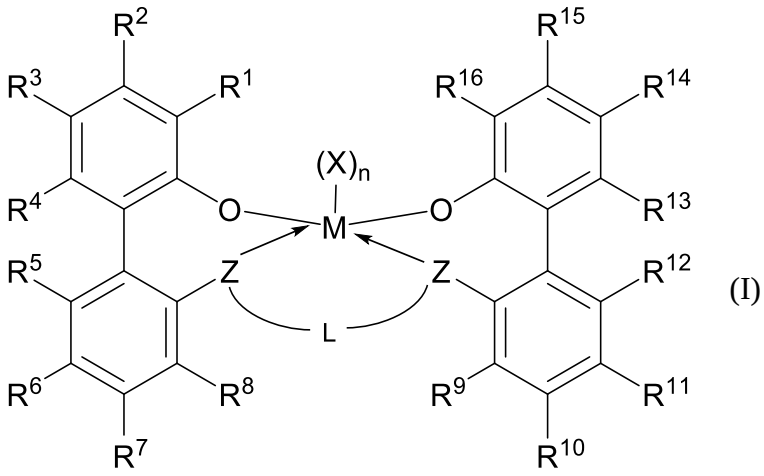
CLAIMS

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



(I)

where:

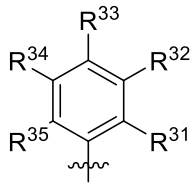
M is a metal chosen from titanium, zirconium, or hafnium, the metal being in a formal oxidation state of +2, +3, or +4;

each X is selected from the group consisting of $–(CH_2)SiR^X_3$, each R^X is independently a $(C_1–C_{30})$hydrocarbyl or a $(C_1–C_{30})$heterohydrocarbyl, and at least one R^X is $(C_2–C_{30})$hydrocarbyl, and any two R^X or all three R^X are optionally covalently linked;

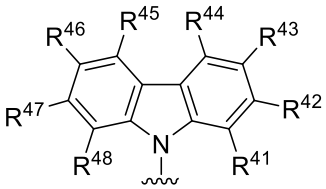
n is 1 or 2;

each Z is independently chosen from −O−, −S−, $−N(R^N)−$, or $–P(R^P)−$;

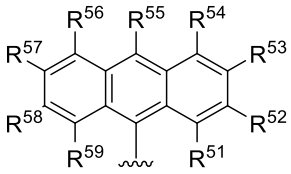
R^1 and R^{16} are independently selected from the group consisting of –H, $(C_1–C_{40})$hydrocarbyl, $(C_1–C_{40})$heterohydrocarbyl, $−Si(R^C)_3$, $−Ge(R^C)_3$, $−P(R^P)_2$, $−N(R^N)_2$, $−OR^C$, $−SR^C$, $−NO_2$, −CN, $−CF_3$, $R^CS(O)−$, $R^CS(O)_2−$, $−N=C(R^C)_2$, $R^CC(O)O−$, $R^COC(O)−$, $R^CC(O)N(R)−$, $(R^C)_2NC(O)−$, halogen, radicals having formula (II), radicals having formula (III), and radicals having formula (IV):



(II)



(III)



(IV)

where each of R^{31}-R^{35}, R^{41}-R^{48}, and R^{51}-R^{59} is independently chosen from –H, (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)$_2$, −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)−, or halogen,

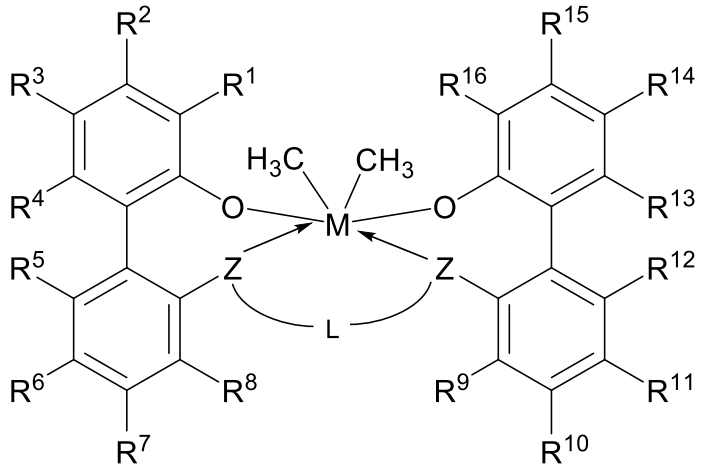
provided that at least one of R^1 or R^{16} is a radical having formula (II), a radical having formula (III), or a radical having formula (IV);

each of R^2-R^4, R^5-R^8, R^9-R^{12}, and R^{13}-R^{15} is independently selected from −H, (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)$_2$−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)−, (R^C)$_2$NC(O)−, and halogen, ;

L is (C_2–C_{40})hydrocarbylene or (C_2–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 –H,

wherein the metal−ligand complex according to formula (I) has a wt.% solubility ratio W/Y of at least 1.5, wherein W is the wt. % solubility of the metal−ligand complex of formula (I) in methylcyclohexane (MCH) at standard temperature and pressure (STP); wherein Y is the wt. % of a corresponding comparative metal−ligand complex of formula (Ia) in MCH at STP; and wherein the corresponding comparative complex has a structure according to formula (Ia):



(Ia)

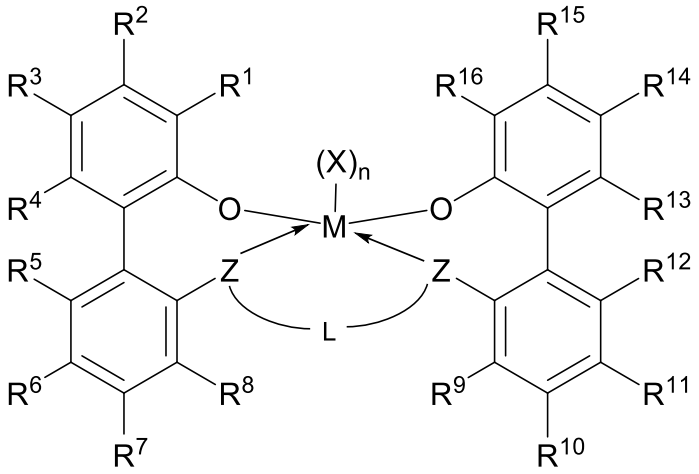
in which M, each Z, each R^1-R^{16}, and L all are identical to corresponding groups of the metal−ligand complex according to formula (I).

2. The catalyst system according to claim 1, wherein:
M is zirconium or hafnium;
each X is $–(CH_2)Si(CH_2CH_3)_3$; and
each Z is oxygen.

3. The catalyst system according to claim 1, wherein:
M is zirconium or hafnium;
each X is selected from the group consisting of $–(CH_2)\,Si(CH_3)(n\text{-}Oct)R^X$; and
each Z is oxygen

4. The catalyst system according to claim 1, wherein exactly two R^X are covalently linked or exactly three R^X are covalently linked.

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



(I)

where:

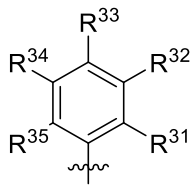
M is a metal chosen from titanium, zirconium, or hafnium, the metal being in a formal oxidation state of +2, +3, or +4;

each X is selected from the group consisting of $–(CH_2)Si(n\text{-}Oct)R^X{}_2$, wherein each R^X is independently a $(C_1–C_{30})$hydrocarbyl or a $(C_1–C_{30})$heterohydrocarbyl, and any two R^X are optionally covalently linked;

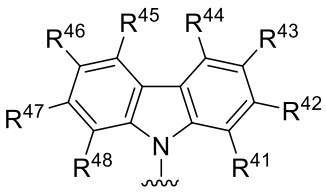
n is 1 or 2;

each Z is −O−;

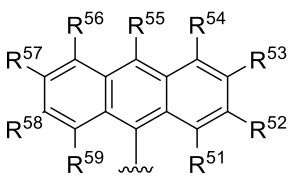
R^1 and R^{16} are independently selected from the group consisting of –H, $(C_1–C_{40})$hydrocarbyl, $(C_1–C_{40})$heterohydrocarbyl, $−Si(R^C)_3$, $−Ge(R^C)_3$, $−P(R^P)_2$, $−N(R^N)_2$, $−OR^C$, $−SR^C$, $−NO_2$, −CN, $−CF_3$, $R^CS(O)−$, $R^CS(O)_2−$, $−N=C(R^C)_2$, $R^CC(O)O−$, $R^COC(O)−$, $R^CC(O)N(R)−$, $(R^C)_2NC(O)−$, halogen, radicals having formula (II), radicals having formula (III), and radicals having formula (IV):



(II)



(III)



(IV)

where each of R^{31}-R^{35}, R^{41}-R^{48}, and R^{51}-R^{59} is independently chosen from –H, (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)$_2$, −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)−, or halogen,

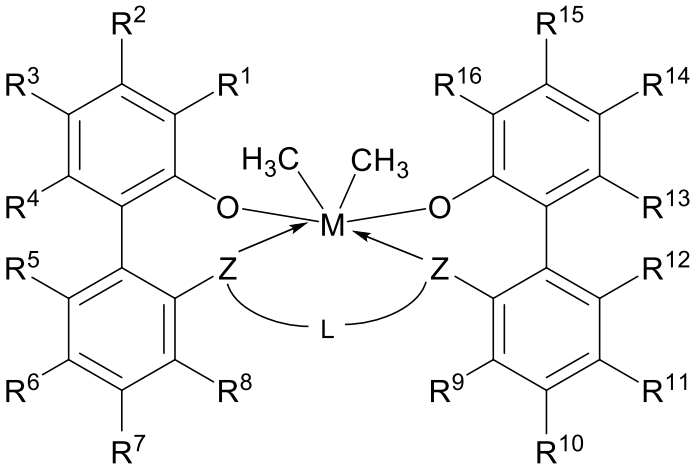
provided that at least one of R^1 or R^{16} is a radical having formula (II), a radical having formula (III), or a radical having formula (IV);

each of R^2-R^4, R^5-R^8, R^9-R^{12}, and R^{13}-R^{15} is independently selected from −H, (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)$_2$−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)−, (R^C)$_2$NC(O)−, and halogen, ;

L is (C_2–C_{40})hydrocarbylene or (C_2–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 –H,

wherein the metal−ligand complex according to formula (I) has a wt.% solubility ratio W/Y of at least 1.5, wherein W is the wt. % solubility of the metal−ligand complex of formula (I) in methylcyclohexane (MCH) at standard temperature and pressure (STP); wherein Y is the wt. % of a corresponding comparative metal−ligand complex of formula (Ia) in MCH at STP; and wherein the corresponding comparative complex has a structure according to formula (Ia):



(Ia)

in which M, each Z, each R^1-R^{16}, and L all are identical to corresponding groups of the metal−ligand complex according to formula (I).