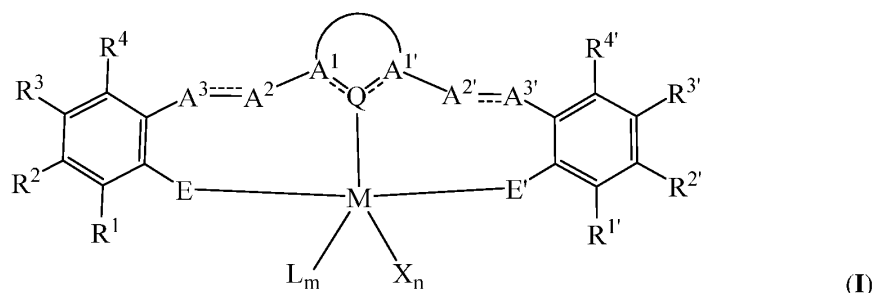


CLAIMS

What is claimed is

1. A polymerization process comprising contacting, in a homogeneous phase, at least one C₃-C₄₀ alpha olefin and ethylene with a catalyst system comprising activator and catalyst compound represented by the Formula (I):



wherein:

M is a group 3, 4, 5, or 6 transition metal or a Lanthanide, preferably Hf, Zr, or Ti;

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;

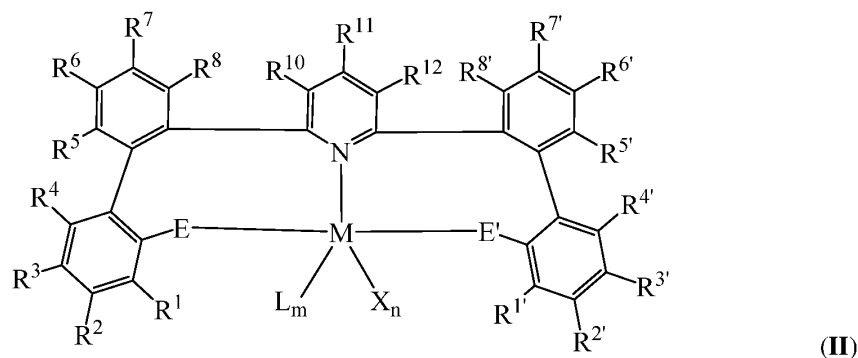
n is 1, 2 or 3;

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 R¹ and R², R² and R³, R³ and R⁴, 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;
- 5 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 a polymer comprising up to 35 mole% ethylene.
2. The polymerization process of claim 1, wherein the C₃-C₄₀ alpha olefin is propylene
- 10 and the polymer comprises 0.1 to 35 mol% ethylene and 99.9 to 65 mol% propylene.
3. The process of claim 1 where the catalyst compound represented by the Formula (II):



wherein:

- 15 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 C₁-C₄₀ hydrocarbyl, a C₁-C₄₀ substituted hydrocarbyl, or a heteroatom-containing group;
- each L is independently a Lewis base;
- each X is independently an anionic ligand;
- 20 n is 1, 2 or 3;
- m is 0, 1, or 2;
- n+m is not greater than 4;
- each of R¹, R², R³, R⁴, R^{1'}, R^{2'}, R^{3'}, and R^{4'} is independently hydrogen, C₁-C₄₀ hydrocarbyl, C₁-C₄₀ substituted hydrocarbyl, a heteroatom or a heteroatom-containing group,
- 25 or one or more of R¹ and R², R² and R³, R³ and R⁴, 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 R⁵, R⁶, R⁷, R⁸, R^{5'}, R^{6'}, R^{7'}, R^{8'}, R¹⁰, R¹¹, and R¹² is independently hydrogen, a
- 5 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
- 10 additional rings.
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 R¹ and R^{1'} are independently a C₄-C₄₀ tertiary
- 15 hydrocarbyl group.
6. The process of claim 1, 2, 3, or 4 wherein R¹ and R^{1'} are independently a C₄-C₄₀ cyclic tertiary hydrocarbyl group.
- 20 7. The process of claim 1, 2, 3, or 4 wherein R¹ and R^{1'} are independently a C₄-C₄₀ 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 20
- 25 carbon atoms, hydrides, amides, alkoxides, sulfides, phosphides, halides, 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,
- 30 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 A¹ and A^{1'} are carbon,
- 35 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 Zr or Hf, Q is nitrogen, both A¹ and A^{1'} are carbon,
5 both E and E' are oxygen, and both R¹ and R^{1'} are C₆-C₂₀ aryls.

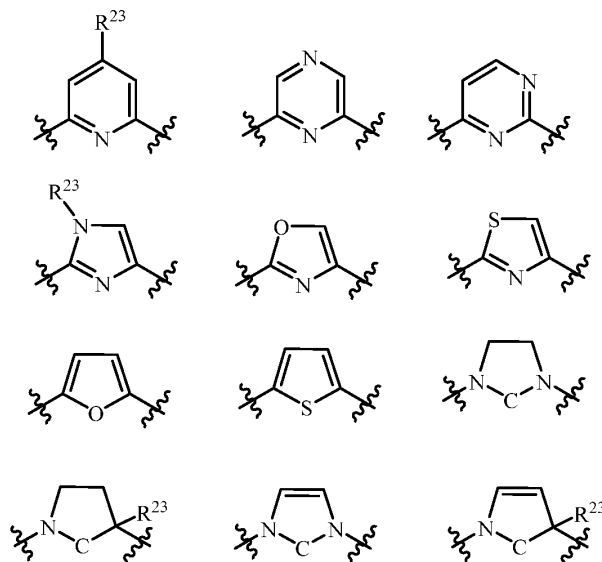
13. The process of claim 1, wherein Q is nitrogen, A¹ and A^{1'} are both carbon, both R¹ and R^{1'} are hydrogen, both E and E' are NR⁹, where R⁹ is selected from a C₁-C₄₀ hydrocarbyl, a C₁-C₄₀ substituted hydrocarbyl, or a heteroatom-containing group.

10

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
15 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:

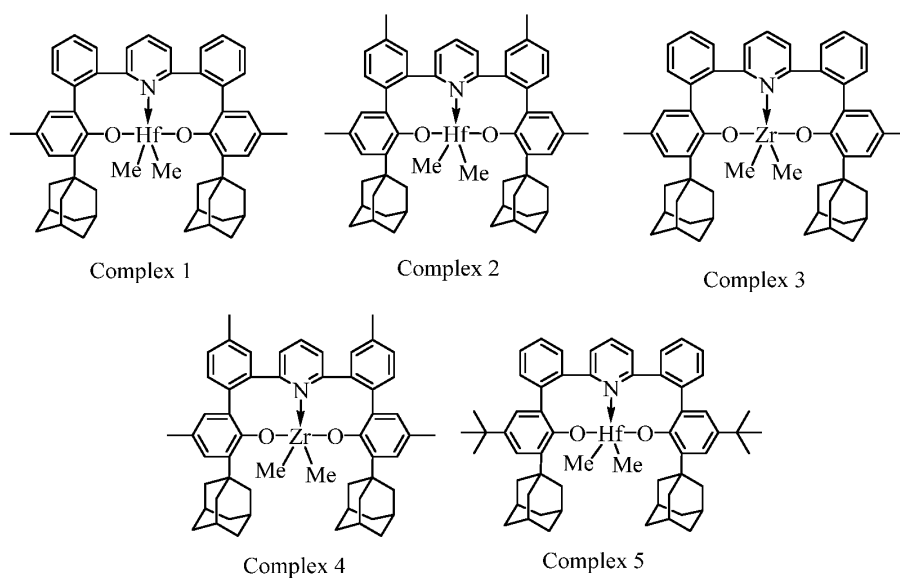


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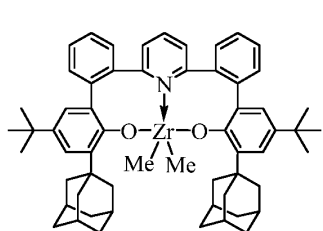
where each R²³ is independently selected from hydrogen, C₁-C₂₀ alkyls, and C₁-C₂₀ substituted alkyls.

17. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, and both
25 R¹ and R^{1'} are C₄-C₂₀ cyclic tertiary alkyls.

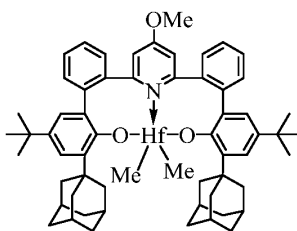
18. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, and both R¹ and R^{1'} are adamantan-1-yl or substituted adamantan-1-yl.
- 5 19. The process of claim 2, wherein M is Zr or Hf, both E and E' are oxygen, and each of R¹, R^{1'}, R³ and R^{3'} are adamantan-1-yl or substituted adamantan-1-yl.
20. The process of claim 2, wherein M is Zr or 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.
- 10 21. The process of claim 2, wherein M is Zr or 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.
22. The process of claim 2, wherein M is Zr or 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.
- 15 23. The process of claim 1 wherein the catalyst compound is represented by one or more of the following formulas:



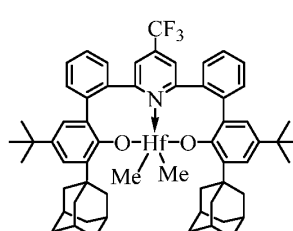
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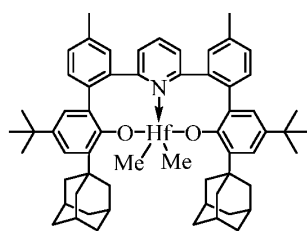
Complex 6



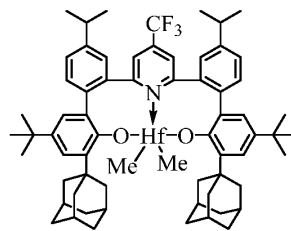
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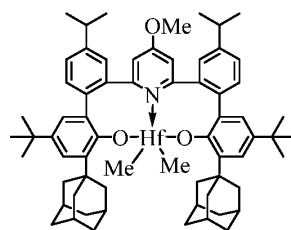
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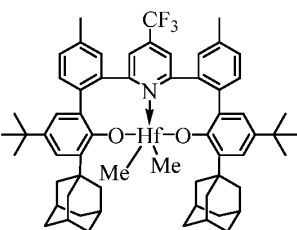
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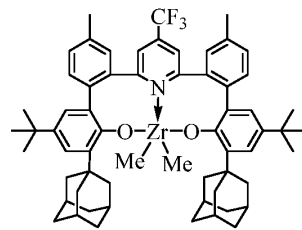
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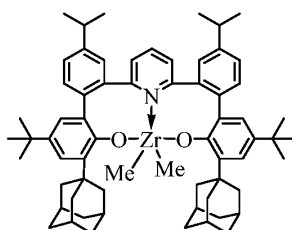
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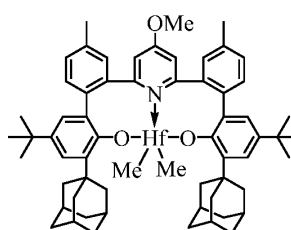
Complex 12



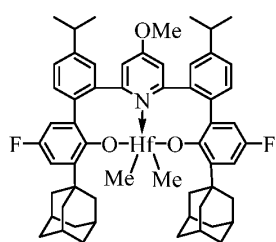
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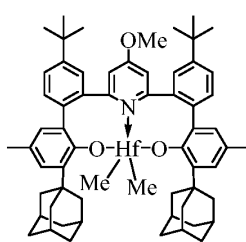
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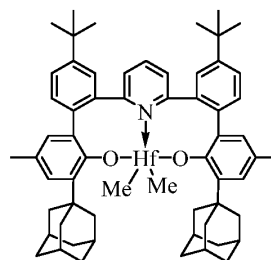
Complex 15



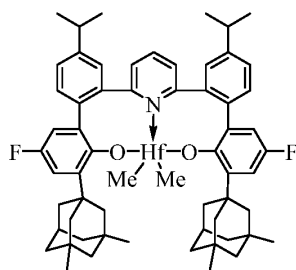
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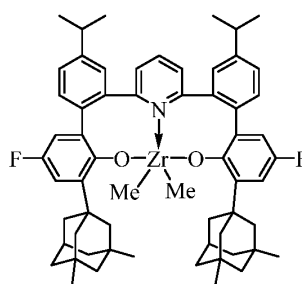
Complex 17



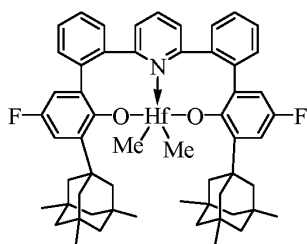
Complex 18



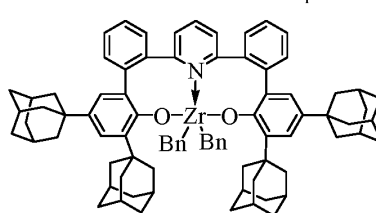
Complex 19



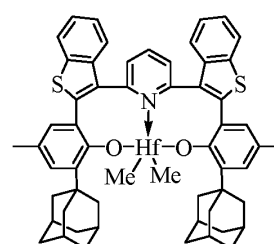
Complex 20



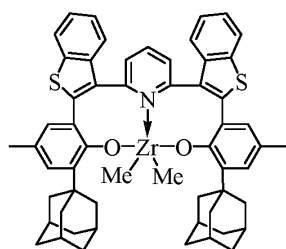
Complex 21



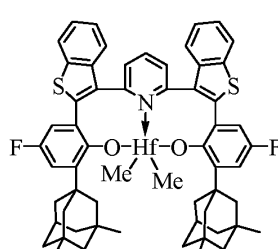
Complex 22



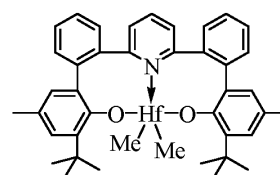
Complex 23



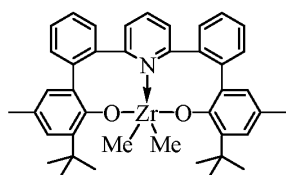
Complex 24



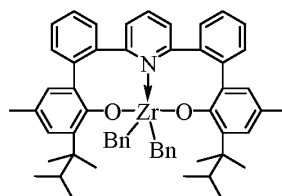
Complex 25



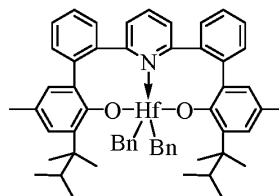
Complex 26



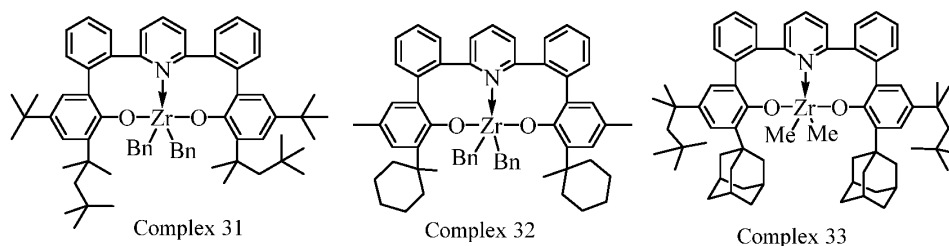
Complex 27



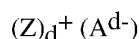
Complex 29



Complex 30

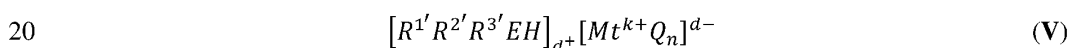


24. The process of claim 23 wherein the catalyst compound is any of complexes 1 to 8.
- 5 25. The process of claim 1, wherein the activator comprises an alumoxane or a non-coordinating anion.
26. The process of claim 1, wherein the activator is soluble in non-aromatic-hydrocarbon solvent.
- 10 27. The process of claim 1, wherein the catalyst system is free of aromatic solvent.
28. The process of claim 24, wherein the activator is represented by the formula:



- 15 wherein Z is (L-H) or a reducible Lewis Acid, L is an 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.

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



20 wherein:

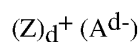
E is nitrogen or phosphorous;

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 C₁ to C₅₀ 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;

- 25 *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, aryloxy, hydrocarbyl, substituted hydrocarbyl, halocarbyl, substituted halocarbyl, or
- 30 halosubstituted-hydrocarbyl radical.

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:

10		11		12	
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 dioctadecylmethylammonium tetrakis(pentafluorophenyl)borate,
dioctadecylmethylammonium tetrakis(perfluoronaphthalen-2-yl)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,
- 25 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,
- 30 tropillium tetrakis(perfluorobiphenyl)borate,
triphenylcarbenium tetrakis(perfluorobiphenyl)borate,
triphenylphosphonium tetrakis(perfluorobiphenyl)borate,
triethylsilylium tetrakis(perfluorobiphenyl)borate,
benzene(diazonium) tetrakis(perfluorobiphenyl)borate,

- [4-t-butyl-PhNMe₂H][(C₆F₃(C₆F₅)₂)₄B],
 trimethylammonium tetraphenylborate,
 triethylammonium tetraphenylborate,
 tripropylammonium tetraphenylborate,
 5 tri(n-butyl)ammonium tetraphenylborate,
 tri(t-butyl)ammonium tetraphenylborate,
 N,N-dimethylanilinium tetraphenylborate,
 N,N-diethylanilinium tetraphenylborate,
 N,N-dimethyl-(2,4,6-trimethylanilinium) tetraphenylborate,
 10 tropillium tetraphenylborate,
 triphenylcarbenium tetraphenylborate,
 triphenylphosphonium tetraphenylborate,
 triethylsilylium tetraphenylborate,
 benzene(diazonium)tetraphenylborate,
 15 trimethylammonium tetrakis(pentafluorophenyl)borate,
 triethylammonium tetrakis(pentafluorophenyl)borate,
 tripropylammonium tetrakis(pentafluorophenyl)borate,
 tri(n-butyl)ammonium tetrakis(pentafluorophenyl)borate,
 tri(sec-butyl)ammonium tetrakis(pentafluorophenyl)borate,
 20 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,
 triphenylcarbenium tetrakis(pentafluorophenyl)borate,
 25 triphenylphosphonium tetrakis(pentafluorophenyl)borate,
 triethylsilylium tetrakis(pentafluorophenyl)borate,
 benzene(diazonium) tetrakis(pentafluorophenyl)borate,
 trimethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl) borate,
 triethylammonium tetrakis-(2,3,4,6-tetrafluorophenyl)borate,
 30 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,
 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,
 5 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,
 10 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,
 15 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,
 20 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,
 triphenylcarbenium tetrakis(perfluorophenyl)borate,
 25 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).
- 30 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 10 MPa, and at a residence time up to 300 minutes.
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34. The process of claim 1 wherein the process occurs at a polymerization temperature of at least of $TP1^{\circ}\text{C}$, wherein $TP1 = 59.97 * \text{EXP}(0.0115 * \text{MFR})$, where MFR is the melt flow rate of the copolymer product.
- 5 35. The process of claim 1 wherein the catalyst activity is 200,000 kg polymer per kg of catalyst or more.
36. The process of claim 1 or 2, wherein the copolymer has a branching index, g'_{vis} , of 0.95 or less.
- 10 37. The process of claim 1 or 2, wherein the copolymer has an Mw of 50,000 g/mol or more, alternatively 100,000 g/mol or more.
38. The process of claim 1 or 2, wherein the copolymer has an Mn of 25,000 g/mol or more, 15 alternatively 50,000 g/mol or more.
39. The process of claim 1 or 2, wherein the copolymer has an Mw/Mn of 1.5 to 15, alternatively 2.0 to 10.
- 20 40. The process of claim 1 or 2, wherein the copolymer has a melt flow rate of 1500g/10 min or less, alternatively 800 g/10 min or less.
41. The process of claim 1 or 2, wherein the copolymer has a Brookfield viscosity of 500 mPa.sec or more, alternatively 1,000 mPa.sec or more, measured at 190°C .
- 25 42. The process of claim 1 or 2, wherein the copolymer has an ethylene content of 5 to 26 mol%.
43. The process of claim 1 or 2, wherein the copolymer has a T_m of 155°C or less, 30 alternatively 140°C or less.
44. The process of claim 1 or 2, wherein the copolymer has a T_c of 120°C or less, alternatively 100°C or less.
- 35 45. The process of claim 1 or 2, wherein the copolymer has a heat of fusion of 100 J/g or less, alternatively 80 J/g or less.
46. The process of claim 1 or 2, wherein the copolymer has a T_m of 150°C or less and a heat of fusion of 5 J/g to 80 J/g.
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47. The process of claim 1 or 2, wherein the r_1r_2 of the copolymer is in range of 0.8 to 3.0, alternatively from 0.9 to 2.6.
48. The process of claim 1 or 2, wherein the copolymer has regio defects of from 0.01 to 1.2 mol%, alternatively from 0.05 to 1.0 mol%.
49. The process of claim 1 or 2, wherein the copolymer has an mm triad tacticity of 75% or greater, alternatively 80% or greater, alternatively from 75 to 99% mm triad tacticity.
50. The process of claim 1 or 2, wherein the copolymer has three or more of the following properties:
- a) an Mw of 50,000 g/mol or more, alternatively 100,000 g/mol or more;
 - b) an Mn of 25,000 g/mol or more, alternatively 50,000 g/mol or more;
 - c) an Mw/Mn of 1.5 to 15, alternatively 2.0 to 10;
 - d) a melt flow rate of 1500g/10 minutes or less, alternatively 800 g/10 minutes or less;
 - e) a Brookfield viscosity of 500 mPa.sec or more, alternatively 1,000 mPa.sec or more;
 - f) an ethylene content of 5 to 26 mol%;
 - g) a Tm of 155°C or less, alternatively 140°C or less;
 - h) a Tc of 120°C or less, alternatively 100°C or less;
 - i) a heat of fusion of 100 J/g or less, alternatively 80 J/g or less;
 - j) an r_1r_2 of the copolymer in range of 0.8 to 3.0, alternatively from 0.9 to 2.6;
 - k) an r_1r_2 is greater than $1.12-(0.0157x)$ where x is the wt% of ethylene as measured by ^{13}C NMR;
 - l) regio defects of from 0.01 to 1.2 mol%, alternatively from 0.05 to 1.0 mol%;
 - m) an mm triad tacticity of 75% or greater, alternatively 80% or greater mm triad tacticity; and
 - n) an EEE triad sequence distribution greater than $(3 \times 10^{-5})x^2 + 0.0005x - 0.0039$ where x is the wt% of ethylene as measured by ^{13}C NMR.
51. A copolymer comprising 0.1 to 35 mol% ethylene and 99.9 to 65 mol% propylene, wherein the copolymer has:
- a) an Mw of 50,000 g/mol or more, alternatively 100,000 g/mol or more;
 - b) an Mn of 25,000 g/mol or more, alternatively 50,000 g/mol or more;
 - c) an Mw/Mn of 1.5 to 15, alternatively 2.0 to 10;
 - d) a melt flow rate of 1500g/10 minutes or less, alternatively 800 g/10 minutes or less;
 - e) a Brookfield viscosity of 500 mPa.sec or more, alternatively 1,000 mPa.sec or more;

- f) a T_m of 155°C or less, alternatively 140°C or less;
- g) a T_c of 120°C or less, alternatively 100°C or less;
- h) a heat of fusion of 100 J/g or less, alternatively 80 J/g or less;
- i) an r_1r_2 of the copolymer in range of 0.8 to 3.0, alternatively from 0.9 to 2.6;
- 5 j) an r_1r_2 is greater than $1.12-(0.0157x)$ where x is the wt% of ethylene as measured by ^{13}C NMR.
- k) regio defects of from 0.01 to 1.2 mol%, alternatively from 0.05 to 1.0 mol%; and
- l) an mm triad tacticity of 75% or greater, alternatively 80% or greater mm triad tacticity; and
- 10 m) an EEE triad sequence distribution greater than $(3 \times 10^{-5})x^2 + 0.0005x - 0.0039$ where x is the wt% of ethylene as measured by ^{13}C NMR

52. A copolymer comprising 5 to 26 mol% ethylene and 95 to 74 mol% propylene, wherein the copolymer has:

- 15 i) an r_1r_2 of the copolymer in range of 0.9 to 3.0, alternatively from 0.92 to 2.6;
- ii) regio defects of from 0.01 to 1.2 mol%, alternatively from 0.05 to 1.0 mol%; and
- iii) an mm triad tacticity of 75% or greater, alternatively 80% or greater mm triad tacticity.

53. A copolymer comprising 5 to 26 mol% ethylene and 95 to 74 mol% propylene, wherein
20 the copolymer has:

- i) an r_1r_2 is greater than $1.12-(0.0157x)$ where x is the wt% of ethylene as measured by ^{13}C NMR;
- ii) regio defects of from 0.01 to 1.2 mol%, alternatively from 0.05 to 1.0 mol%; and
- iii) an mm triad tacticity of 75% or greater, alternatively 80% or greater mm triad
25 tacticity.

54. The process of any of claims 1 to 50 wherein the process occurs at a temperature of from about 140°C to about 65°C and the catalyst activity is 100,000 kg polymer per kg of catalyst or more.

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