OSi(R^C)_{3-Q}(OR^C)_Q, –CH₂Ge(R^C)_{3-Q}(OR^C)_Q,
 –Ge(R^C)_{3-Q}(OR^C)_Q, –P(R^C)_{2-W}(OR^C)_W, –P(O)(R^C)_{2-W}(OR^C)_W, –N(R^C)₂, –NH(R^C),
 –N(Si(R^C)₃)₂, –NR^CSi(R^C)₃, –NHSi(R^C)₃, –OR^C, –SR^C, –NO₂, –CN, –CF₃,
 –OCF₃, –S(O)R^C, –S(O)₂R^C, –OS(O)₂R^C, –N=C(R^C)₂, –N=CH(R^C), –N=CH₂,
 –N=P(R^C)₃, –OC(O)R^C, –C(O)OR^C, –N(R^C)C(O)R^C, –N(R^C)C(O)H,
 –NHC(O)R^C, –C(O)N(R^C)₂, –C(O)NHR^C, –C(O)NH₂, a halogen, B(R^Y)₄,
 Al(R^Y)₄, or Ga(R^Y)₄, or a hydrogen, wherein each R^C is independently a
 substituted or unsubstituted (C₁–C₃₀)hydrocarbyl, or a substituted or
 unsubstituted (C₁–C₃₀)heterohydrocarbyl, and each Q is 0, 1, 2 or 3, and each W
 is 0, 1, or 2; each R^Y is –H, (C₁–C₃₀)hydrocarbyl, or halogen atom;

each T is independently Lewis Base;

n is 0, 1, or 2, when n is 1, X and T are optionally linked, when n is 2, X and one of T are
 optionally linked;

the metal–ligand complex is overall charge-neutral;

each Z is independently chosen from –O–, –S–, –N(R^N)–, or –P(R^P)–, wherein the
 dotted line optionally defines a dative bond;

R^1 and R^{16} are independently selected from the group consisting of (C_1-C_{40}) hydrocarbyl, (C_1-C_{40}) heterohydrocarbyl, $-\text{Si}(R^C)_3$, $-\text{Ge}(R^C)_3$, $-\text{P}(R^P)_2$, $-\text{N}(R^N)_2$, $-\text{OR}^C$, $-\text{SR}^C$, $-\text{NO}_2$, $-\text{CN}$, $-\text{CF}_3$, $R^C\text{S}(\text{O})-$, $R^C\text{S}(\text{O})_2-$, $-\text{N}=\text{C}(R^C)_2$, $R^C\text{C}(\text{O})\text{O}-$, $R^C\text{OC}(\text{O})-$, $R^C\text{C}(\text{O})\text{N}(\text{R})-$, $(R^C)_2\text{NC}(\text{O})-$, or halogen;

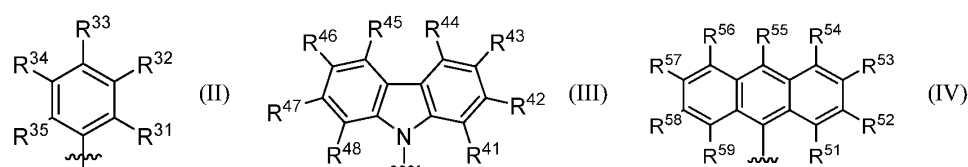
R^2 , R^3 , R^4 , R^5 , R^6 , R^7 , R^8 , R^9 , R^{10} , R^{11} , R^{12} , R^{13} , R^{14} , and R^{15} are independently selected from $-\text{H}$, (C_1-C_{40}) hydrocarbyl, (C_1-C_{40}) heterohydrocarbyl, $-\text{Si}(R^C)_3$, $-\text{Ge}(R^C)_3$, $-\text{P}(R^P)_2$, $-\text{N}(R^N)_2$, $-\text{OR}^C$, $-\text{SR}^C$, $-\text{NO}_2$, $-\text{CN}$, $-\text{CF}_3$, $R^C\text{S}(\text{O})-$, $R^C\text{S}(\text{O})_2-$, $(R^C)_2\text{C}=\text{N}-$, $(R^C)_2\text{P}=\text{N}-$, $R^C\text{C}(\text{O})\text{O}-$, $R^C\text{OC}(\text{O})-$, $R^C\text{C}(\text{O})\text{N}(\text{R})-$, $(R^C)_2\text{NC}(\text{O})-$, and halogen;

provided that when M is yttrium or a lanthanide metal, R^1 is not $-\text{H}$, phenyl or *tert*-butyl; and R^{16} is not $-\text{H}$, phenyl or *tert*-butyl;

L is (C_1-C_{40}) hydrocarbylene or (C_1-C_{40}) heterohydrocarbylene; and

each R^C , R^P , and R^N in formula (I) is independently a (C_1-C_{30}) hydrocarbyl, (C_1-C_{30}) heterohydrocarbyl, or $-\text{H}$.

2. The metal-ligand complex according to claim 1, where R^1 and R^{16} are chosen from radicals having formula (II), radicals having formula (III), and radicals having formula (IV):



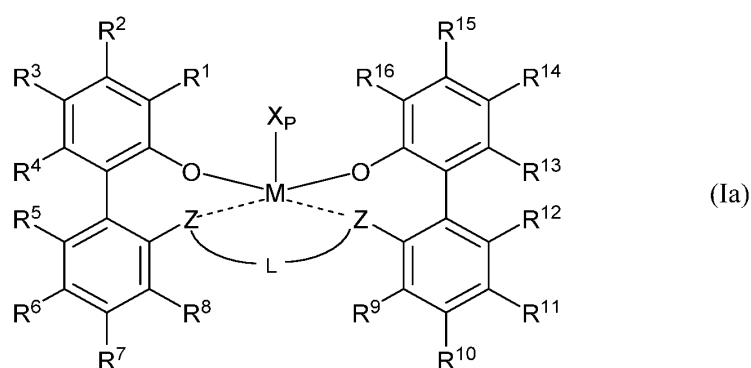
where each of R^{31-35} , R^{41-48} , and R^{51-59} is independently chosen from $-\text{H}$, (C_1-C_{40}) hydrocarbyl, (C_1-C_{40}) heterohydrocarbyl, $-\text{Si}(R^C)_3$, $-\text{Ge}(R^C)_3$, $-\text{P}(R^P)_2$, $-\text{N}(R^N)_2$, $-\text{OR}^C$, $-\text{SR}^C$, $-\text{NO}_2$, $-\text{CN}$, $-\text{CF}_3$, $R^C\text{S}(\text{O})-$, $R^C\text{S}(\text{O})_2-$, $(R^C)_2\text{C}=\text{N}-$, $R^C\text{C}(\text{O})\text{O}-$, $R^C\text{OC}(\text{O})-$, $R^C\text{C}(\text{O})\text{N}(\text{R})-$, $(R^C)_2\text{NC}(\text{O})-$, or halogen; provided that when R^1 and R^{16} are formula (II), at least one of R^{31} to R^{35} is not $-\text{H}$.

3. The metal-ligand complex of claim 1 or claim 2, wherein when M is yttrium or a lanthanide metal, at least one of R^{5-8} is not $-\text{H}$ and at least one of R^{9-12} is not $-\text{H}$.

4. The metal–ligand complex according to claim 1 or claim 2, wherein R^1 and R^{16} are identical.
5. The metal–ligand complex according to claim 2, wherein at least one of R^1 and R^{16} is a radical having formula (III).
6. The metal–ligand complex according to claim 5, wherein R^{42} and R^{47} are (C_1-C_{20}) hydrocarbyl, $-Si[(C_1-C_{20})hydrocarbyl]_3$, or $-Ge[(C_1-C_{20})hydrocarbyl]_3$.
7. The metal–ligand complex according to claim 5, wherein R^{43} and R^{46} are (C_1-C_{20}) hydrocarbyl, $-Si[(C_1-C_{20})hydrocarbyl]_3$, or $-Ge[(C_1-C_{20})hydrocarbyl]_3$.
8. The metal–ligand complex according to claims 5-7, wherein optionally R^{42} and R^{43} are bonded together, and optionally R^{46} and R^{47} are bonded together.
9. The metal–ligand complex according to claim 2, wherein at least one of R^1 and R^{16} is a radical having formula (II), wherein at least one of R^{31} to R^{35} is not $-H$.
10. The metal–ligand complex according to claim 9, wherein R^{32} and R^{34} are (C_1-C_{20}) hydrocarbyl, $-Si[(C_1-C_{20})hydrocarbyl]_3$, or $-Ge[(C_1-C_{20})hydrocarbyl]_3$.
11. The metal–ligand complex according to claim 2, wherein at least one of R^1 and R^{16} is a radical having formula (IV).
12. The metal–ligand complex according to claim 11, wherein at least two of R^{52} , R^{53} , R^{55} , R^{57} , and R^{58} are (C_1-C_{20}) hydrocarbyl, $-Si[(C_1-C_{20})hydrocarbyl]_3$, or $-Ge[(C_1-C_{20})hydrocarbyl]_3$.
13. The metal–ligand complex according to claim 11 or claim 12, wherein optionally R^{52} and R^{53} are linked to form a cyclic structure, and optionally R^{57} and R^{58} are linked to form a cyclic structure.
14. The metal–ligand complex according to any of the preceding claims, wherein:
at least one of R^6 , R^7 , and R^8 is halogen; and
at least one of R^9 , R^{10} , and R^{11} is halogen.

15. The metal–ligand complex according to any one of claims 1 to 12, wherein at least one of R^8 and R^9 is not $-H$.
16. The metal–ligand complex according to any of the preceding claims, wherein R^3 and R^{14} are (C_1-C_{10}) alkyl.
17. The metal–ligand complex according to any one of the preceding claims, wherein R^3 and R^{14} are methyl, R^6 and R^{11} are halogen.
18. The metal–ligand complex according to any one of claims 1-15, wherein R^3 and R^{14} are $-OR^C$, wherein R^C is (C_1-C_{30}) hydrocarbyl.
19. The metal–ligand complex according to any one of claims 1-15, wherein R^6 and R^{11} are *tert*-butyl.
20. The metal–ligand complex according to any one of claims 1 to 15, wherein R^3 and R^{14} are *tert*-octyl, *n*-octyl, or *n*-octylalkoxy.
21. The metal–ligand complex according to any one of the preceding claims, where L is chosen from $-CH_2-$, $-CH_2(CH_2)_mCH_2-$ where m is from 0 to 3, $-CH_2Si(R^C)_2CH_2-$, $-CH_2Ge(R^C)_2CH_2-$, $-CH(CH_3)CH_2CH^*(CH_3)$, and $-CH_2(\text{phen-1,2-di-yl})CH_2-$, where each R^C in L is (C_1-C_{20}) hydrocarbyl, and “C*” is a carbon atom from which a hydrogen atom is removed to form a secondary or tertiary alkyl radical.
22. The metal–ligand complex according to any one of the preceding claims, wherein X is $-CH_2Si[(C_1-C_{20})\text{alkyl}]_3$, (C_1-C_{12}) alkyl, or halogen atom.
23. The metal–ligand complex according to any one of the preceding claims, wherein n is 1 or 2; and at least one T is (C_1-C_{20}) heterohydrocarbon, wherein the hetero atom of the heterohydrocarbon is oxygen.
24. The metal–ligand complex according to any one of the preceding claims, wherein n is 1 or 2; and at least one T is tetrahydrofuran, diethyl ether, or methyl *tert*-butyl ether (MTBE).
25. The metal–ligand complex according to any one of the preceding claims, wherein:
 R^2 , R^4 , R^5 , R^{12} , R^{13} , and R^{15} are hydrogen; and
each Z is oxygen.

26. A polymerization process comprising:
 polymerizing ethylene and one or more olefins in the presence of a catalyst
 system comprising the metal–ligand complex of any one of claims 1-24,
 under olefin polymerizing conditions to form an ethylene-based polymer.
27. The polymerization process of claim 26, wherein the catalyst system further comprises at least one co-catalyst.
28. The polymerization process of claim 26, wherein a co-catalyst is absent from the catalyst system.
29. The polymerization process of any one of claims 26 to 28, wherein the polymerization process is a solution polymerization process.
30. The polymerization process of any one of claims 26 to 29, wherein the catalyst system further comprises an additive.
31. The polymerization process of claim 30, wherein the additive is modified methylaluminoxane.
32. The polymerization process of claim 30, wherein the additive is alkylaluminum.
33. The polymerization process of claim 26, wherein the polymerizing ethylene occurs in the presence of a borate based additive.
34. An olefin propogating catalytic species according to formula (Ia):



where:

M is scandium, yttrium, or a lanthanide metal having an oxidation state of +3;

X_P is a ligand chosen from hydrocarbyl, wherein the hydrocarbyl is branched or unbranched having at least 30 carbon atoms;

each Z is independently chosen from -O-, -S-, -N(R^N)-, or -P(R^P)-, wherein the dotted line optionally defines a dative bond;

R¹ and R¹⁶ are independently selected from the group consisting of (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)heterohydrocarbyl, -Si(R^C)₃, -Ge(R^C)₃, -P(R^P)₂, -N(R^N)₂, -OR^C, -SR^C, -NO₂, -CN, -CF₃, R^CS(O)-, R^CS(O)₂-, -N=C(R^C)₂, R^CC(O)O-, R^COC(O)-, R^CC(O)N(R)-, (R^C)₂NC(O)-, or halogen;

R², R³, R⁴, R⁵, R⁶, R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, R¹⁴, and R¹⁵ are independently selected from -H, (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)heterohydrocarbyl, -Si(R^C)₃, -Ge(R^C)₃, -P(R^P)₂, -N(R^N)₂-OR^C, -SR^C, -NO₂, -CN, -CF₃, R^CS(O)-, R^CS(O)₂-, (R^C)₂C=N-, (R^C)₂P=N-, R^CC(O)O-, R^COC(O)-, R^CC(O)N(R)-, (R^C)₂NC(O)-, and halogen;

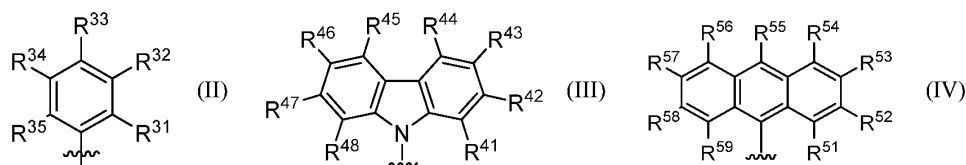
provided that when M is yttrium or a lanthanide metal, R¹ is not -H, phenyl or *tert*-butyl; and R¹⁶ is not -H, phenyl or *tert*-butyl;

L is (C₁-C₄₀)hydrocarbylene or (C₁-C₄₀)heterohydrocarbylene; and

each R^C, R^P, and R^N in formula (I) is independently a (C₁-C₃₀)hydrocarbyl, (C₁-C₃₀)heterohydrocarbyl, or -H.

35. The olefin propagating catalytic species of claim 34, wherein M is yttrium or a lanthanide metal, at least one of R⁵⁻⁸ is not -H and at least one of R⁹⁻¹² is not -H.

36. The olefin propagating catalytic species of claim 34 or claim 35, where R¹ and R¹⁶ are chosen from radicals having formula (II), radicals having formula (III), and radicals having formula (IV):



where each of R³¹⁻³⁵, R⁴¹⁻⁴⁸, and R⁵¹⁻⁵⁹ is independently chosen from -H, (C₁-C₄₀)hydrocarbyl, (C₁-C₄₀)heterohydrocarbyl, -Si(R^C)₃, -Ge(R^C)₃,

$-\text{P}(\text{R}^{\text{P}})_2$, $-\text{N}(\text{R}^{\text{N}})_2$, $-\text{OR}^{\text{C}}$, $-\text{SR}^{\text{C}}$, $-\text{NO}_2$, $-\text{CN}$, $-\text{CF}_3$, $\text{R}^{\text{C}}\text{S}(\text{O})-$, $\text{R}^{\text{C}}\text{S}(\text{O})_2-$, $(\text{R}^{\text{C}})_2\text{C}=\text{N}-$, $\text{R}^{\text{C}}\text{C}(\text{O})\text{O}-$, $\text{R}^{\text{C}}\text{OC}(\text{O})-$, $\text{R}^{\text{C}}\text{C}(\text{O})\text{N}(\text{R}^{\text{N}})-$, $(\text{R}^{\text{C}})_2\text{NC}(\text{O})-$, or halogen; provided that when R^1 and R^{16} are formula (II), at least one of R^{31} to R^{35} is not $-\text{H}$.

37. The olefin propogating catalytic species of claim 34 or claim 35, wherein at least one of R^8 and R^9 is not $-\text{H}$.
38. The olefin propogating catalytic species of any one of claims 34 to 36, wherein R^3 and R^{14} are $(\text{C}_1-\text{C}_{10})$ alkyl.
39. The olefin propogating catalytic species of any one of claims 34 to 37, wherein R^3 and R^{14} are $-\text{OR}^{\text{C}}$, wherein R^{C} is $(\text{C}_1-\text{C}_{30})$ hydrocarbyl.
40. The olefin propogating catalytic species of any one of claims 34 to 37, wherein R^3 and R^{14} are *tert*-octyl, *n*-octyl, or *n*-octylalkoxy.
41. The olefin propogating catalytic species of any one of claims 34 to 40, wherein R^6 and R^{11} are *tert*-butyl.
42. The olefin propogating catalytic species of any one of claims 34 to 41, wherein R^1 and R^{16} are chosen from radicals having formula (III) and optionally R^{42} and R^{43} are linked to form a cyclic structure, and optionally R^{46} and R^{47} are linked to form a cyclic structure.
43. The olefin propogating catalytic species of any one of claims 34 to 42, where L is chosen from $-\text{CH}_2-$, $-\text{CH}_2(\text{CH}_2)_m\text{CH}_2-$ where m is from 0 to 3, $-\text{CH}_2\text{Si}(\text{R}^{\text{C}})_2\text{CH}_2-$, $-\text{CH}_2\text{Ge}(\text{R}^{\text{C}})_2\text{CH}_2-$, $-\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}^*(\text{CH}_3)$, and $-\text{CH}_2(\text{phen-1,2-di-yl})\text{CH}_2-$, where each R^{C} in L is $(\text{C}_1-\text{C}_{20})$ hydrocarbyl, and "C*" is a carbon atom from which a hydrogen atom is removed to form a secondary or tertiary alkyl radical.
44. A catalyst structure comprising a scandium, yttria, or a lanthanide metal having an oxidation state of +3 coordinated to a bis(phenylphenoxy) ligand.