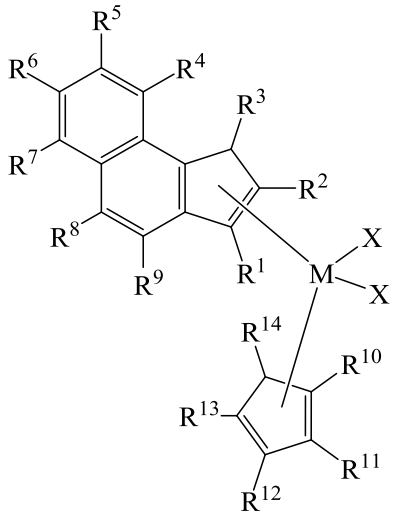
CLAIMS:

1. A catalyst system comprising activator, support, and catalyst compound represented by Formula (I):



(I)

where M is a group 4 metal,

each of R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9, R^{10}, R^{11}, R^{12}, R^{13}, and R^{14} is independently hydrogen, or a linear or branched C_1-C_{50} substituted or unsubstituted hydrocarbyl, halocarbyl or silylcarbyl, wherein at least one of R^1 and R^3 is not hydrogen, and

each X is independently a halide or C_1-C_{50} substituted or unsubstituted hydrocarbyl, hydride, amide, alkoxide, sulfide, phosphide, halide, diene, amine, phosphine, ether, or a combination thereof, or two Xs are joined together to form a metallocycle ring, or two Xs are joined to form a chelating ligand, a diene ligand, or an alkylidene.

2. The catalyst system of claim 1, wherein R^1 is linear or branched C_1-C_{10} substituted or unsubstituted hydrocarbyl.

3. The catalyst system of claim 1 or 2, wherein R^3 is linear or branched C_1-C_{10} substituted or unsubstituted hydrocarbyl.

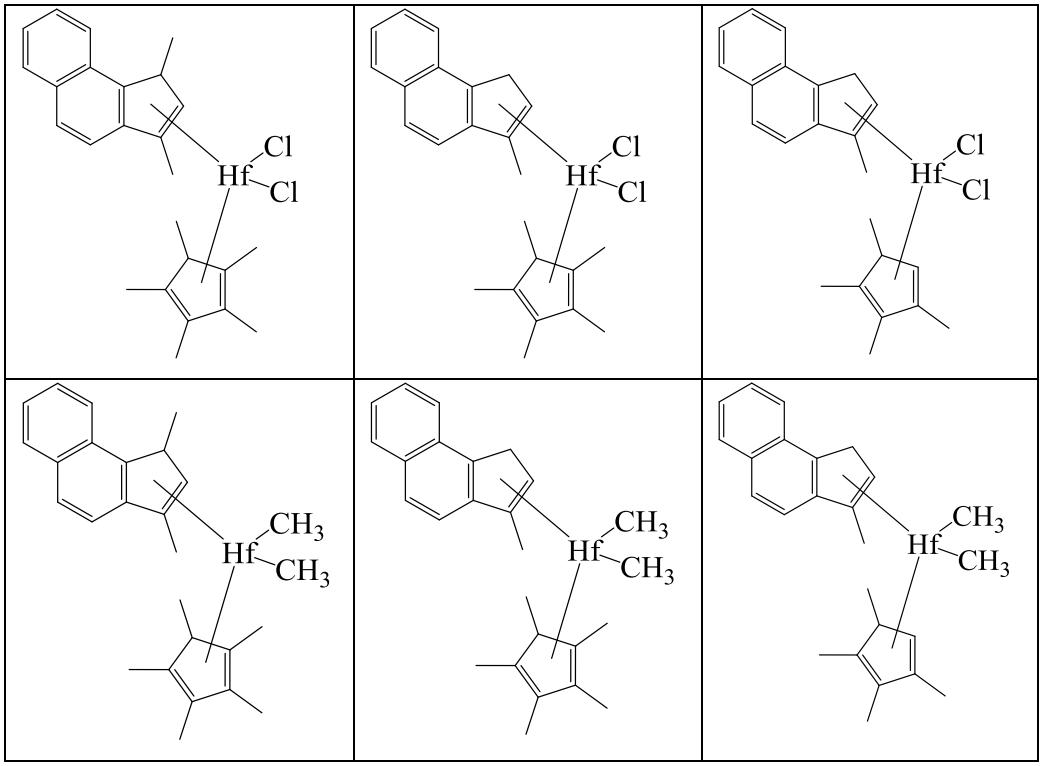
4. The catalyst system of claim 1, wherein each of R^1 and R^3 is independently linear or branched C_1-C_5 unsubstituted hydrocarbyl.

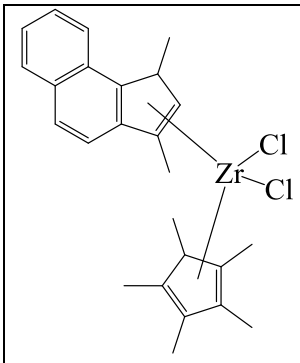
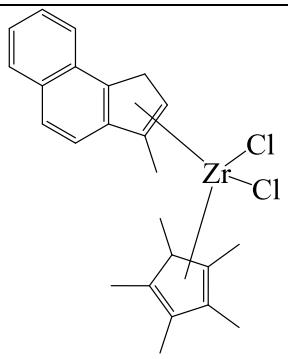
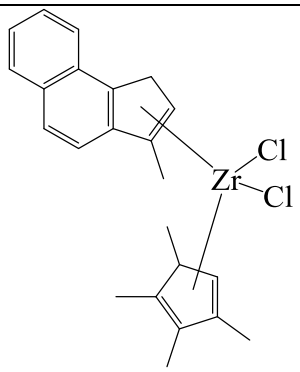
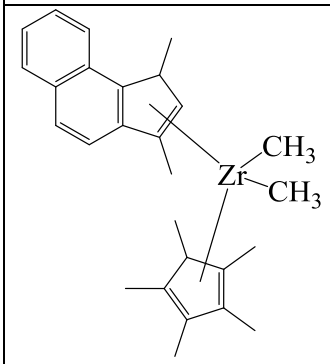
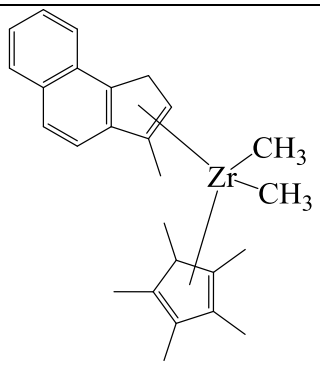
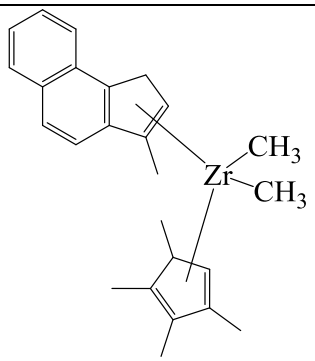
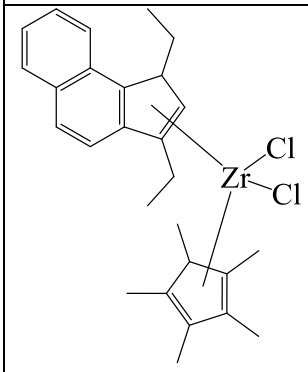
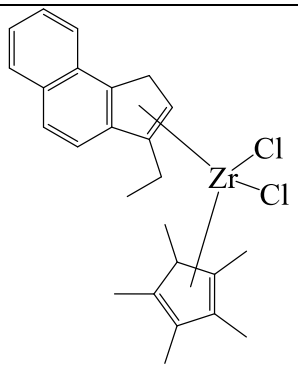
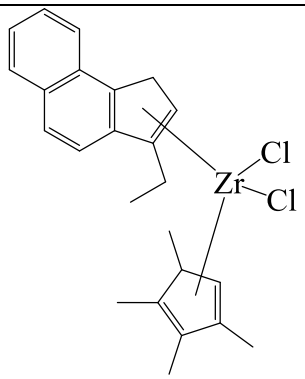
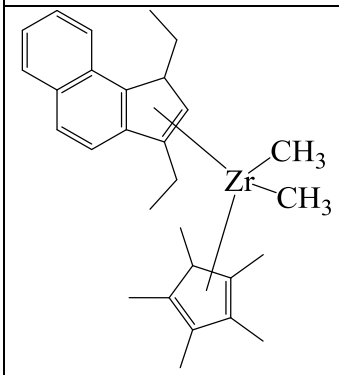
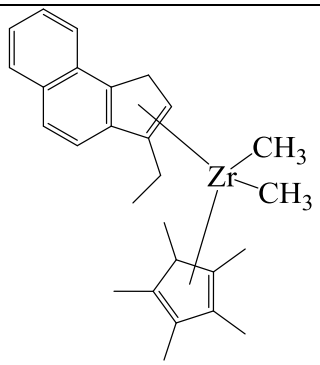
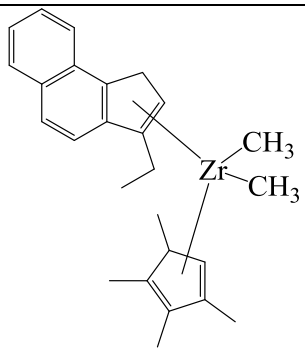
5. The catalyst system of any of claims 1 to 4, wherein each X is independently a halide or C_1-C_{10} substituted or unsubstituted hydrocarbyl.

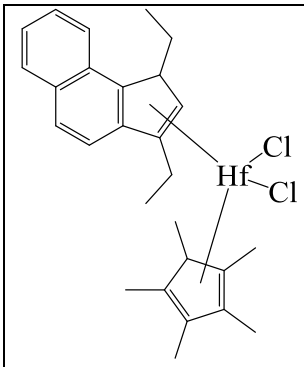
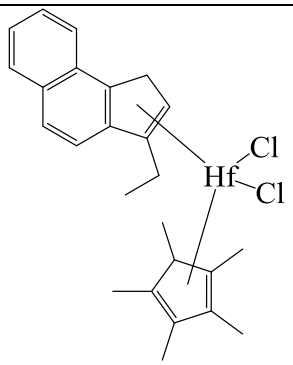
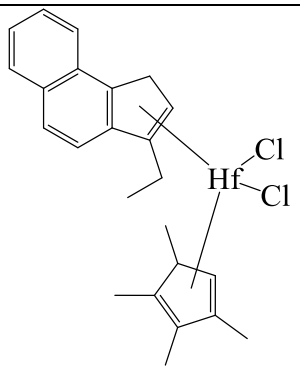
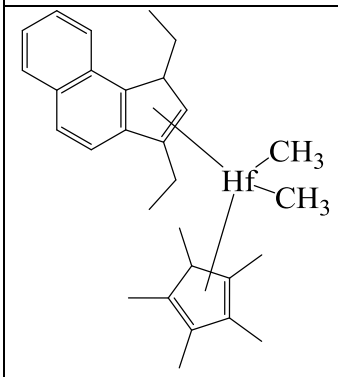
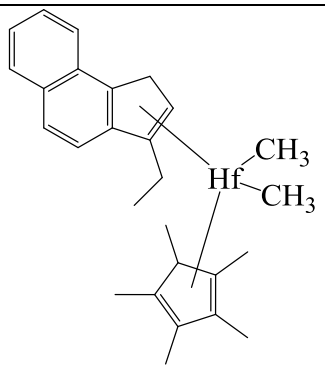
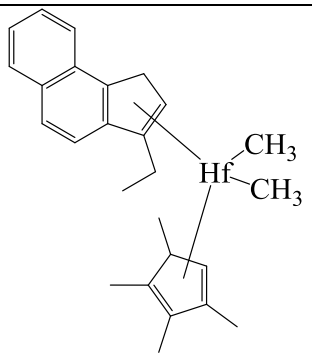
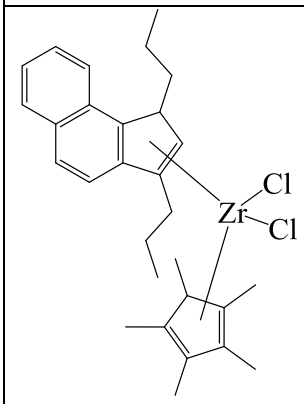
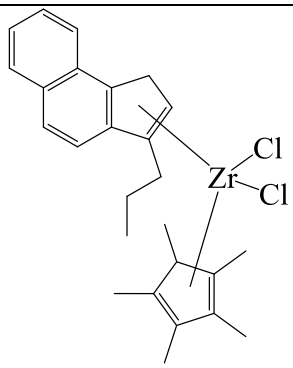
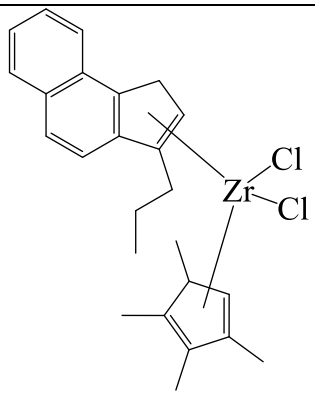
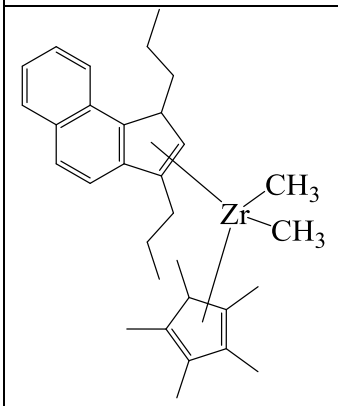
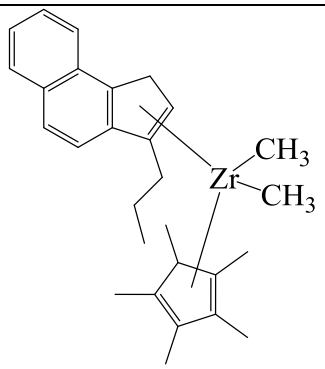
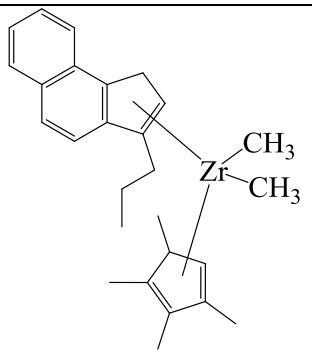
6. The catalyst system of any of claims 1 to 5, wherein R^{10} is hydrogen or C_1-C_{10} substituted or unsubstituted hydrocarbyl, and wherein each of R^{11}, R^{12}, R^{13}, and R^{14} is independently C_1-C_{10} substituted or unsubstituted hydrocarbyl.

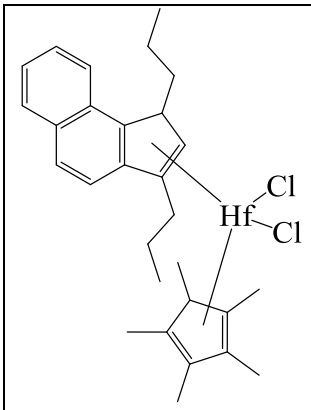
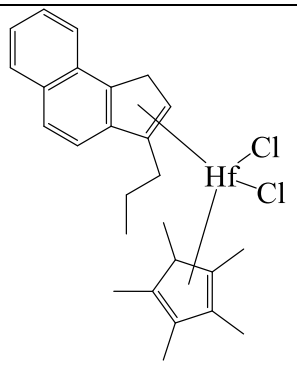
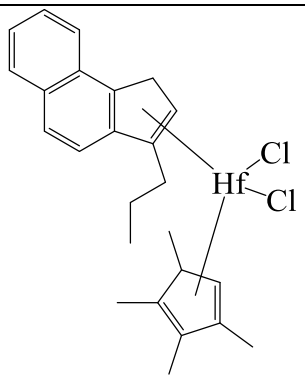
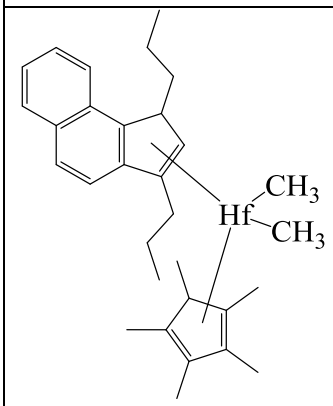
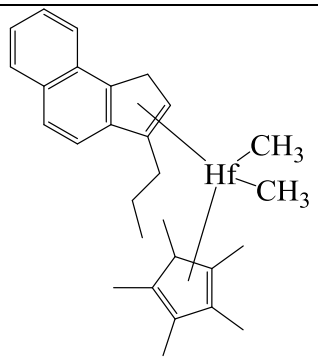
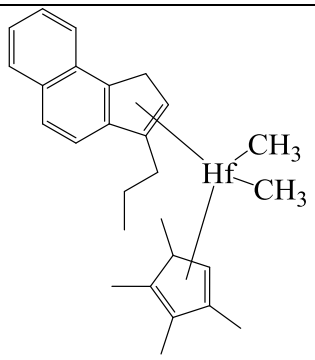
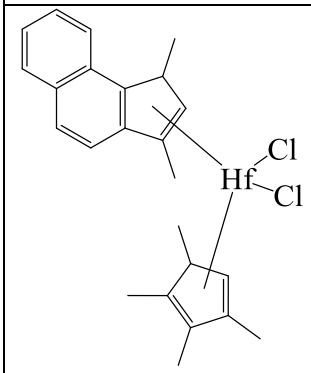
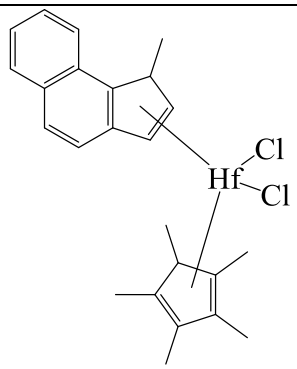
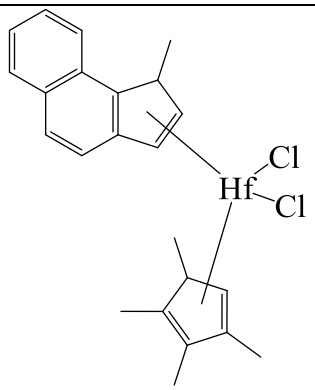
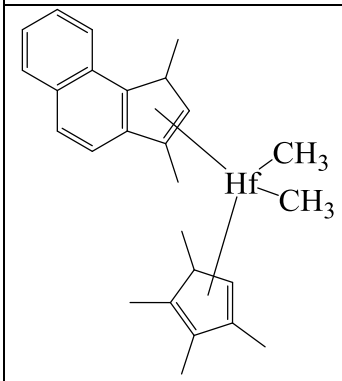
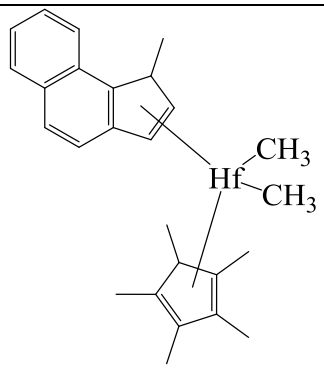
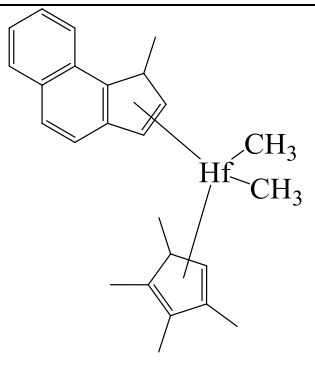
7. The catalyst system of claim 1, wherein each of R^1 and R^3 is independently linear or branched C_1-C_5 unsubstituted hydrocarbyl; wherein each X is independently a halide or C_1-C_{10} substituted or unsubstituted hydrocarbyl; wherein R^{10} is hydrogen or C_1-C_{10} substituted or unsubstituted hydrocarbyl; and wherein each of R^{11}, R^{12}, R^{13}, and R^{14} is independently C_1-C_{10} substituted or unsubstituted hydrocarbyl.

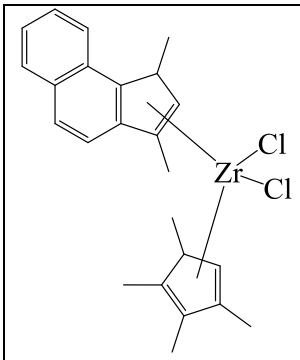
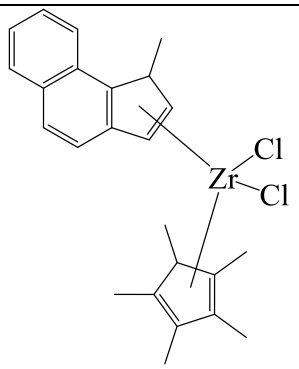
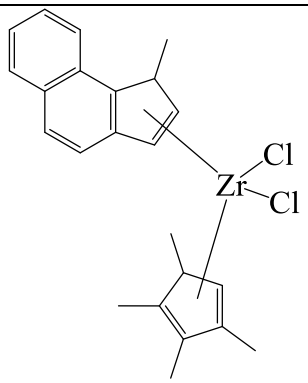
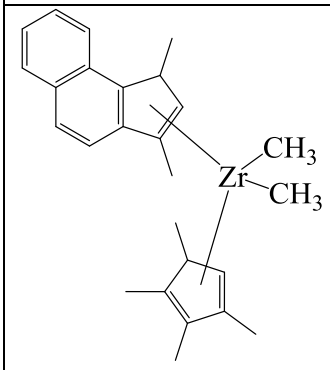
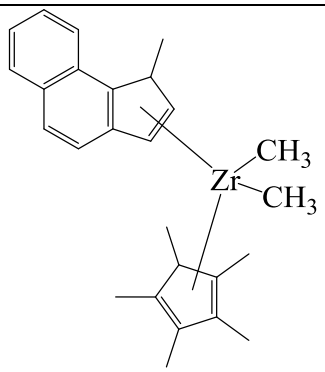
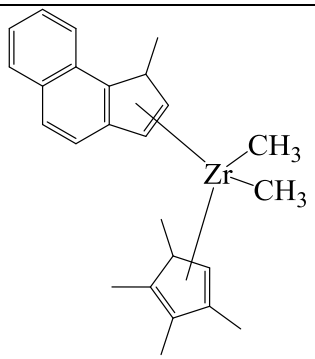
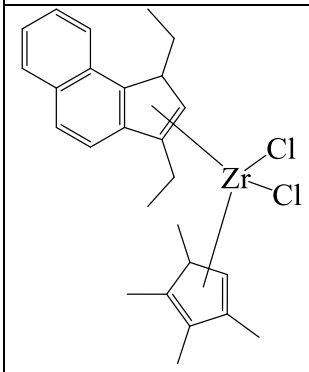
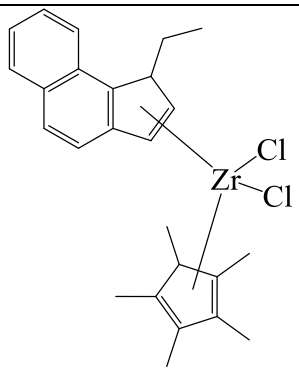
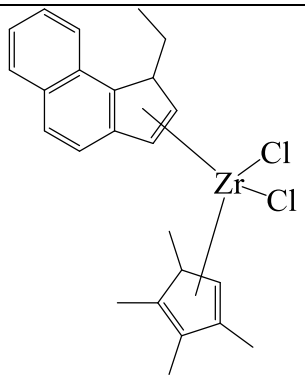
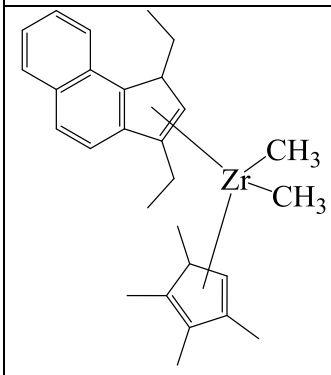
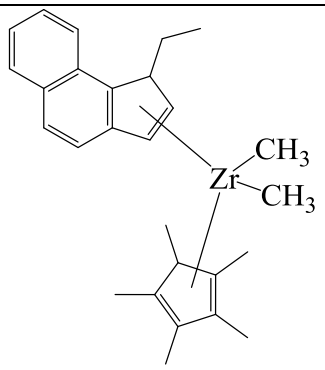
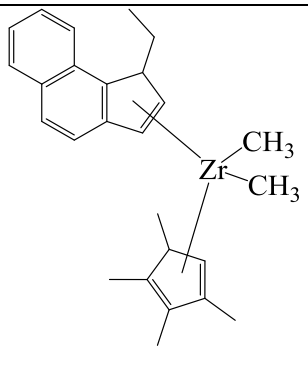
8. The catalyst system of claim 1, wherein the catalyst compound represented by Formula (I) comprises one or more of:

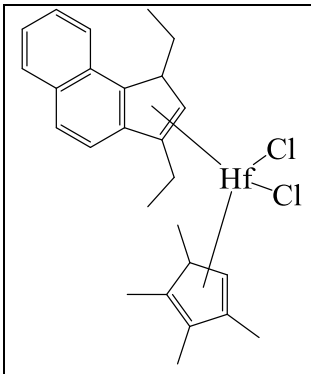
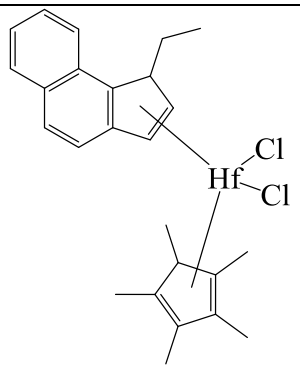
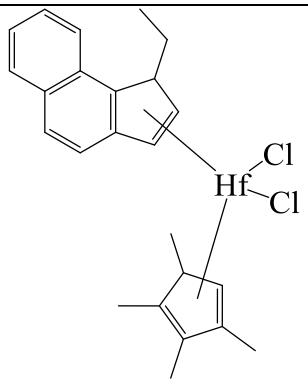
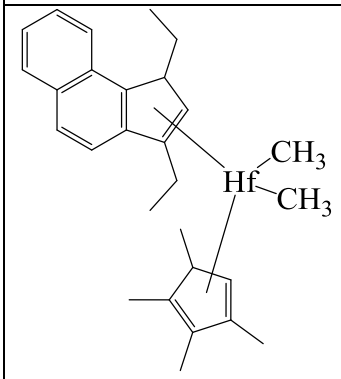
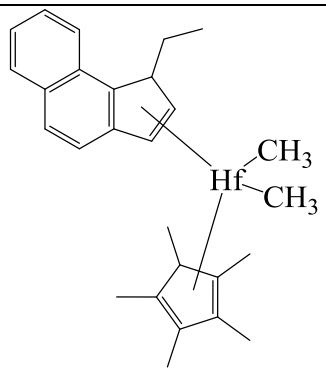
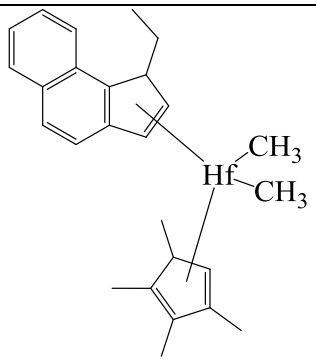
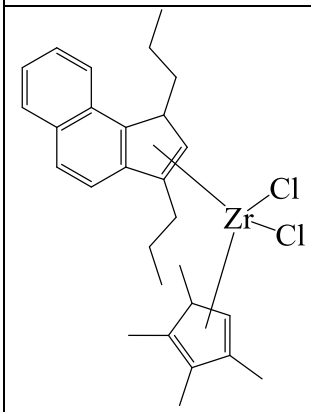
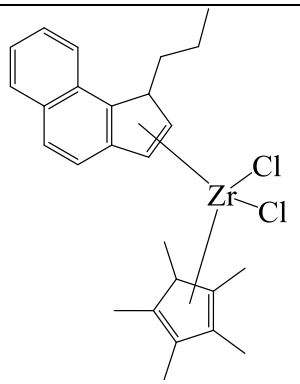
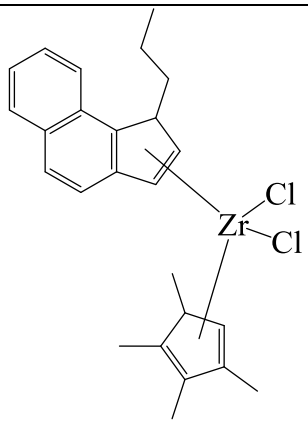
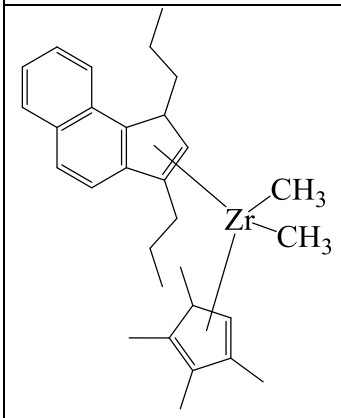
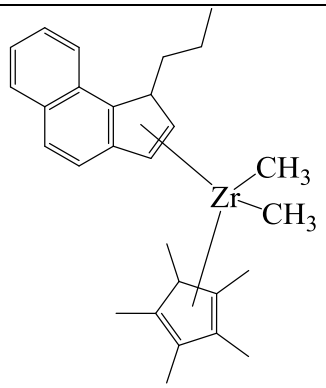
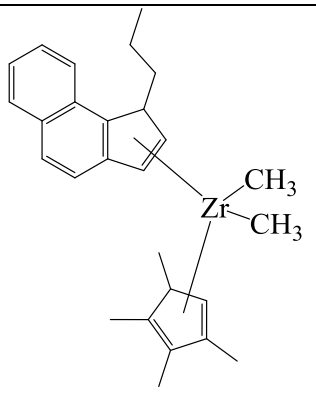


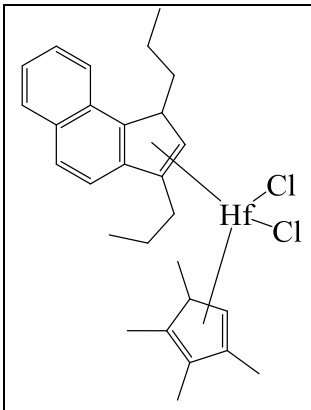
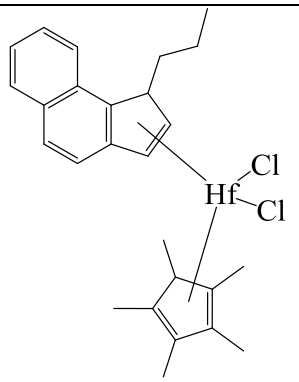
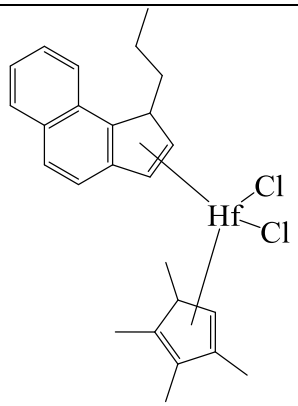
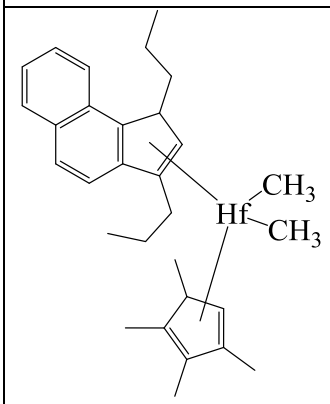
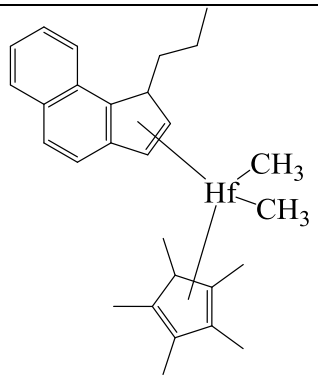
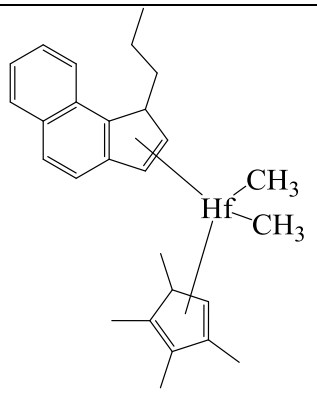
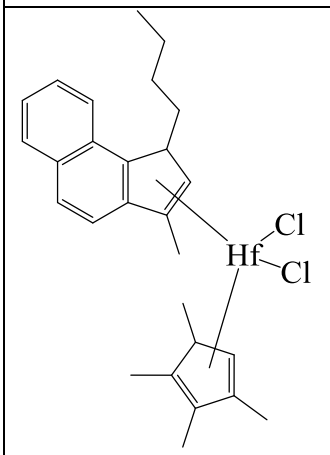
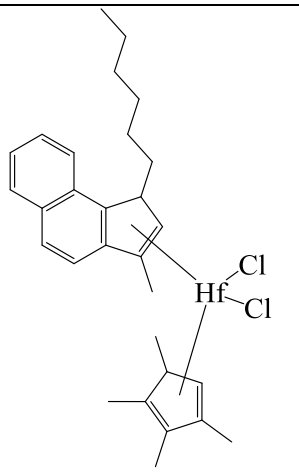
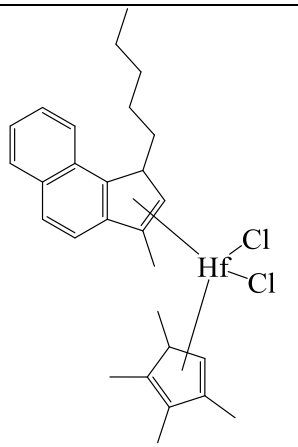
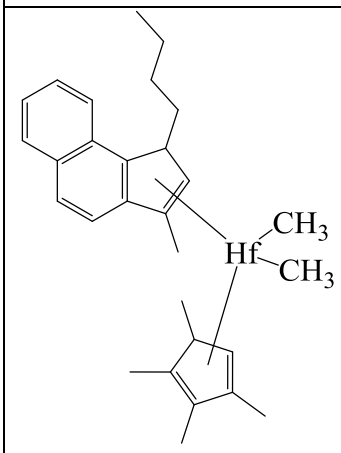
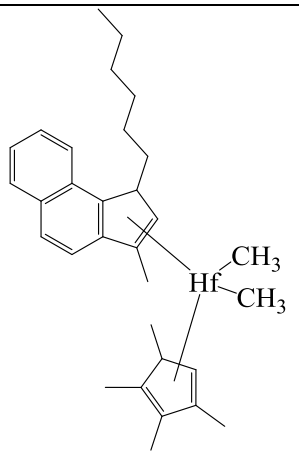
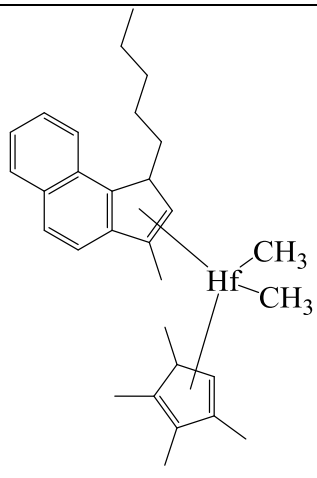
		
		
		
		

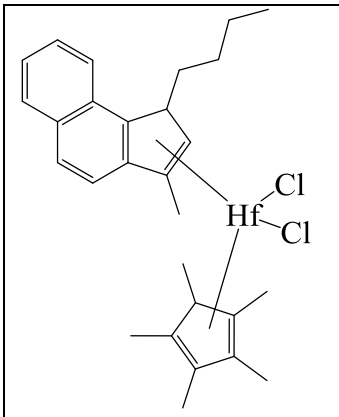
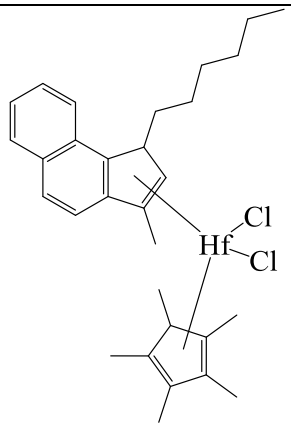
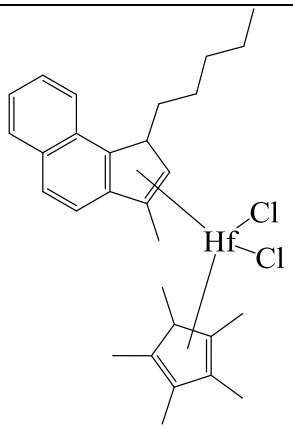
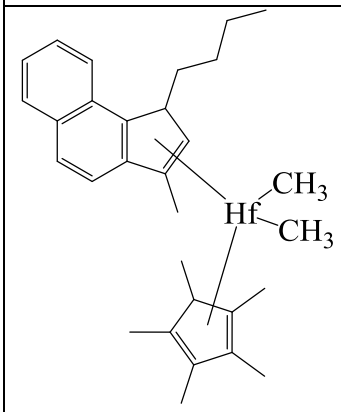
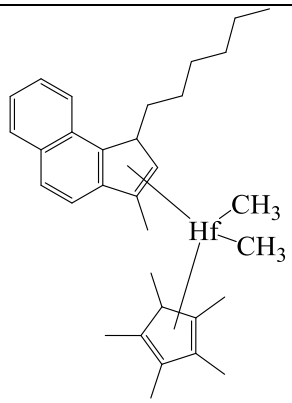
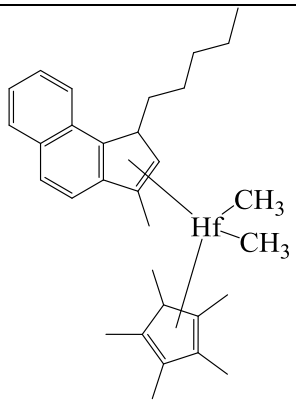
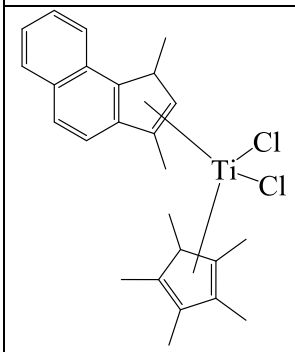
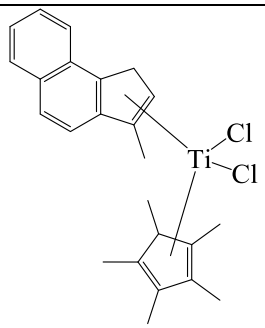
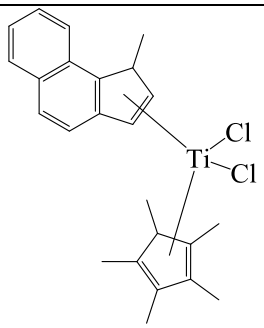
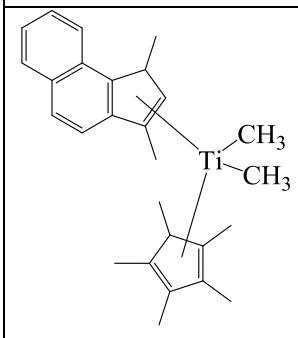
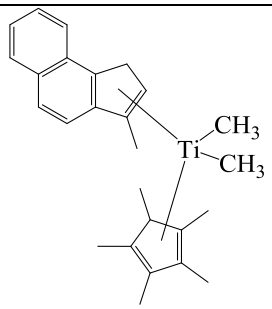
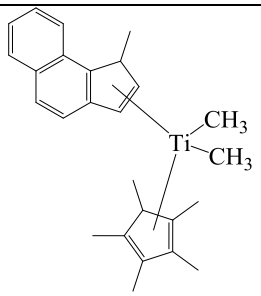
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Cl Zr Cl	Cl Zr Cl	Cl Zr Cl
CH3 Zr CH3	CH3 Zr CH3	CH3 Zr CH3

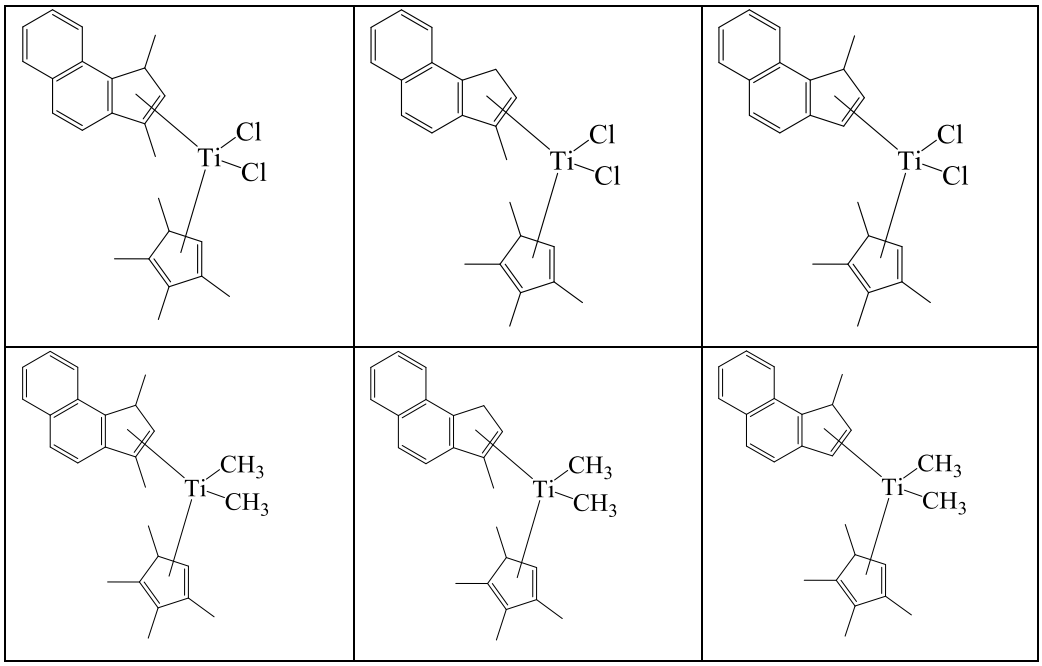
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Cl Zr Cl	Cl Zr Cl	Cl Zr Cl
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Cl Hf Cl	Cl Hf Cl	Cl Hf Cl
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Cl Ti Cl	Cl Ti Cl	Cl Ti Cl
CH3 Ti CH3	CH3 Ti CH3	CH3 Ti CH3



9. The catalyst system of any of claims 1 to 8 further comprising a bridged or unbridged metallocene catalyst compound other than a catalyst compound represented by the Formula (I) represented by the formula:

$Cp^ACp^BM'X'_n$, or $Cp^A(A)Cp^BM'X'_n$,

wherein each Cp^A and Cp^B is independently selected from the group consisting of cyclopentadienyl ligands, one or both Cp^A and Cp^B may contain heteroatoms, and one or both Cp^A and Cp^B may be substituted by one or more R'' groups, wherein M' is selected from the group consisting of Groups 3 through 12 atoms and lanthanide Group atoms, wherein X' is an anionic leaving group, wherein n is 0 or an integer from 1 to 4, wherein R'' is selected from the group consisting of alkyl, lower alkyl, substituted alkyl, heteroalkyl, alkenyl, lower alkenyl, substituted alkenyl, heteroalkenyl, alkynyl, lower alkynyl, substituted alkynyl, heteroalkynyl, alkoxy, lower alkoxy, aryloxy, alkylthio, lower alkyl thio, arylthio, aryl, substituted aryl, heteroaryl, aralkyl, aralkylene, alkaryl, alkarylene, haloalkyl, haloalkenyl, haloalkynyl, heteroalkyl, heterocycle, heteroaryl, a heteroatom-containing group, hydrocarbyl, lower hydrocarbyl, substituted hydrocarbyl, heterohydrocarbyl, silyl, boryl, phosphino, phosphine, amino, amine, ether, and thioether; wherein (A) is selected from the group consisting of divalent alkyl, divalent lower alkyl, divalent substituted alkyl, divalent heteroalkyl, divalent alkenyl, divalent lower alkenyl, divalent substituted alkenyl, divalent heteroalkenyl, divalent alkynyl, divalent lower alkynyl, divalent substituted

alkynyl, divalent heteroalkynyl, divalent alkoxy, divalent lower alkoxy, divalent aryloxy, divalent alkylthio, divalent lower alkyl thio, divalent arylthio, divalent aryl, divalent substituted aryl, divalent heteroaryl, divalent aralkyl, divalent aralkylene, divalent alkaryl, divalent alkarylene, divalent haloalkyl, divalent haloalkenyl, divalent haloalkynyl, divalent heteroalkyl, divalent heterocycle, divalent heteroaryl, a divalent heteroatom-containing group, divalent hydrocarbyl, divalent lower hydrocarbyl, divalent substituted hydrocarbyl, divalent heterohydrocarbyl, divalent silyl, divalent boryl, divalent phosphino, divalent phosphine, divalent amino, divalent amine, divalent ether, and divalent thioether.

10. The catalyst system of any of claims 1 to 8 further comprising one or more of:
bis(n-propylcyclopentadienyl)hafnium dichloride,
bis(n-propylcyclopentadienyl)hafnium dimethyl,
bis(n-propylcyclopentadienyl)zirconium dichloride,
bis(n-propylcyclopentadienyl)zirconium dimethyl,
bis(n-propylcyclopentadienyl)titanium dichloride,
bis(n-propylcyclopentadienyl)titanium dimethyl,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)zirconium dichloride,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)zirconium dimethyl,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)hafnium dichloride,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)hafnium dimethyl,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)titanium dichloride,
(n-propylcyclopentadienyl, pentamethylcyclopentadienyl)titanium dimethyl,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)zirconium dichloride,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)zirconium dimethyl,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)hafnium dichloride,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)hafnium dimethyl,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)titanium dichloride,
(n-propylcyclopentadienyl, tetramethylcyclopentadienyl)titanium dimethyl,
bis(cyclopentadienyl)zirconium dichloride,
bis(cyclopentadienyl)titanium dichloride,
bis(cyclopentadienyl)hafnium dichloride,
bis(cyclopentadienyl)zirconium dimethyl,

bis(cyclopentadienyl)titanium dimethyl,
bis(cyclopentadienyl)hafnium dimethyl,
bis(n-butylcyclopentadienyl)hafnium dichloride,
bis(n-butylcyclopentadienyl)hafnium dimethyl,
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bis(1-methyl-3-n-butylcyclopentadienyl)hafnium dimethyl,
bis(1-methyl-3-n-butylcyclopentadienyl)zirconium dichloride,
bis(1-methyl-3-n-butylcyclopentadienyl)zirconium dimethyl,
bis(1-methyl-3-n-butylcyclopentadienyl)titanium dichloride, and
bis(1-methyl-3-n-butylcyclopentadienyl)titanium dimethyl.

11. The catalyst system of any of claims 1 to 8 further comprising bis(n-propylcyclopentadienyl)hafnium dimethyl.

12. The catalyst system of claim 9, wherein each of Cp^A and Cp^B is independently selected from the group consisting of: cyclopentadienyl, n-propylcyclopentadienyl, pentamethylcyclopentadienyl, tetramethylcyclopentadienyl, and n-butylcyclopentadienyl.

13. The catalyst system of claim 1, wherein the support comprises silica.

14. The catalyst system of any of claims 1 to 13 where the support material is slurried in a non-polar solvent and the resulting slurry is first contacted with the

activator for a period of time between about 0.5 hours and about 24 hours, then is contacted with a solution of at least one catalyst compound.

15. The catalyst system of any of claims 1 to 14, wherein the activator comprises one or more of:
N,N-dimethylanilinium tetra(perfluorophenyl)borate,
N,N-dimethylanilinium tetrakis(perfluoronaphthyl)borate,
N,N-dimethylanilinium tetrakis(perfluorobiphenyl)borate,
N,N-dimethylanilinium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triphenylcarbenium tetrakis(perfluoronaphthyl)borate,
triphenylcarbenium tetrakis(perfluorobiphenyl)borate,
triphenylcarbenium tetrakis(3,5-bis(trifluoromethyl)phenyl)borate,
triphenylcarbenium tetra(perfluorophenyl)borate,
trimethylammonium tetrakis(perfluoronaphthyl)borate,
triethylammonium tetrakis(perfluoronaphthyl)borate,
tripropylammonium tetrakis(perfluoronaphthyl)borate,
tri(n-butyl)ammonium tetrakis(perfluoronaphthyl)borate,
tri(t-butyl)ammonium tetrakis(perfluoronaphthyl)borate,
N,N-diethylanilinium tetrakis(perfluoronaphthyl)borate,
N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(perfluoronaphthyl)borate, and
tropillium tetrakis(perfluoronaphthyl)borate.

16. The catalyst system of any of claims 1 to 15, wherein the activator comprises an alumoxane.

17. The catalyst system of any of claims 1 to 12, 14, 15, or 16, wherein the support material is selected from the group consisting of Al_2O_3, ZrO_2, SiO_2, or SiO_2/Al_2O_2.

18. The catalyst system of any of claims 1 to 17, wherein the support material is fluorided.

19. A process for producing a polyolefin composition comprising contacting at least one olefin with the catalyst system of any of claims 1 to 18 and obtaining a polyolefin.

20. The process of claim 19, wherein the polyolefin composition is a multi-modal polyolefin composition comprising a low molecular weight fraction, wherein the low molecular weight fraction is produced by the catalyst compound represented by Formula (I).

21. The process of claim 19 or 20, wherein the activator comprises alumoxane, non-coordinating anion or a mixture thereof.

22. The process of any of claims 19 to 21, 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 time up to about 300 minutes.

24. The process of any of claims 19 to 22, wherein the at least one olefin comprises ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, undecene, dodecene, or mixtures thereof.

25. The process of any of claims 19 to 24, wherein the process is a gas phase process or a slurry phase process.

26. A process for producing a polyolefin composition comprising contacting at least one olefin comprising ethylene, propylene, butene, pentene, hexene, heptene, octene, nonene, decene, undecene, dodecene, or mixtures thereof, with the catalyst system of claim 1, where the support material is slurried in a non-polar solvent and the resulting slurry is first contacted with the activator for a period of time between about 0.5 hours and about 24 hours, then is contacted with a solution of at least one catalyst compound.