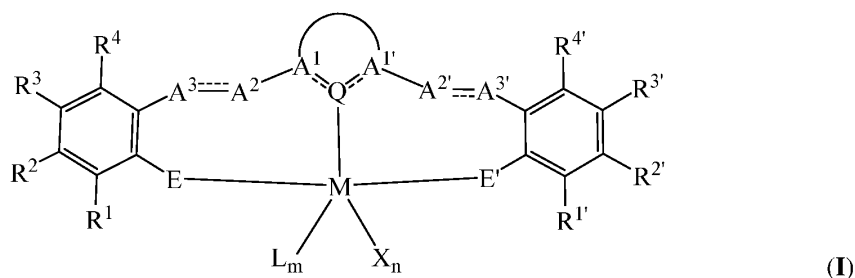


CLAIMS

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
- 5 Formula (I):



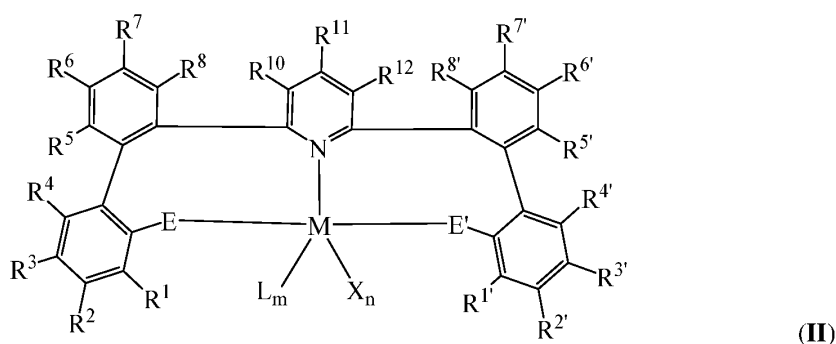
wherein:

- M is a group 3, 4, 5, or 6 transition metal or a Lanthanide;
- E and E' are each independently O, S, or NR⁹ where R⁹ is independently hydrogen, a
- 10 C₁-C₄₀ hydrocarbyl, a C₁-C₄₀ substituted hydrocarbyl or a heteroatom-containing group;
- Q is group 14, 15, or 16 atom that forms a dative bond to metal M;
- A¹QA^{1'} are part of a heterocyclic Lewis base containing 4 to 40 non-hydrogen atoms that links A² to A^{2'} via a 3-atom bridge with Q being the central atom of the 3-atom bridge, A¹ and A^{1'} are independently C, N, or C(R²²), where R²² is selected from hydrogen, C₁-C₂₀
- 15 hydrocarbyl, C₁-C₂₀ substituted hydrocarbyl;
- A³---A² is a divalent group containing 2 to 40 non-hydrogen atoms that links A¹ 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;
- 20 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;
- 25 each of R¹, R², R³, R⁴, R^{1'}, R^{2'}, R^{3'}, and R^{4'} is independently hydrogen, a C₁-C₄₀ hydrocarbyl, a C₁-C₄₀ 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;

- 5 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.

- 10 2. The process of claim 1 where the catalyst compound represented by the Formula (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
 15 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;
 20 $n+m$ 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
 25 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 R⁵, R⁶, R⁷, R⁸, R^{5'}, R^{6'}, R^{7'}, R^{8'}, R¹⁰, R¹¹, and R¹² is independently hydrogen, a C₁-C₄₀ hydrocarbyl, a C₁-C₄₀ substituted hydrocarbyl, a heteroatom or a heteroatom-containing group, or one or more of R⁵ and R⁶, R⁶ and R⁷, R⁷ and R⁸, R^{5'} and R^{6'}, R^{6'} and R^{7'}, R^{7'} and R^{8'}, R¹⁰ and R¹¹, or R¹¹ and R¹² 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.

10

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.

15

5. The process of claim 1, 2, 3, or 4 wherein R¹ and R^{1'} is independently a C₄-C₄₀ tertiary hydrocarbyl group.

6. The process of claim 1, 2, 3, or 4 wherein R¹ and R^{1'} is independently a C₄-C₄₀ cyclic tertiary hydrocarbyl group.

20

7. The process of claim 1, 2, 3, or 4 wherein R¹ and R^{1'} is independently a C₄-C₄₀ polycyclic tertiary hydrocarbyl group.

25

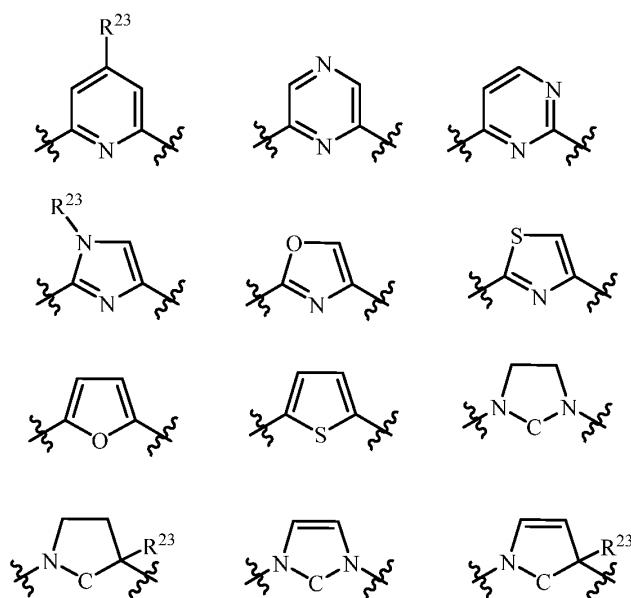
8. The process any of claims 1 to 7 wherein each X is, independently, selected from the group consisting of substituted or unsubstituted hydrocarbyl radicals having from 1 to 30 carbon atoms, substituted or unsubstituted silylcarbyl radicals having from 3 to 30 carbon atoms, hydrides, amides, alkoxides, 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).

30

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).

35

10. The process of claim 1, wherein M is Zr or Hf, Q is nitrogen, both A¹ and A^{1'} are carbon, both E and E' are oxygen, and both R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls.
11. The process of claim 1, wherein M is Zr or Hf, Q is nitrogen, both A¹ and A^{1'} are carbon, both E and E' are oxygen, and both R¹ 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 R¹ and R^{1'} are adamantan-1-yl or substituted adamantan-1-yl.
14. The process of claim 1, wherein Q is carbon, A¹ and A^{1'} are both nitrogen, and both E and E' are oxygen.
15. The process of claim 1, wherein Q is carbon, A¹ is nitrogen, A^{1'} is C(R²²), and both E and E' are oxygen, where R²² is selected from hydrogen, C₁-C₂₀ hydrocarbyl, C₁-C₂₀ 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 2, wherein M is Zr or Hf, both E and E' are oxygen, and both
5 R^1 and $R^{1'}$ are C_4 - C_{20} cyclic tertiary alkyls.

18. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, and both
 R^1 and $R^{1'}$ are adamantan-1-yl or substituted adamantan-1-yl.

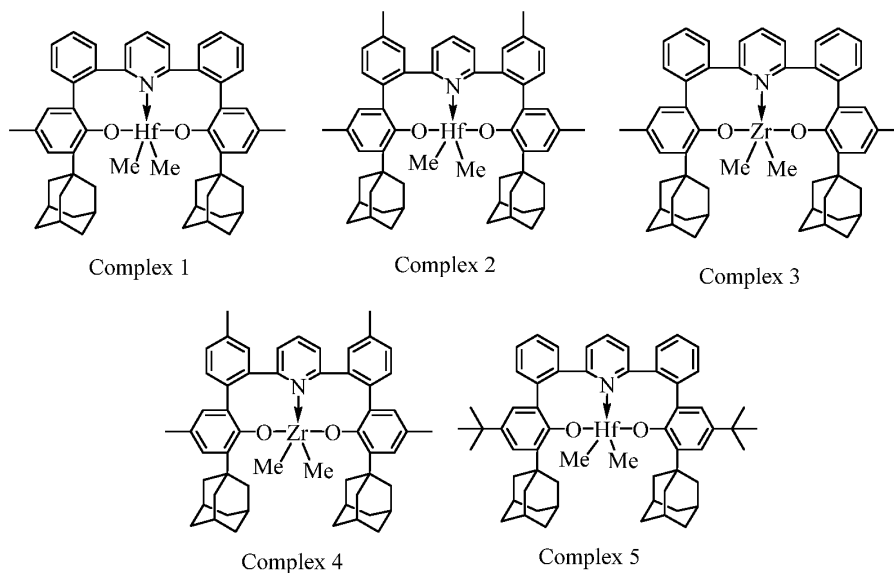
10 19. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, and each of
 R^1 , $R^{1'}$, R^3 and $R^{3'}$ are adamantan-1-yl or substituted adamantan-1-yl.

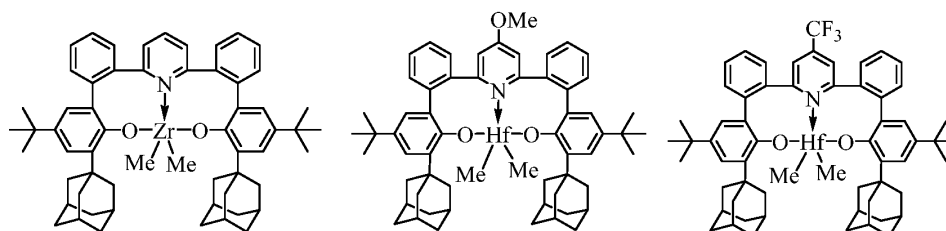
20. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, both R^1 and
 $R^{1'}$ are C_4 - C_{20} cyclic tertiary alkyls, and both R^7 and $R^{7'}$ are C_1 - C_{20} alkyls.

15 21. The process of claim 2, wherein M is Zr or Hf, both E and E' are O, both R^1 and $R^{1'}$ are
 C_4 - C_{20} cyclic tertiary alkyls, and both R^7 and $R^{7'}$ are C_1 - C_{20} alkyls.

22. The process of claim 2, wherein M is Zr or Hf, both E and E' are O, both R^1 and $R^{1'}$ are
20 C_4 - C_{20} cyclic tertiary alkyls, and both R^7 and $R^{7'}$ are C_1 - C_3 alkyls.

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

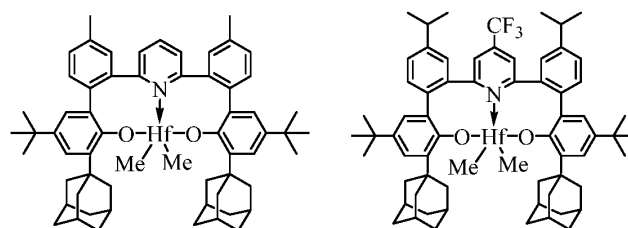




Complex 6

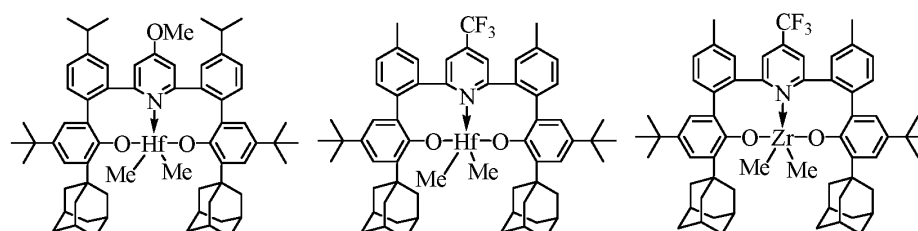
Complex 7

Complex 8



Complex 9

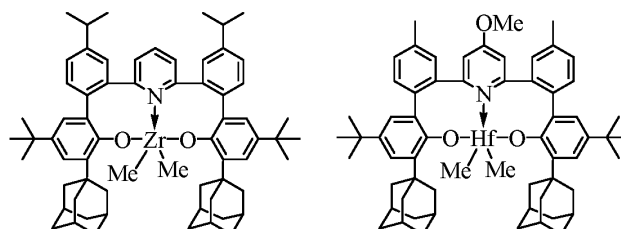
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Complex 11

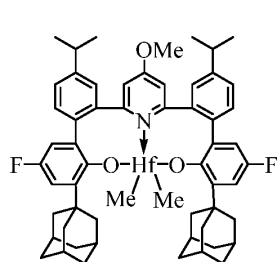
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Complex 13

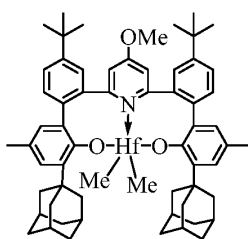


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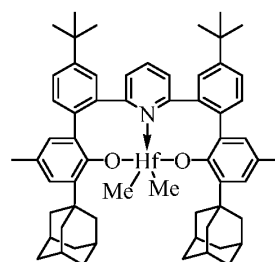
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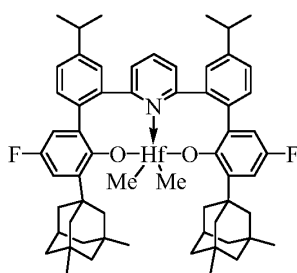
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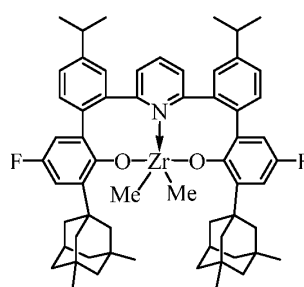
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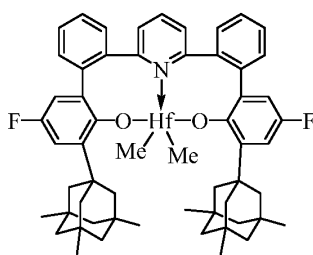
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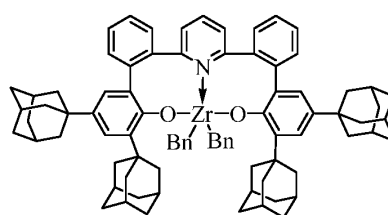
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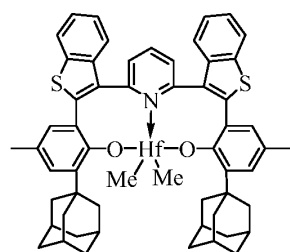
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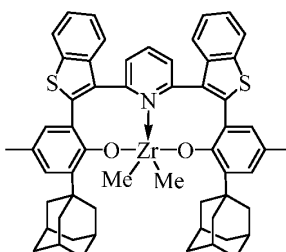
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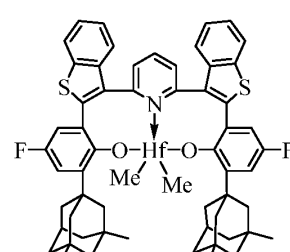
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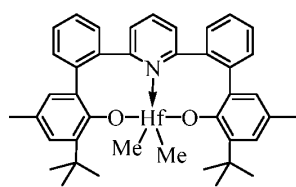
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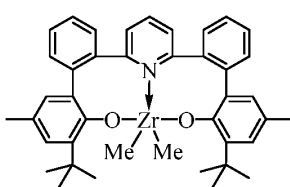
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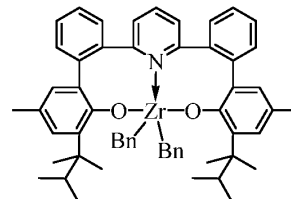
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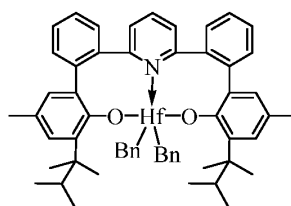
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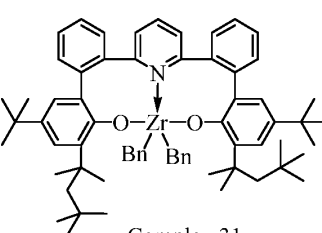
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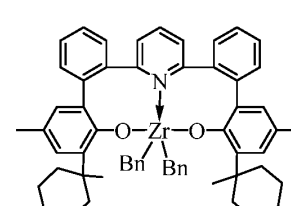
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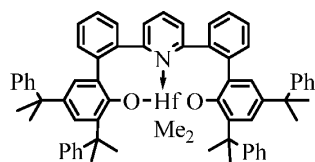
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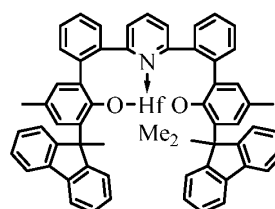
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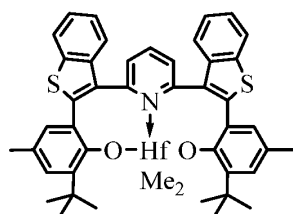
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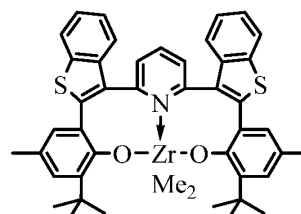
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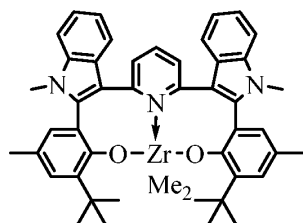
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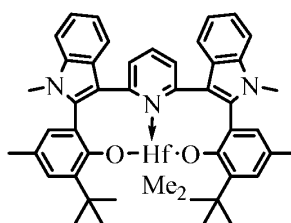
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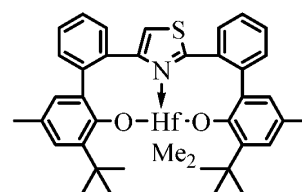
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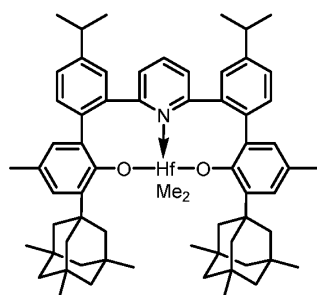
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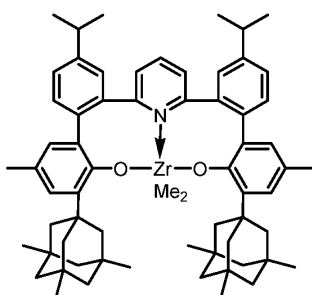
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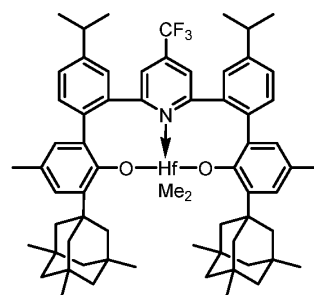
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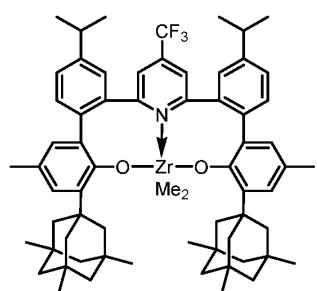
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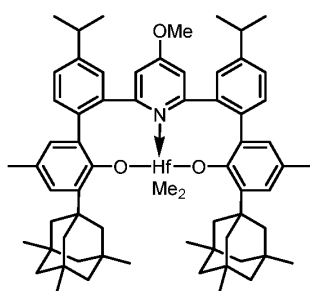
Complex 41



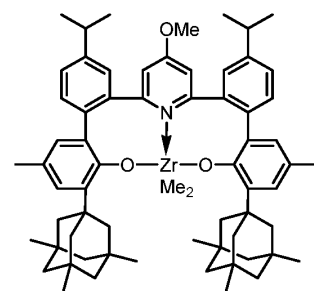
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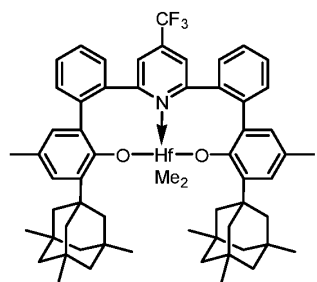
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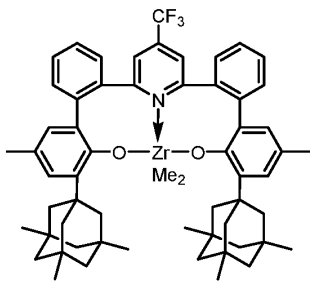
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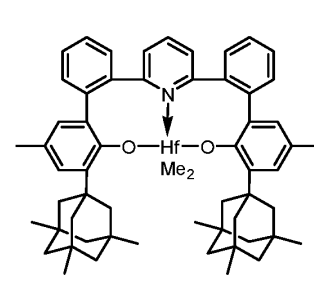
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Complex 46

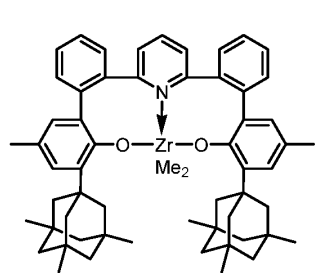


Complex 47

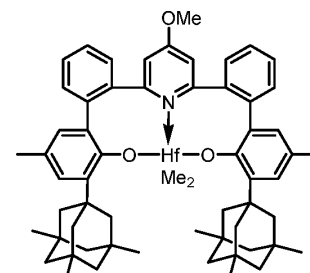


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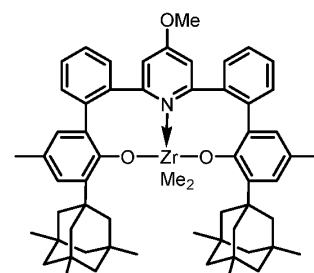
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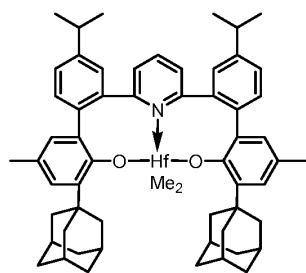
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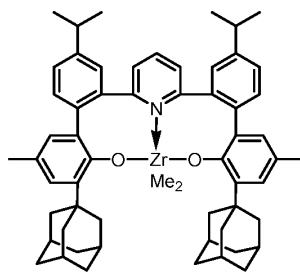
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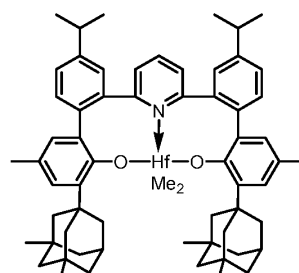
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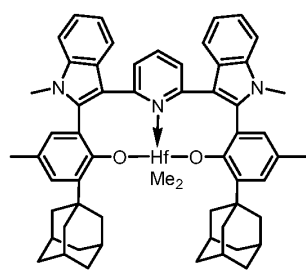
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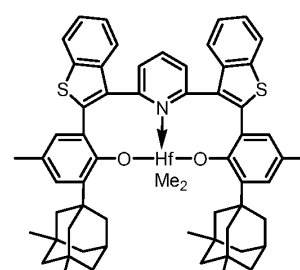
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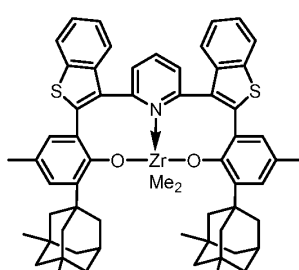
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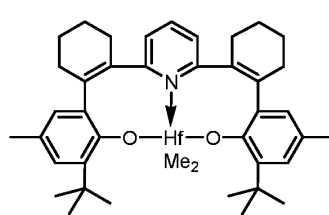
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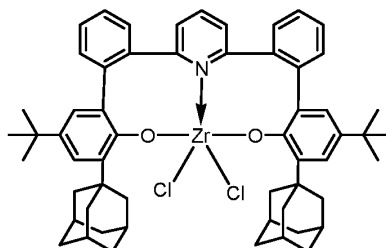
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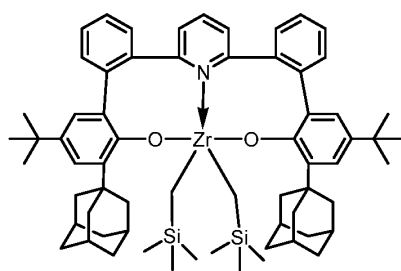
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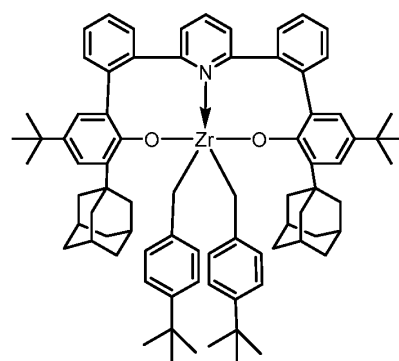
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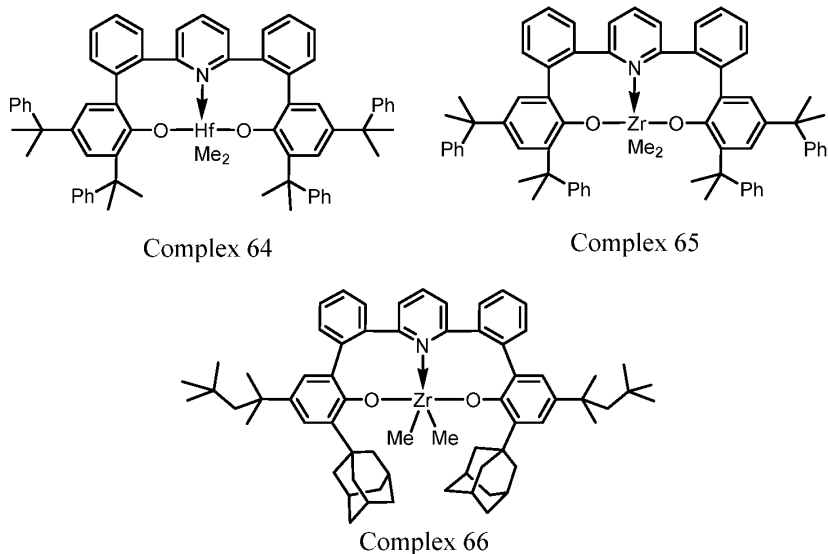
Complex 60



Complex 62



Complex 63



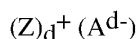
24. The process of claim 23 wherein the catalyst compound is selected from Complexes 1,
 5 2, 5, 7, 9, 10, 11, 12, 14, 15, 16, 19, 20, 23, and 25.

25. The process of claim 1, wherein the activator comprises an alumoxane and/or a non-coordinating anion.

10 26. The process of claim 1, wherein the activator is soluble in non-aromatic-hydrocarbon solvent.

27. The process of claim 1, wherein the catalyst system is free of aromatic solvent.

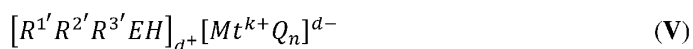
15 28. The process of claim 1, wherein the activator is represented by the formula:



wherein Z is (L-H) or a reducible Lewis Acid, L is a neutral Lewis base; H is hydrogen; (L-H)⁺ is a Bronsted acid; A^{d-} is a non-coordinating anion having the charge d-; and d is an integer from 1 to 3.

20

29. The process of claim 1, wherein the activator is represented by the formula:



wherein:

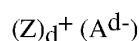
E is nitrogen or phosphorous;

d is 1, 2 or 3; k is 1, 2, or 3; n is 1, 2, 3, 4, 5, or 6; $n - k = d$;

$R^{1'}$, $R^{2'}$, and $R^{3'}$ are independently a C_1 to C_{50} hydrocarbyl group optionally substituted with one or more alkoxy groups, silyl groups, a halogen atoms, or halogen containing groups, wherein $R^{1'}$, $R^{2'}$, and $R^{3'}$ together comprise 15 or more carbon atoms;

- 5 Mt is an element selected from group 13 of the Periodic Table of the Elements; and each Q is independently a hydride, bridged or unbridged dialkylamido, halide, alkoxide, aryloxide, hydrocarbyl, substituted hydrocarbyl, halocarbyl, substituted halocarbyl, or halosubstituted-hydrocarbyl radical.

- 10 30. The process of claim 1, wherein the activator is represented by the formula:



wherein A^{d-} is a non-coordinating anion having the charge d^- ; and d is an integer from 1 to 3 and $(Z)_d^+$ is represented by one or more of:

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13		14		15	
16		17		18	
19		20		21	
22		23		24	

25		26		27	
29		28		30	
31		32		33	
34		35		36	

31. The process of claim 1, wherein the activator is one or more of:

- N-methyl-4-nonadecyl-N-octadecylbenzenaminium tetrakis(pentafluorophenyl)borate,
N-methyl-4-nonadecyl-N-octadecylbenzenaminium tetrakis(perfluoronaphthalen-2-yl)borate,
5 dioctadecylmethyllumonium tetrakis(pentafluorophenyl)borate,
dioctadecylmethyllumonium tetrakis(perfluoronaphthalen-2-naphyl)borate,
N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate,
triphenylcarbenium tetrakis(pentafluorophenyl)borate,
trimethylammonium tetrakis(perfluoronaphthalen-2-yl)borate,
10 triethylammonium tetrakis(perfluoronaphthalen-2-yl)borate,
tripropylammonium tetrakis(perfluoronaphthalen-2-yl)borate,
tri(n-butyl)ammonium tetrakis(perfluoronaphthalen-2-yl)borate,
tri(t-butyl)ammonium tetrakis(perfluoronaphthalen-2-yl)borate,
N,N-dimethylanilinium tetrakis(perfluoronaphthalen-2-yl)borate,
15 N,N-diethylanilinium tetrakis(perfluoronaphthalen-2-yl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(perfluoronaphthalen-2-yl)borate,
tropillium tetrakis(perfluoronaphthalen-2-yl)borate,
triphenylcarbenium tetrakis(perfluoronaphthalen-2-yl)borate,
triphenylphosphonium tetrakis(perfluoronaphthalen-2-yl)borate,
20 triethylsilylium tetrakis(perfluoronaphthalen-2-yl)borate,

- benzene(diazonium) tetrakis(perfluoronaphthalen-2-yl)borate,
trimethylammonium tetrakis(perfluorobiphenyl)borate,
triethylammonium tetrakis(perfluorobiphenyl)borate,
tripropylammonium tetrakis(perfluorobiphenyl)borate,
5 tri(n-butyl)ammonium tetrakis(perfluorobiphenyl)borate,
tri(t-butyl)ammonium tetrakis(perfluorobiphenyl)borate,
N,N-dimethylanilinium tetrakis(perfluorobiphenyl)borate,
N,N-diethylanilinium tetrakis(perfluorobiphenyl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(perfluorobiphenyl)borate,
10 tropillium tetrakis(perfluorobiphenyl)borate,
triphenylcarbenium tetrakis(perfluorobiphenyl)borate,
triphenylphosphonium tetrakis(perfluorobiphenyl)borate,
triethylsilylium tetrakis(perfluorobiphenyl)borate,
benzene(diazonium) tetrakis(perfluorobiphenyl)borate,
15 [4-t-butyl-PhNMe₂H][(C₆F₃(C₆F₅)₂)₄B],
trimethylammonium tetraphenylborate,
triethylammonium tetraphenylborate,
tripropylammonium tetraphenylborate,
tri(n-butyl)ammonium tetraphenylborate,
20 tri(t-butyl)ammonium tetraphenylborate,
N,N-dimethylanilinium tetraphenylborate,
N,N-diethylanilinium tetraphenylborate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetraphenylborate,
tropillium tetraphenylborate,
25 triphenylcarbenium tetraphenylborate,
triphenylphosphonium tetraphenylborate,
triethylsilylium tetraphenylborate,
benzene(diazonium)tetraphenylborate,
trimethylammonium tetrakis(pentafluorophenyl)borate,
30 triethylammonium tetrakis(pentafluorophenyl)borate,
tripropylammonium tetrakis(pentafluorophenyl)borate,
tri(n-butyl)ammonium tetrakis(pentafluorophenyl)borate,
tri(sec-butyl)ammonium tetrakis(pentafluorophenyl)borate,

- N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate,
N,N-diethylanilinium tetrakis(pentafluorophenyl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(pentafluorophenyl)borate,
tropillium tetrakis(pentafluorophenyl)borate,
5 triphenylcarbenium tetrakis(pentafluorophenyl)borate,
triphenylphosphonium tetrakis(pentafluorophenyl)borate,
triethylsilylium tetrakis(pentafluorophenyl)borate,
benzene(diazonium) tetrakis(pentafluorophenyl)borate,
trimethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl) borate,
10 triethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
tripropylammonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
tri(n-butyl)ammonium tetrakis-(2,3,4,6-tetrafluoro-phenyl)borate,
dimethyl(t-butyl)ammonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
N,N-dimethylanilinium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
15 N,N-diethylanilinium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
tropillium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
triphenylcarbenium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
triphenylphosphonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
20 triethylsilylium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
benzene(diazonium) tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
trimethylammonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triethylammonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
tripropylammonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
25 tri(n-butyl)ammonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
tri(t-butyl)ammonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
N,N-dimethylanilinium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
N,N-diethylanilinium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
30 tropillium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triphenylcarbenium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triphenylphosphonium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triethylsilylium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
benzene(diazonium) tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,

- di-(i-propyl)ammonium tetrakis(pentafluorophenyl)borate,
dicyclohexylammonium tetrakis(pentafluorophenyl)borate,
tri(o-tolyl)phosphonium tetrakis(pentafluorophenyl)borate,
tri(2,6-dimethylphenyl)phosphonium tetrakis(pentafluorophenyl)borate,
5 triphenylcarbenium tetrakis(perfluorophenyl)borate,
1-(4-(tris(pentafluorophenyl)borate)-2,3,5,6-tetrafluorophenyl)pyrrolidinium,
tetrakis(pentafluorophenyl)borate,
4-(tris(pentafluorophenyl)borate)-2,3,5,6-tetrafluoropyridine, and
triphenylcarbenium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate).
- 10 32. The process of claim 1, wherein the process is a solution process.
33. The process of claim 1 wherein the process occurs at a temperature of from about 0°C
to about 300°C, at a pressure in the range of from about 0.35 MPa to about 18 MPa, and at a
15 run time up to 300 minutes.
34. The process of claim 33 wherein the process occurs at a temperature of 65°C to
about 150°C.
- 20 35. The process of claim 1 further comprising obtaining propylene polymer comprising at
least 55 mol% propylene.
36. The process of claim 35 wherein the propylene polymer is isotactic and has a mmmm
pentad tacticity index of 75% or greater.
- 25 37. The process of claim 35 wherein the polymer has a T_m of 150°C or greater as measured
by DSC, alternately greater than 155°C.
38. The process of claim 35 wherein the polymer has a M_w of 50,000 g/mol or greater (as
30 measured by GPC-DRI, relative to linear polystyrene standards).
39. The process of claim 35 wherein the polymer has less than 200 total regio
defects/10,000 monomer units and greater than 1 total regio defects/10,000 monomer units as
measured by ¹³C-NMR spectroscopy.
- 35 40. The process of claim 35 wherein the polymer has less than 30 1,3-regio defects/10,000
monomer units as measured by ¹³C-NMR.

41. The process of claim 35 wherein the polymer has a percentage of total regio defects less than 40%.
- 5 42. The process of claim 35 wherein the polymer has 1) a T_m as measured by DSC of 155°C or greater, 2) wherein the total regio defects/10,000 monomer units is less than $-1.18 \times T_m(^{\circ}\text{C}) + 210$, and 3) wherein the total regio defects is not less than 3 total regio defects/10,000 monomer units.
- 10 43. The process of claim 35 wherein the polymer has greater than 0.05 unsaturated end-groups per 1,000C as determined by ^1H NMR.
44. The process of claim 35 wherein the polymer has 1) a M_w (GPC-DRI, relative to linear polystyrene standards) less than $(10^{-8})(e^{0.1962z})$ where z is the $T_m (^{\circ}\text{C})$ of the polymer as measured by DSC (2nd melt), and 2) a M_w greater than $(2 \times 10^{-16})(e^{0.2956x})$ where x is the T_m of the polymer as measured by DSC (2nd melt), and 3) wherein the T_m of the polymer is 155°C or greater.
- 15 45. The process of claim 35 wherein the polymer is a propylene-alpha-olefin copolymer wherein the alpha-olefin is a $\text{C}_4\text{-C}_{20}$ alpha olefin and wherein the propylene-alpha-olefin copolymer contains as 20 mol% propylene or greater, with the lower limit of $\text{C}_4\text{-C}_{20}$ alpha-olefin being 1 mol%.
- 20 46. The process of the claim 45 wherein the alpha-olefin is a $\text{C}_4\text{-C}_{14}$ alpha-olefin, or mixtures thereof.
- 25 47. The process of claim 45 wherein the propylene-alpha-olefin copolymer has at least 50% isotactic triads as measured by ^{13}C NMR.
- 30 48. An isotactic polypropylene polymer
- 1) T_m of 155°C or greater as measured by DSC (2nd melt),
- 2) a mmmm pentad tacticity index of 90% or greater,
- 3) a M_w of 50,000 g/mol or greater (as measured by GPC-DRI, relative to linear polystyrene standards),
- 35 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.

49. The polymer of claim 48 wherein the polymer has less than 5 1,3-regio defects/10,000 monomer units as measured by ^{13}C -NMR.
- 5 50. The polymer of claim 48 wherein the polymer has a percentage of total regio defects less than 30%.
51. The polymer of claim 48 wherein the polymer has 1) total regio defects/10,000 monomer units of less than $-1.18 \times T_m + 210$, and 2) wherein the total regio defects is not less
10 than 3 total regio defects/10,000 monomer units.
52. The polymer of claim 48 wherein the polymer has greater than 0.05 unsaturated end-groups per 1000C as determined by ^1H NMR.
- 15 53. The polymer of claim 48 wherein the polymer has 1) a Mw (GPC-DRI, relative to linear polystyrene standards) less than $(10^{-8})(e^{0.1962x})^z$ where z is the T_m ($^{\circ}\text{C}$) of the polymer as measured by DSC (2nd melt) and 2) a Mw greater than $(2 \times 10^{-16})(e^{0.2956z})$ where z is the T_m of the polymer as measured by DSC (2nd melt), and 3) wherein the T_m of the polymer is 155°C or greater.
- 20 54. The polymer of claim 48 wherein the T_m is 160°C or greater.
55. The polymer of claim 48 wherein the Mw is 100,000 g/mol or greater.
- 25 56. The polymer of claim 48 wherein the mmmm pentad tacticity index of 95% or greater.
57. An isotactic crystalline propylene polymer produced in a process comprising contacting in a homogeneous phase, propylene with a catalyst system comprising activator and a transition metal catalyst complex of a dianionic, tridentate ligand that features a central neutral
30 heterocyclic Lewis base and two phenolate donors, where the tridentate ligand coordinates to the metal center to form two eight-membered rings.
58. The polymer of claim 57 wherein the polymer has a melting point of 120°C or higher.
- 35 59. The polymer of claim 57 wherein the polymer has a mmmm pentad tacticity index of 70% or greater.

60. The polymer of claim 57, 58, or 59 wherein the polymerization temperature is 70°C or higher.
61. The process of claim 2, wherein M is Hf, both E and E' are oxygen, and both R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls.
62. The process of claim 2, wherein M is Hf, both E and E' are oxygen, and both R¹ and R^{1'} are adamantan-1-yl or substituted adamantan-1-yl.
63. The process of claim 2, wherein M is Hf, both E and E' are oxygen, and each of R¹, R^{1'}, R³ and R^{3'} are adamantan-1-yl or substituted adamantan-1-yl.
64. The process of claim 2, wherein M is Hf, both E and E' are oxygen, both R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls, and both R⁷ and R^{7'} are C₁-C₂₀ alkyls.
65. The process of claim 2, wherein M is Hf, both E and E' are O, both R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls, and both R⁷ and R^{7'} are C₁-C₂₀ alkyls.
66. The process of claim 2, wherein M is Hf, both E and E' are O, both R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls, and both R⁷ and R^{7'} are C₁-C₃ alkyls.
67. The process of claim 1, wherein the propylene copolymer has a heat of fusion of greater than 100 J/g, preferably greater than 110 J/g.
68. An isotactic crystalline propylene polymer produced by a polymerization process comprising contacting in a homogeneous phase propylene with a catalyst system comprising an activator and a group 4 bis(phenolate) catalyst compound, wherein the polymerization process takes place at a temperature of 90°C or higher, to produce a polymer with the following characteristics:
- i) a Mw (GPC-DRI, relative to linear polystyrene standards) less than (10⁻⁸) (e^{0.1962z}), where z is the T_m (°C) of the polymer as measured by DSC (2nd melt);
 - ii) a Mw (GPC-DRI, relative to linear polystyrene standards) greater than (2x10⁻¹⁶)(e^{0.2956z}) where z is the T_m (°C) of the polymer as measured by DSC (2nd melt).
69. The polymer of claim 68 wherein the T_m is 160°C or greater.

70. The polymer of claim 68 wherein the Mw is 100,000 g/mol or greater.
71. The polymer of claim 68 wherein the mmmm pentad tacticity index of 95% or greater.