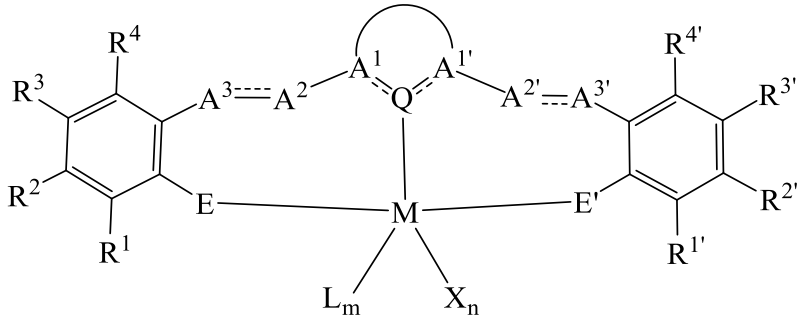
**CLAIMS**

What is claimed is:

1. A polymerization process comprising contacting in a homogeneous phase, propylene with a catalyst system comprising activator and catalyst compound represented by the Formula (**I**):




(**I**)

wherein:

M is a group 3, 4, 5, or 6 transition metal or a Lanthanide;

E and E' are each independently O, S, or $NR^9$ where $R^9$ is independently hydrogen, a $C_1$-$C_{40}$ hydrocarbyl, a $C_1$-$C_{40}$ substituted hydrocarbyl or a heteroatom-containing group;

Q is group 14, 15, or 16 atom that forms a dative bond to metal M;

$A^1QA^{1'}$ are part of a heterocyclic Lewis base containing 4 to 40 non-hydrogen atoms that links $A^2$ to $A^{2'}$ via a 3-atom bridge with Q being the central atom of the 3-atom bridge, $A^1$ and $A^{1'}$ are independently C, N, or $C(R^{22})$, where $R^{22}$ is selected from hydrogen, $C_1$-$C_{20}$ hydrocarbyl, $C_1$-$C_{20}$ substituted hydrocarbyl;

$A^{3}\!=\!\!-\!\!-\!A^{2}$ is a divalent group containing 2 to 40 non-hydrogen atoms that links $A^1$ to the E-bonded aryl group via a 2-atom bridge;

$A^{2'}\!=\!\!-\!\!-\!A^{3'}$ is a divalent group containing 2 to 40 non-hydrogen atoms that links $A^{1'}$ to the E'-bonded aryl group via a 2-atom bridge;

L is a Lewis base;

X is an anionic ligand;

n is 1, 2 or 3;

m is 0, 1, or 2;

n+m is not greater than 4;

each of $R^1$, $R^2$, $R^3$, $R^4$, $R^{1'}$, $R^{2'}$, $R^{3'}$, and $R^{4'}$ is independently hydrogen, a $C_1$-$C_{40}$ hydrocarbyl, a $C_1$-$C_{40}$ substituted hydrocarbyl, a heteroatom or a heteroatom-containing group,

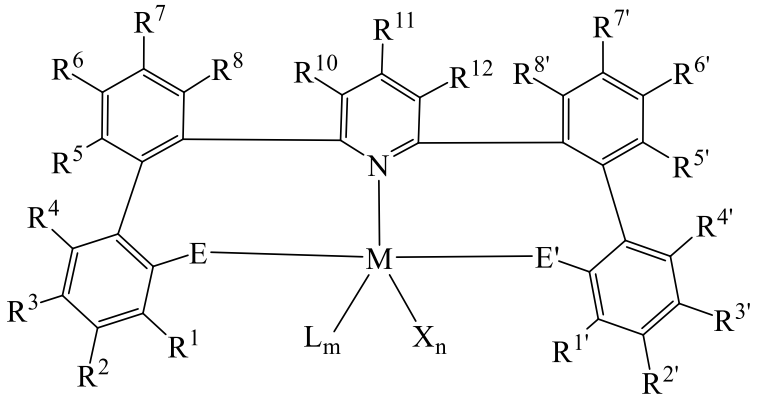
and one or more of $R^1$ and $R^2$, $R^2$ and $R^3$, $R^3$ and $R^4$, $R^{1'}$ and $R^{2'}$, $R^{2'}$ and $R^{3'}$, $R^{3'}$ and $R^{4'}$ may be joined to form one or more substituted hydrocarbyl rings, unsubstituted hydrocarbyl rings, substituted heterocyclic rings, or unsubstituted heterocyclic rings each having 5, 6, 7, or 8 ring atoms, and where substitutions on the ring can join to form additional rings;

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

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

any two X groups may be joined together to form a dianionic ligand group; and obtaining propylene polymer.

2. The process of claim 1 where the catalyst compound represented by the Formula (**II**):




(**II**)

wherein:

M is a group 3, 4, 5, or 6 transition metal or a Lanthanide;

E and E' are each independently O, S, or $NR^9$, where $R^9$ is independently hydrogen, a $C_1$-$C_{40}$ hydrocarbyl, a $C_1$-$C_{40}$ substituted hydrocarbyl, or a heteroatom-containing group;

each L is independently a Lewis base;

each X is independently an anionic ligand;

n is 1, 2 or 3;

m is 0, 1, or 2;

n+m is not greater than 4;

each of $R^1$, $R^2$, $R^3$, $R^4$, $R^{1'}$, $R^{2'}$, $R^{3'}$, and $R^{4'}$ is independently hydrogen, $C_1$-$C_{40}$ hydrocarbyl, $C_1$-$C_{40}$ substituted hydrocarbyl, a heteroatom or a heteroatom-containing group, or one or more of $R^1$ and $R^2$, $R^2$ and $R^3$, $R^3$ and $R^4$, $R^{1'}$ and $R^{2'}$, $R^{2'}$ and $R^{3'}$, $R^{3'}$ and $R^{4'}$ may be joined to form one or more substituted hydrocarbyl rings, unsubstituted hydrocarbyl rings, substituted heterocyclic rings, or unsubstituted heterocyclic rings each having 5, 6, 7, or 8 ring atoms, and where substitutions on the ring can join to form additional rings; any two L groups may be joined together to form a bidentate Lewis base;

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

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

each of $R^5$, $R^6$, $R^7$, $R^8$, $R^{5'}$, $R^{6'}$, $R^{7'}$, $R^{8'}$, $R^{10}$, $R^{11}$, and $R^{12}$ is independently hydrogen, a $C_1$-$C_{40}$ hydrocarbyl, a $C_1$-$C_{40}$ substituted hydrocarbyl, a heteroatom or a heteroatom-containing group, or one or more of $R^5$ and $R^6$, $R^6$ and $R^7$, $R^7$ and $R^8$, $R^{5'}$ and $R^{6'}$, $R^{6'}$ and $R^{7'}$, $R^{7'}$ and $R^{8'}$, $R^{10}$ and $R^{11}$, or $R^{11}$ and $R^{12}$ may be joined to form one or more substituted hydrocarbyl rings, unsubstituted hydrocarbyl rings, substituted heterocyclic rings, or unsubstituted heterocyclic rings each having 5, 6, 7, or 8 ring atoms, and where substitutions on the ring can join to form additional rings.

3. The process of claim 1 or 2 wherein the M is Hf, Zr or Ti.

4. The process of claim 1, 2 or 3 wherein E and E' are each O.

5. The process of claim 1, 2, 3, or 4 wherein $R^1$ and $R^{1'}$ is independently a $C_4$-$C_{40}$ tertiary hydrocarbyl group.

6. The process of claim 1, 2, 3, or 4 wherein $R^1$ and $R^{1'}$ is independently a $C_4$-$C_{40}$ cyclic tertiary hydrocarbyl group.

7. The process of claim 1, 2, 3, or 4 wherein $R^1$ and $R^{1'}$ is independently a $C_4$-$C_{40}$ polycyclic tertiary hydrocarbyl group.

8. The process any of claims 1 to 7 wherein each X is, independently, selected from the group consisting of substituted or unsubstituted hydrocarbyl radicals having from 1 to 30 carbon atoms, substituted or unsubstituted silylcarbyl radicals having from 3 to 30 carbon atoms, hydrides, amides, alkoxides, sulfides, phosphides, halides, substituted benzyl radicals having from 8 to 30 carbon atoms, and a combination thereof, (two X's may form a part of a fused ring or a ring system).

9. The process any of claims 1 to 8 wherein each L is, independently, selected from the group consisting of: ethers, thioethers, amines, phosphines, ethyl ether, tetrahydrofuran, dimethylsulfide, triethylamine, pyridine, alkenes, alkynes, allenes, and carbenes and a combinations thereof, optionally two or more L's may form a part of a fused ring or a ring system).

10. The process of claim 1, wherein M is Zr or Hf, Q is nitrogen, both $A^1$ and $A^{1'}$ are carbon, both E and E' are oxygen, and both $R^1$ and $R^{1'}$ are $C_4$-$C_{20}$ cyclic tertiary alkyls.

11. The process of claim 1, wherein M is Zr or Hf, Q is nitrogen, both $A^1$ and $A^{1'}$ are carbon, both E and E' are oxygen, and both $R^1$ and $R^{1'}$ are adamantan-1-yl or substituted adamantan-1-yl.

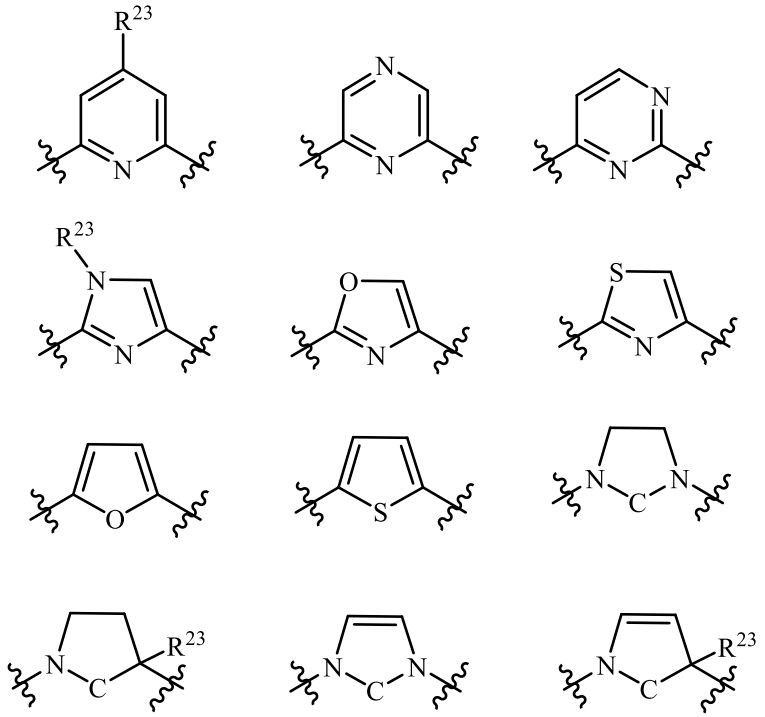
12. The process of claim 1, wherein M is Hf.

13. The process of claim 1, wherein both $R^1$ and $R^{1'}$ are adamantan-1-yl or substituted adamantan-1-yl.

14. The process of claim 1, wherein Q is carbon, $A^1$ and $A^{1'}$ are both nitrogen, and both E and E' are oxygen.

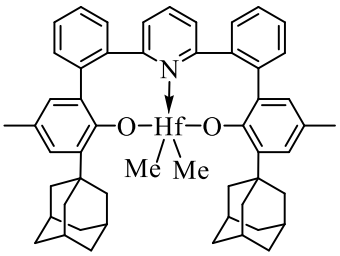
15. The process of claim 1, wherein Q is carbon, $A^1$ is nitrogen, $A^{1'}$ is $C(R^{22})$, and both E and E' are oxygen, where $R^{22}$ is selected from hydrogen, $C_1$-$C_{20}$ hydrocarbyl, $C_1$-$C_{20}$ substituted hydrocarbyl.

16. The process of claim 1, wherein the heterocyclic Lewis base is selected from the groups represented by the following formulas:

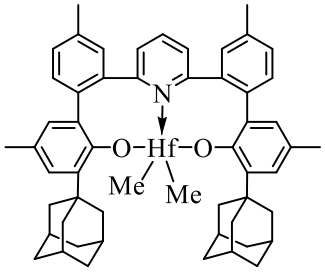


where each $R^{23}$ is independently selected from hydrogen, $C_1$-$C_{20}$ alkyls, and $C_1$-$C_{20}$ substituted alkyls.

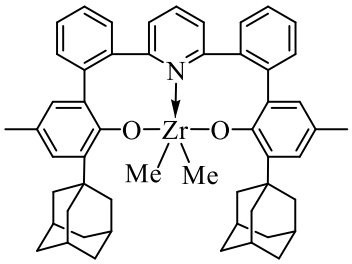
17. The process of claim 1 wherein the catalyst compound is represented by one or more of the following formulas:



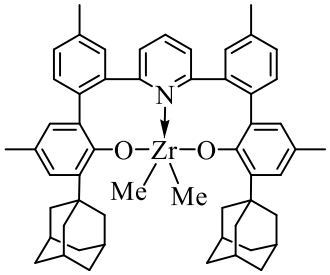

Complex 1



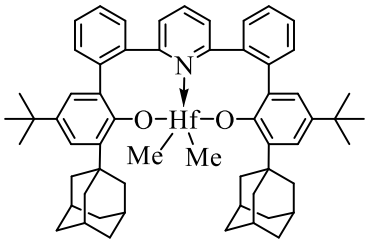

Complex 2



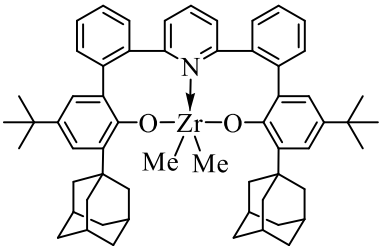

Complex 3



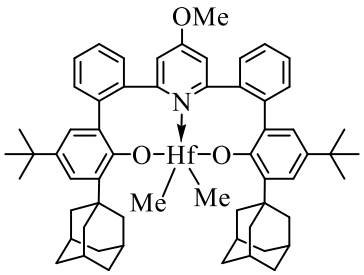

Complex 4



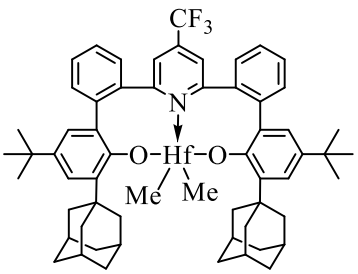

Complex 5



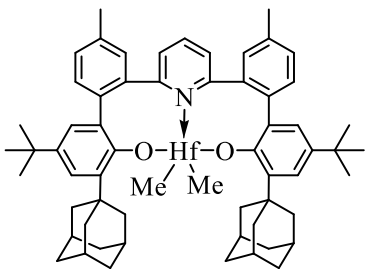

Complex 6



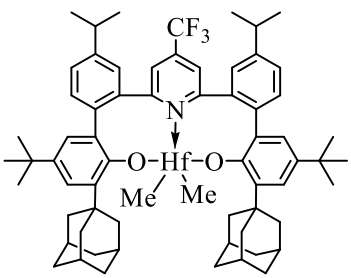

Complex 7



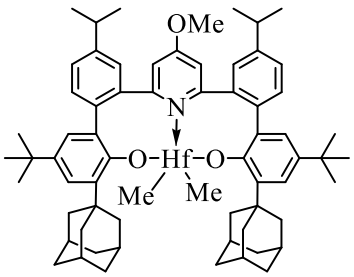

Complex 8



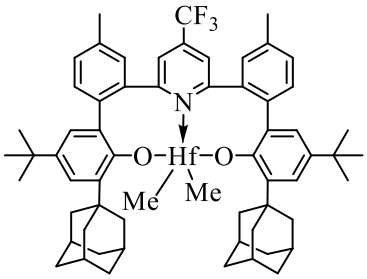

Complex 9



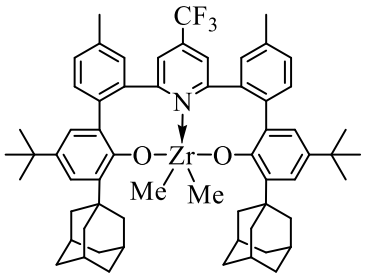

Complex 10



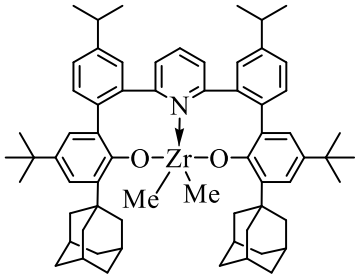

Complex 11



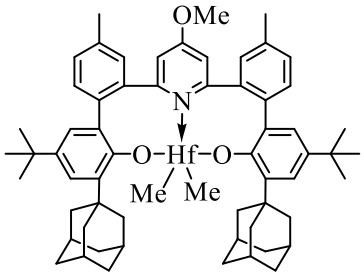

Complex 12



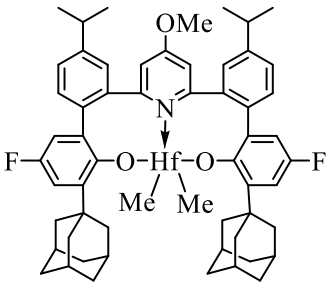

Complex 13



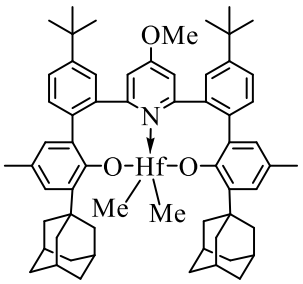

Complex 14



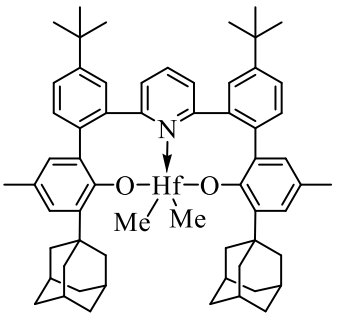

Complex 15



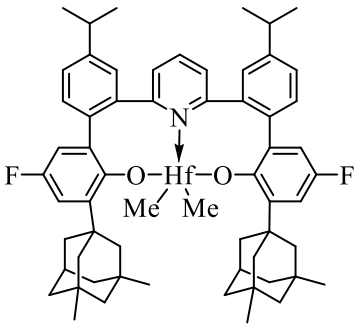

Complex 16



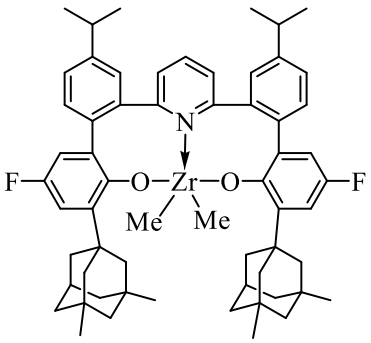

Complex 17



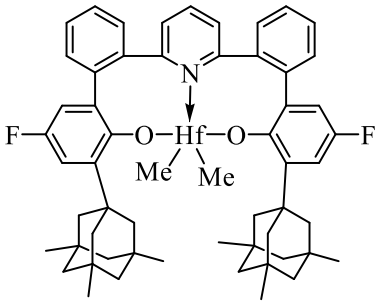

Complex 18



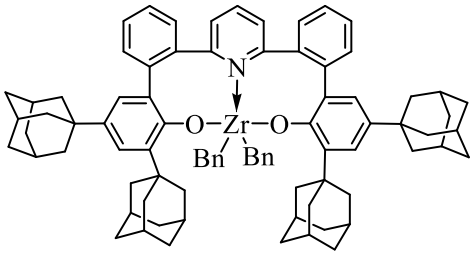

Complex 19



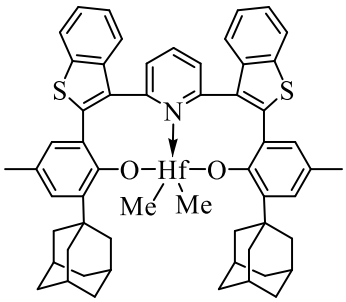

Complex 20



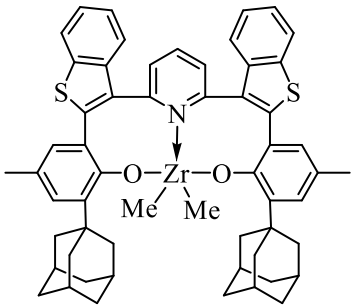

Complex 21



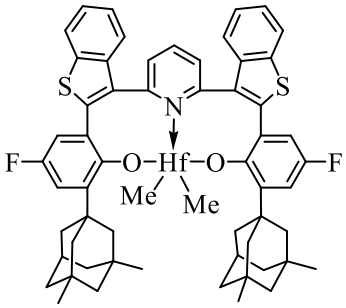

Complex 22



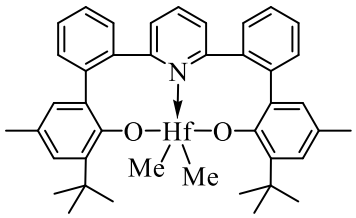

Complex 23



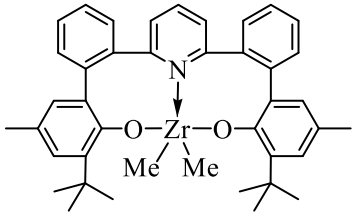

Complex 24



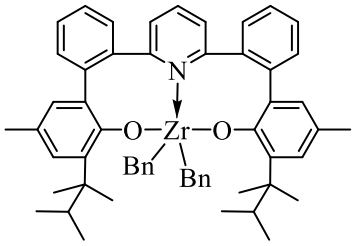

Complex 25



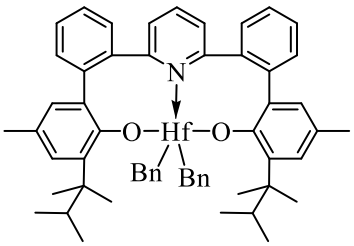

Complex 26



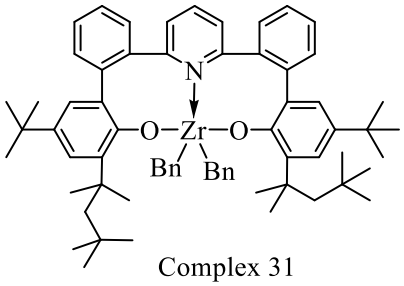

Complex 27



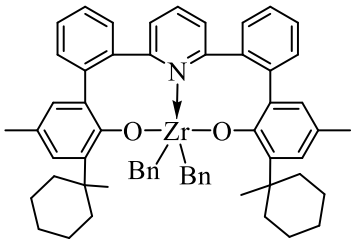

Complex 29



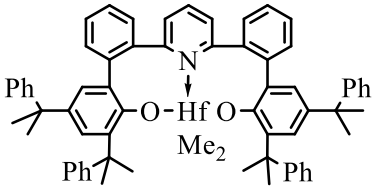

Complex 30



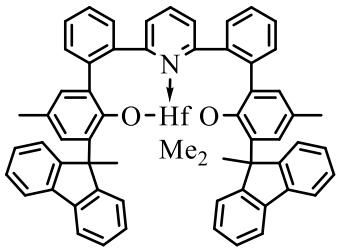

Complex 31



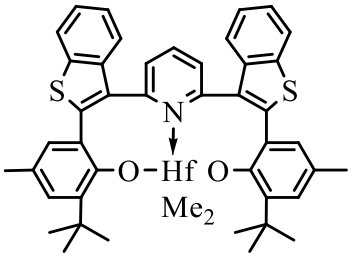

Complex 32



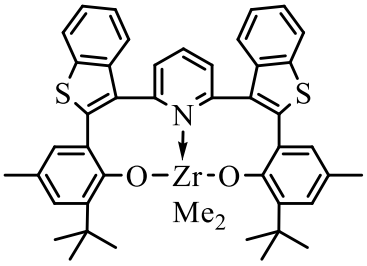

Complex 33



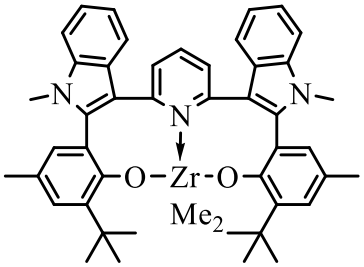

Complex 34



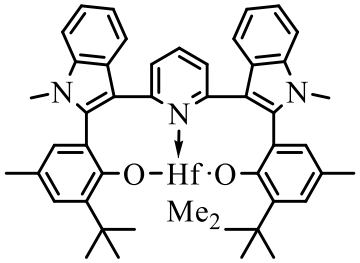

Complex 35



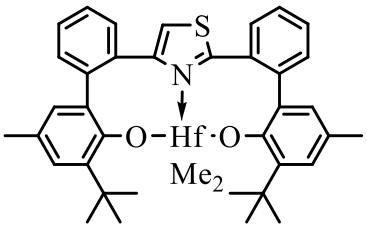

Complex 36



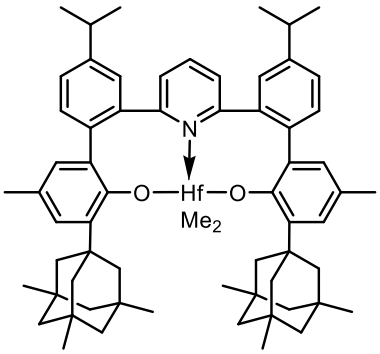

Complex 37



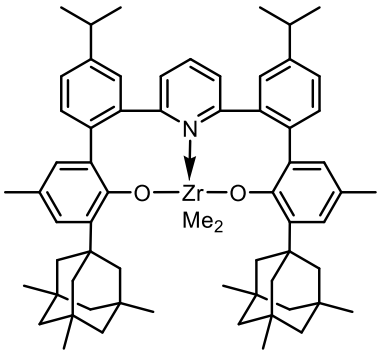

Complex 38



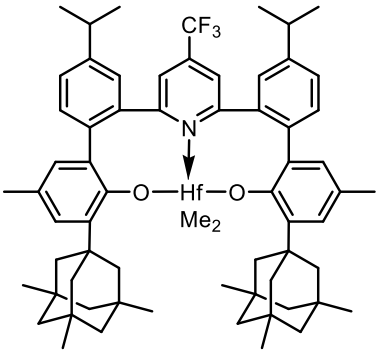

Complex 39



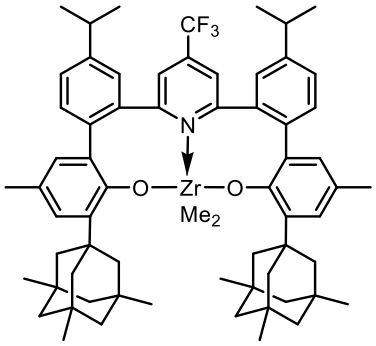

Complex 40



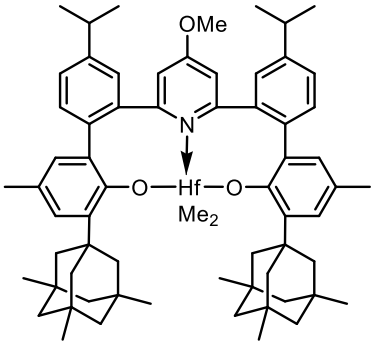

Complex 41



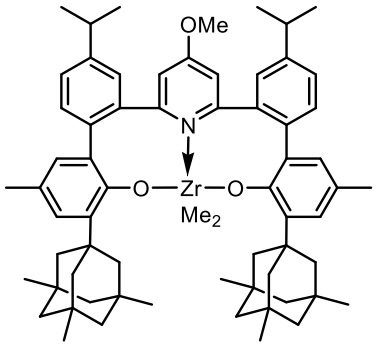

Complex 42



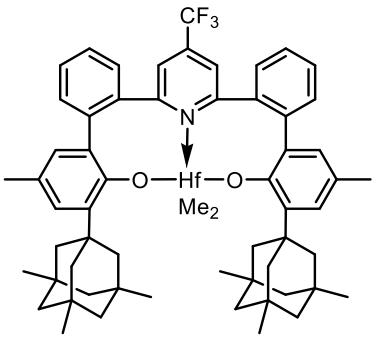

Complex 43



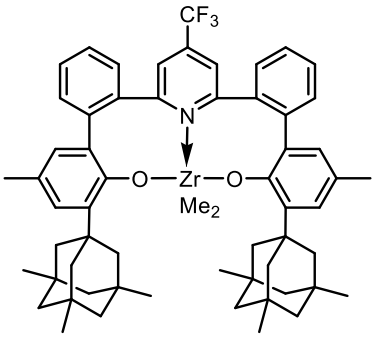

Complex 44



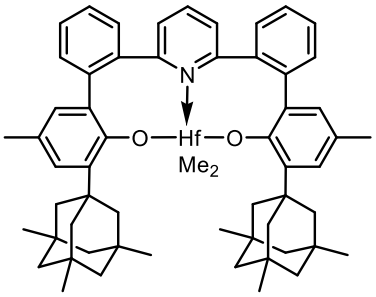

Complex 45



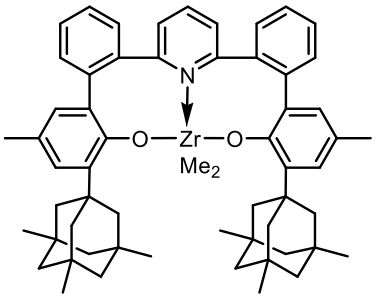

Complex 46



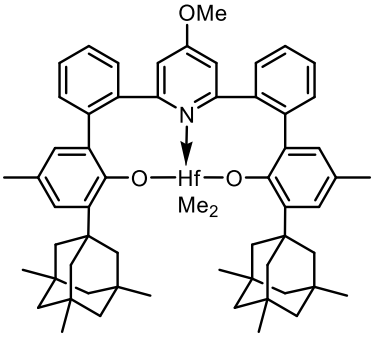

Complex 47



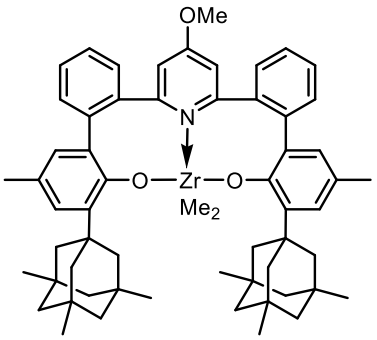

Complex 48



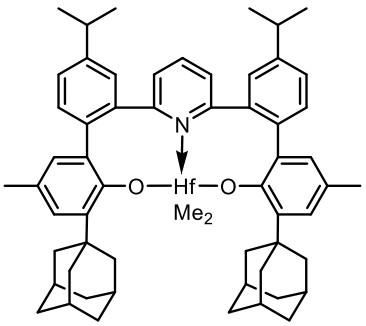

Complex 49



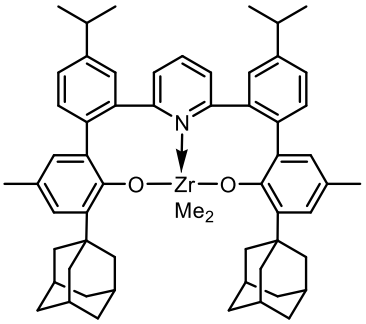

Complex 50



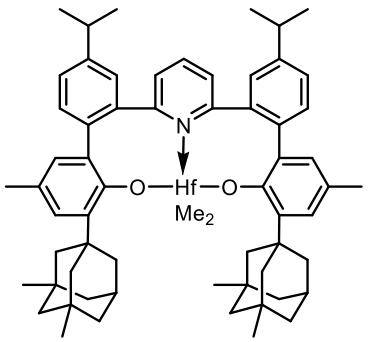

Complex 51



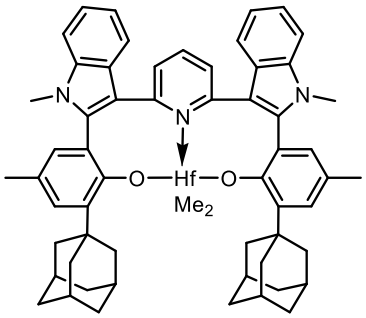

Complex 52



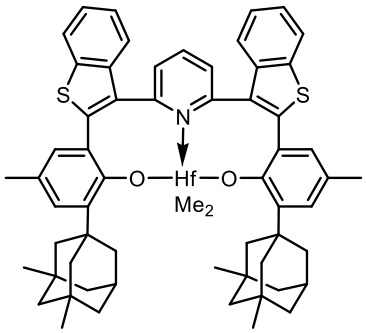

Complex 53



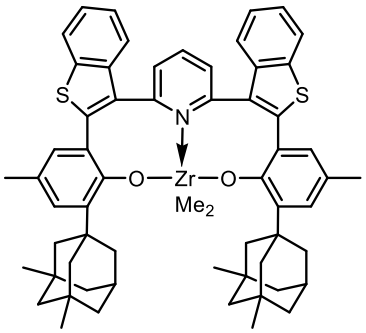

Complex 54



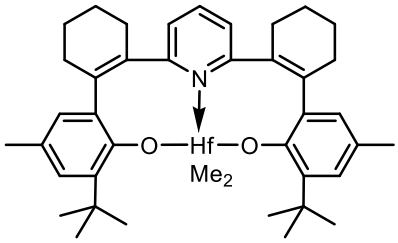

Complex 56



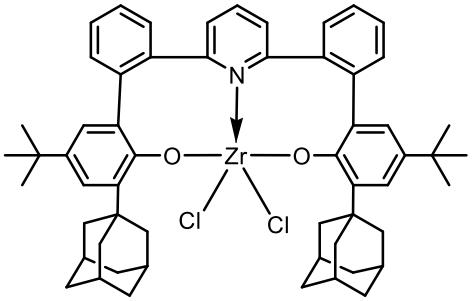

Complex 57



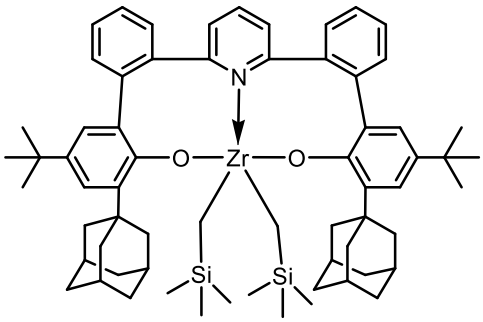

Complex 58



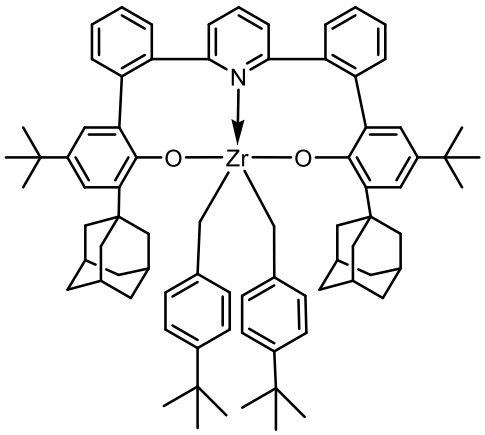

Complex 59



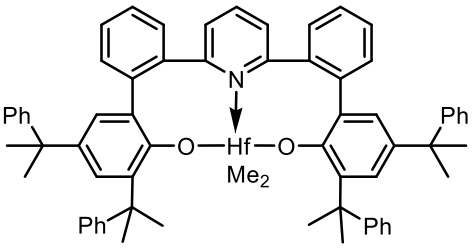

Complex 60



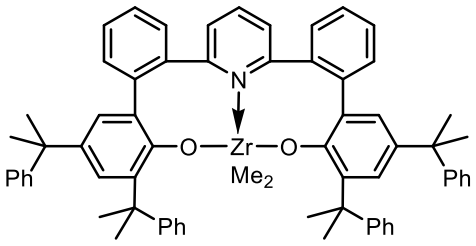

Complex 62



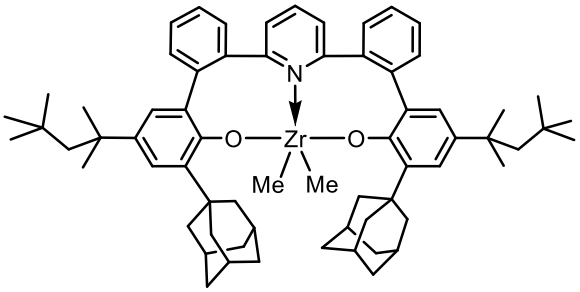

Complex 63




Complex 64




Complex 65




Complex 66

18. An isotactic polypropylene polymer

1) Tm of 155°C or greater as measured by DSC (2nd melt),

2) a mmmm pentad tacticity index of 90% or greater,

3) a Mw of 50,000 g/mol or greater (as measured by GPC-DRI, relative to linear polystyrene standards),

4) less than 35 total regio defects/10,000 monomer units and greater than 1 total regio defects/10,000 monomer units as measured by $^{13}$C-NMR.

19. The polymer of claim 18 wherein the polymer has less than 5 1,3-regio defects/10,000 monomer units as measured by $^{13}$C-NMR.

20. The polymer of claim 18 wherein the polymer has a percentage of total regio defects less than 30%.