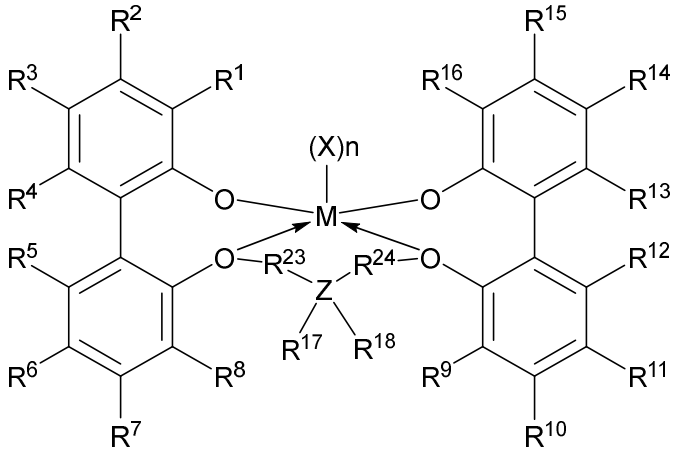
CLAIMS

1. A catalyst system comprising a metal–ligand complex according to formula (I):



(I)

where:

M is a metal chosen from titanium, zirconium, or hafnium;

n is 1 or 2;

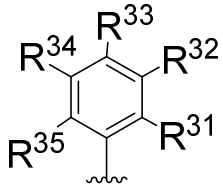
when n is 1, X is a monodentate ligand or a bidentate ligand;

when n is 2, each X is an independently chosen monodentate ligand;

the metal–ligand complex is overall charge-neutral;

each Z is independently chosen from silicon or germanium;

R^1 and R^{16} are independently radicals having formula (II):



(II)

where:

each of $R^{31–35}$ is independently chosen from (C_1–C_{40})hydrocarbyl, (C_1–C_{40})heterohydrocarbyl, −Si(R^C)$_3$, −OR^C, −SR^C, −CN, −CF_3, halogen, and –H,

each of $R^{2–4}$, $R^{5–8}$, $R^{9–12}$, and $R^{13–15}$ is independently selected from (C_1–C_{40})hydrocarbyl, (C_1–C_{40})heterohydrocarbyl, −Si(R^C)$_3$, −Ge(R^C)$_3$, −P(R^P)$_2$, −N(R^N)$_2$,−N=CHR^C, −OR^C, −SR^C, −NO_2, −CN, −CF_3, R^CS(O)−, R^CS(O)$_2$−, (R^C)$_2$C=N−, R^CC(O)O−, R^COC(O)−, R^CC(O)N(R^N)−, (R^C)$_2$NC(O)−, halogen, and −H;

R^{17} and R^{18} are independently (C_5–C_{40})hydrocarbyl;

R^{23} and R^{24} are independently selected from $-(CR^C_2)_m-$, where m is 1 or 2; and

each R^C, R^P, and R^N in formula (I) is independently (C_1–C_{30})hydrocarbyl, (C_1–C_{30})heterohydrocarbyl, or −H.

2. The catalyst system according to claim 1, wherein:

R^{17} and R^{18} are independently (C_5–C_{20})alkyl;

R^6 and R^{11} are independently (C_2–C_{12})alkyl;

R^{32} and R^{34} are *tert*-butyl;

R^3 and R^{14} are independently (C_1–C_{12})alkyl;

R^8 and R^9 are −H; and

each X is a ligand independently chosen from (C_1–C_{40})hydrocarbyl, (C_1–C_{40})heterohydrocarbyl, –$CH_2Si(R^C)_{3-Q}(OR^C)_Q$, −$Si(R^C)_{3-Q}(OR^C)_Q$, –$OSi(R^C)_{3-Q}(OR^C)_Q$, −$CH_2Ge(R^C)_{3-Q}(OR^C)_Q$, −$Ge(R^C)_{3-Q}(OR^C)_Q$, −$P(R^C)_{2-W}(OR^C)_W$, −$P(O)(R^C)_{2-W}(OR^C)_W$, −$N(R^C)_2$, −$NH(R^C)$, −$N(Si(R^C)_3)_2$, −$NR^CSi(R^C)_3$, −$NHSi(R^C)_3$, −$OR^C$, −CN, −$CF_3$, and halogen, wherein each R^C is independently a substituted or unsubstituted (C_1–C_{30})hydrocarbyl, or a substituted or unsubstituted (C_1–C_{30})heterohydrocarbyl, each Q is 0, 1, 2 or 3, and each W is 0, 1, or 2.

3. The catalyst system according to either one of claims 1 or 2, wherein:

R^7 and R^{10} are halogen; and

R^5 and R^{12} are halogen.

4. The catalyst system according to any one of claims 1 to 3, wherein R^{17} and R^{18} are independently (C_5–C_{20})cycloalkyl.

5. A polymerization process for producing an ethylene-based polymer, the polymerization process comprising:

polymerizing ethylene and optionally a (C_3–C_{12})α-olefin in the presence of a catalyst system according to any one of claims 1 to 4, wherein the ethylene-based polymer has:

a density from 0.850 g/cm^3 to 0.970 g/cm^3 measured according to ASTM D792;

a melt flow ratio (I_{10}/I_2) from 5 to 15, where melt index I_2 is measured according to ASTM D1238 at 190 °C and 2.16 kg load, and melt index I_{10} is measured according to ASTM D1238 at 190 °C and 10 kg load; and

a molecular weight distribution (MWD) from 1 to 5, where MWD is a ratio of weight average molecular weight to number average molecular weight.

6. The polymerization process according to claim 5, wherein the catalyst system further comprises at least one cocatalyst, and wherein the at least one cocatalyst comprises modified methylaluminoxane (MMAO) comprising 10–20% trialkyl aluminum species.

7. The polymerization process according to either one of claims 5 or 6, wherein the ethylene and the (C_3–C_{12})α-olefin are polymerized via solution polymerization.

8. The polymerization process according to claim 7, wherein the ethylene and the (C_3–C_{12})α-olefin are polymerized via solution polymerization in a loop reactor system.

9. The polymerization process according to any one of claims 5 to 8, wherein the (C_3–C_{12})α-olefin is 1-butene.

10. The polymerization process according to claim 9, wherein the ethylene-based polymer comprises from 20 wt% to 40 wt% units derived from 1-butene, based on a total weight of the ethylene-based polymer.

11. The polymerization process according to any one of claims 5 to 10, wherein:
the density of the ethylene-based polymer is from 0.854 g/cm^3 to 0.875 g/cm^3; and
the melt index I_2 of the ethylene-based polymer is from 0.1 to 30 dg/min.

12. The polymerization process according to any one of claims 5 to 10, wherein:
the density of the ethylene-based polymer is from 0.854 g/cm^3 to 0.875 g/cm^3; and
the ethylene-based polymer has a weight average molecular weight from 50 kg/mol to 200 kg/mol.

13. The polymerization process according to any one of claims 5 to 12, wherein:
the ethylene-based polymer comprises less than 0.01 vinyls per 1000 carbons;
the ethylene-based polymer has an HCC (high comonomer content) value of less than 3.0 wt%, wherein the HCC value is measured using thermal gradient interaction chromatography (TGIC) in accordance with HCC Measurement Method; and

the ethylene-based polymer has less than 0.0075 BBB triads per 1000 carbons, wherein the BBB triads content is measured in accordance with BBB Measurement Method.

14. An ethylene-based polymer comprising the polymerized reaction product of ethylene monomer and 1-butene comonomer, wherein the ethylene-based polymer has:

a density from 0.854 g/cm^3 to 0.875 g/cm^3 measured according to ASTM D792;

a melt index I_2 from 0.1 to 30 dg/min, where melt index I_2 is measured according to ASTM D1238 at 190 °C and 2.16 kg load;

a melt flow ratio (I_{10}/I_2) from 5 to 15, where melt index I_{10} is measured according to ASTM D1238 at 190 °C and 10 kg load;

a molecular weight distribution (MWD) from 1.5 to 5, where MWD is a ratio of weight average molecular weight to number average molecular weight;

an HCC (high comonomer content) value of less than 1.4 wt%, wherein the HCC value is measured using thermal gradient interaction chromatography (TGIC) in accordance with HCC Measurement Method; and

a BBB triads content of less than 0.0075 BBB triads per 1000 carbons, wherein the BBB triads content is measured in accordance with BBB Measurement Method.

15. The ethylene-based polymer according to claim 14, wherein:

the ethylene-based polymer comprises from 20 wt% to 40 wt% units derived from 1-butene comonomer, based on a total weight of the ethylene-based polymer; and

the ethylene-based polymer comprises less than 0.01 vinyls per 1000 carbons.