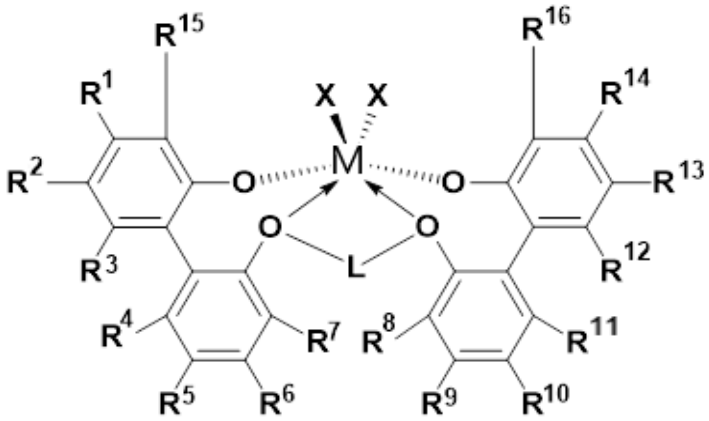
What is claimed is:

1. A use of a supported biphenylphenol polymerization catalyst to make a bimodal polyethylene composition via a gas-phase polymerization process or make a unimodal polyethylene composition via slurry-phase polymerization process, wherein the supported biphenylphenol polymerization catalyst is made from a biphenylphenol polymerization precatalyst of Formula I:



(Formula I)

wherein each of R^7 and R^8 independently is a C_1 alkyl, halogen, or a hydrogen;

wherein each of R^5 and R^{10} independently is a C_1 to C_{20} alkyl, aryl, aralkyl, halogen, or a hydrogen;

wherein each of R^4 and R^{11} independently is a halogen or a hydrogen;

wherein each of R^2 and R^{13} independently is a C_1 to C_{20} alkyl, aryl or aralkyl or a hydrogen;

wherein each of R^{15} and R^{16} independently is a 2,7-disubstituted carbazol-9-yl or a 3,6-disubstituted carbazol-9-yl;

wherein L is a C_3 or C_4 alkylene that forms a 3-carbon bridge or 4-carbon bridge, respectively, between the two oxygen atoms to which L is covalently bonded;

wherein each of R^1, R^3, R^{12}, and R^{14} is a hydrogen;

wherein each of R^6 and R^9 is a hydrogen or C_1-C_8 alkyl; optionally, R^6 can be linked with R^7 and R^8 can be linked to R^9 to form a cyclic structure;

wherein each X independently is a halogen, a hydrogen, a (C_1-C_{20})alkyl, a (C_7-C_{20})aralkyl, a (C_1-C_6)alkyl-substituted (C_6-C_{12})aryl, or a (C_1-C_6)alkyl-substituted benzyl, $-CH_2Si(R^C)_3$, where R^C is C_1-C_{12} hydrocarbon; and

wherein M is Zr or Hf.

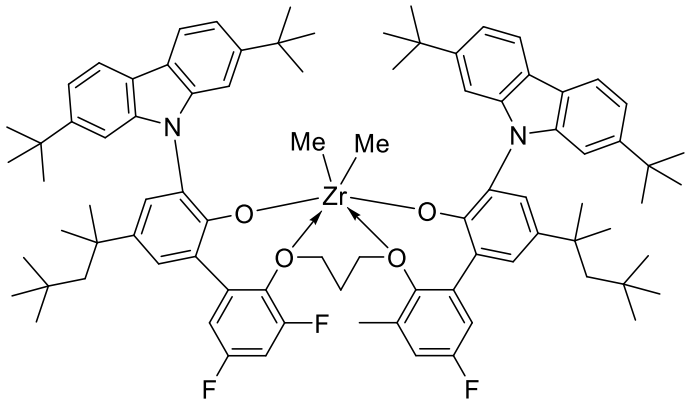
2. The use of claim 1, wherein:

R^7 and R^8 are a C_1 alkyl, fluorine, or hydrogen; and

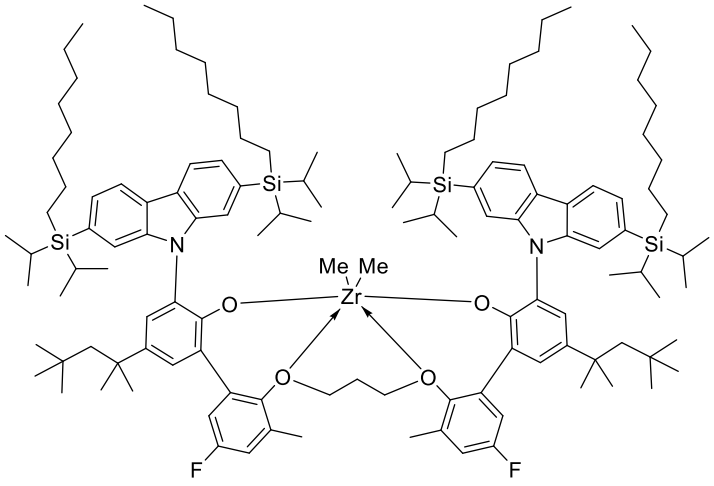
at least two of R^5, R^6, R^9 and R^{10} are fluorine.

3. The use of claim 1 or 2, wherein each of R^{15} and R^{16} is 2,7-disubstituted carbazol-9-yl selected from a group consisting of a 2,7-di-t-butylcarbazol-9-yl, a 2,7-di-ethylcarbazol-9-yl, a 2,7-di-methylcarbazol-9-yl.

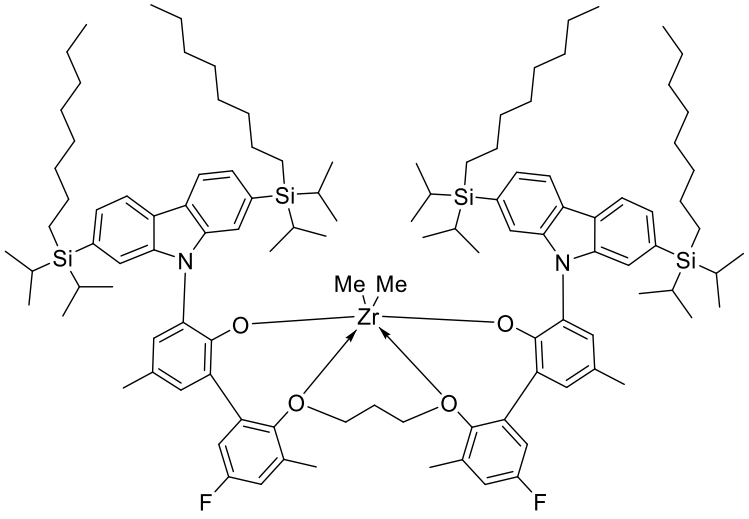
4. The use of claim 3, wherein the biphenylphenol polymerization precatalyst of Formula I is selected from a group consisting of the structures (i), (ii), (iii), and (viii).



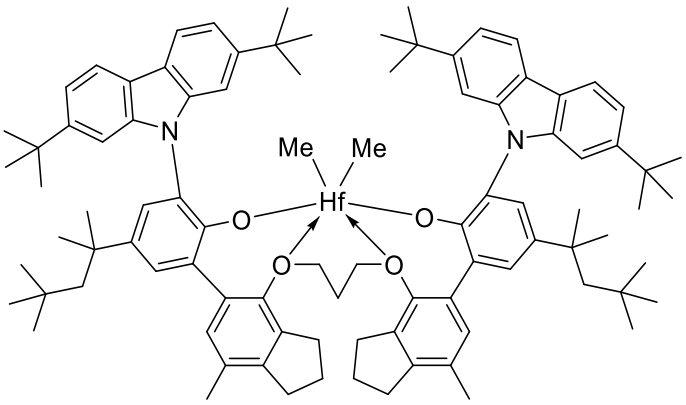
(i)



(ii)



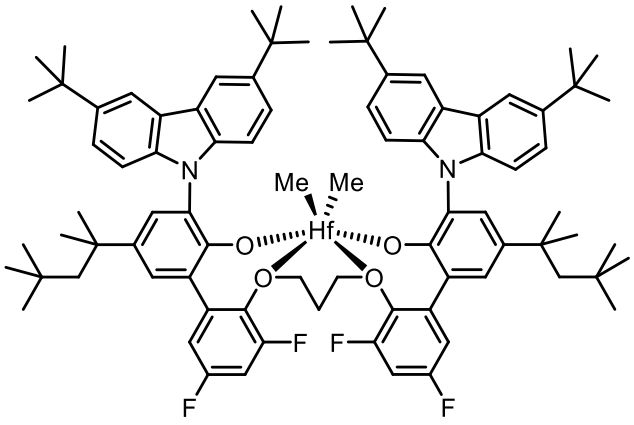
(iii)



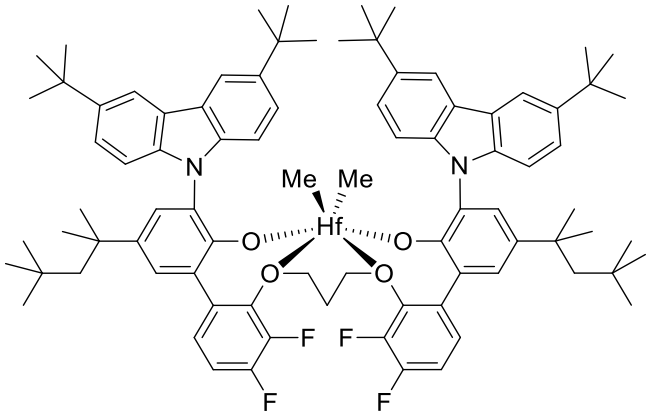
(viii).

5. The use of claim 1 or 2, wherein each of R^{15} and R^{16} is a 3,6-di-t-butylcarbazol-9-yl.

6. The use of claim 5, wherein the biphenylphenol polymerization precatalyst of Formula I is selected from a group consisting of the structures (iv) and (v).



(iv)



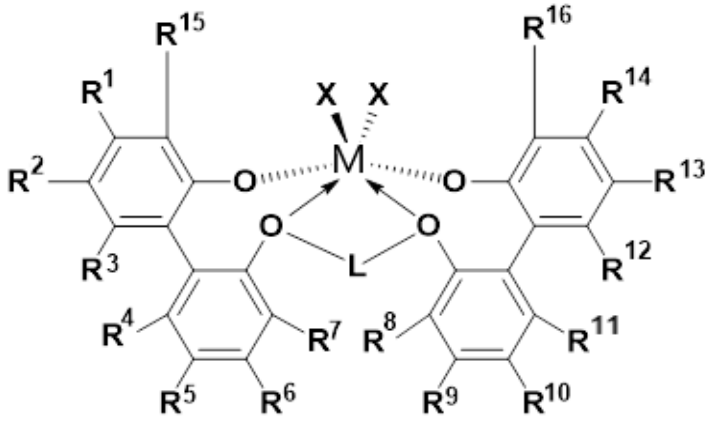
(v).

7. The use of claim 1, wherein each X is C_1 alkyl.

8. A method of making a supported biphenylphenol polymerization catalyst, the method comprising:

disposing ~~the~~ a biphenylphenol polymerization precatalyst of Formula I on a support to give a supported biphenylphenol polymerization precatalyst; and

contacting, under activating conditions, the supported biphenylphenol polymerization precatalyst of Formula I with an activator so as to activate the supported biphenylphenol polymerization precatalyst of Formula I, thereby making the supported biphenylphenol polymerization catalyst,



(Formula I)

wherein each of R^7 and R^8 independently is a C_1 alkyl, halogen, or a hydrogen;

wherein each of R^5 and R^{10} independently is a C_1 to C_{20} alkyl, aryl, aralkyl, halogen, or a hydrogen;

wherein each of R^4 and R^{11} independently is a halogen or a hydrogen;

wherein each of R^2 and R^{13} independently is a C_1 to C_{20} alkyl, aryl or aralkyl or a hydrogen;

wherein each of R^{15} and R^{16} independently is a 2,7-disubstituted carbazol-9-yl or a 3,6-disubstituted carbazol-9-yl;

wherein L is a C_3 or C_4 alkylene that forms a 3-carbon bridge or 4-carbon bridge, respectively, between the two oxygen atoms to which L is covalently bonded;

wherein each of R^1, R^3, R^{12}, and R^{14} is a hydrogen;

wherein each of R^6 and R^9 is a hydrogen or C_1-C_8 alkyl; optionally, R^6 can be linked with R^7 and R^8 can be linked to R^9 to form a cyclic structure;

wherein each X independently is a halogen, a hydrogen, a (C_1-C_{20})alkyl, a (C_7-C_{20})aralkyl, a (C_1-C_6)alkyl-substituted (C_6-C_{12})aryl, or a (C_1-C_6)alkyl-substituted benzyl, $-CH_2Si(R^C)_3$, where R^C is C_1-C_{12} hydrocarbon; and

wherein M is Zr or Hf.

9. A method of making a bimodal polyethylene composition, the method comprising:

polymerizing ethylene in a single gas-phase polymerization reactor under gas-phase polymerization conditions in presence of the supported biphenylphenol polymerization catalyst made by the method of claim 8 to make the bimodal polyethylene composition without help from any other polymerization catalyst; wherein the bimodal polyethylene composition comprises a high molecular weight polyethylene component and a low molecular weight polyethylene component.

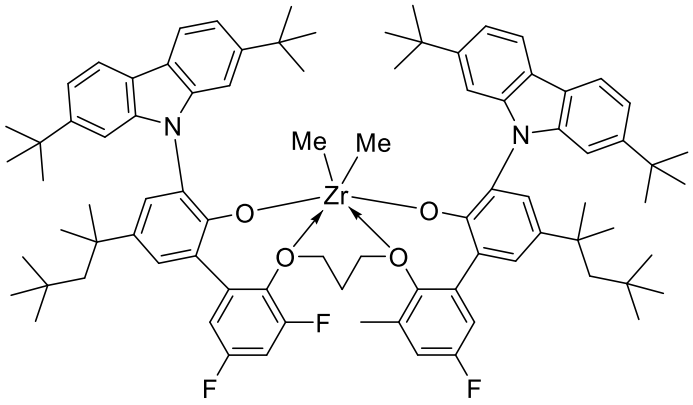
10. The method of claim 9 in which the bimodal polyethylene composition has a polydispersity index (PDI) in a range from 5 to 40 or 7 to 40.

11. A method of making a unimodal polyethylene composition, the method comprising:

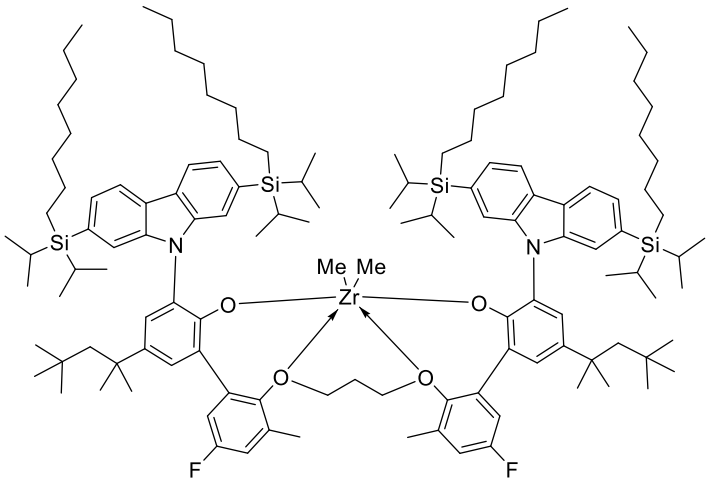
polymerizing ethylene in a single slurry-phase polymerization reactor under slurry-phase polymerization conditions in presence of the supported biphenylphenol polymerization catalyst made by the method of claim 8 to make the polyethylene composition without help from any other polymerization catalyst, wherein the unimodal polyethylene composition has a polydispersity index (PDI) in a range from 5 to 40 or 7 to 40.

12. The method of any one of claims 9 to 11 wherein the polymerizing step comprises the use of any one of claims 1 to 7.

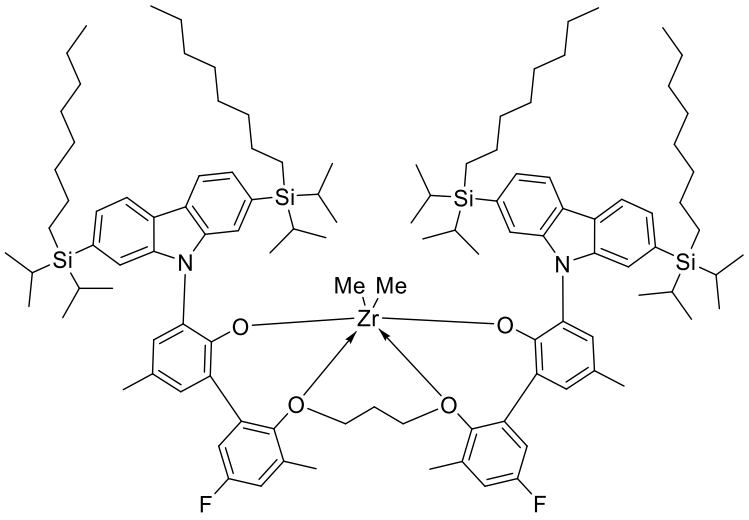
13. A biphenylphenol polymerization precatalyst selected from a group consisting of the structures (i), (ii), (iii), and (v):



(i);

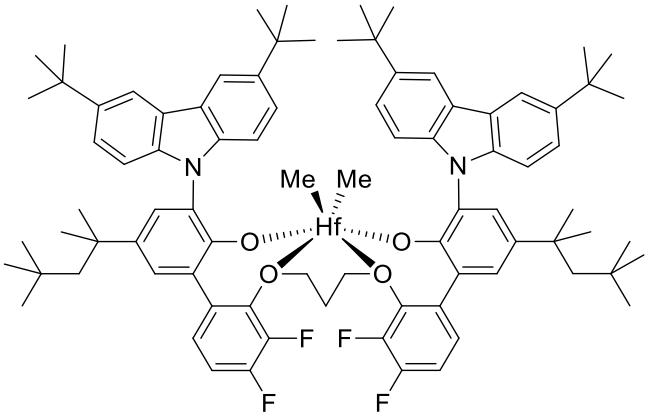


(ii);



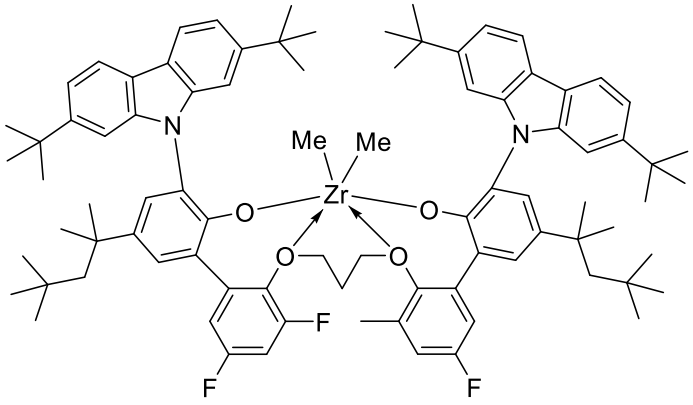
(iii);

and

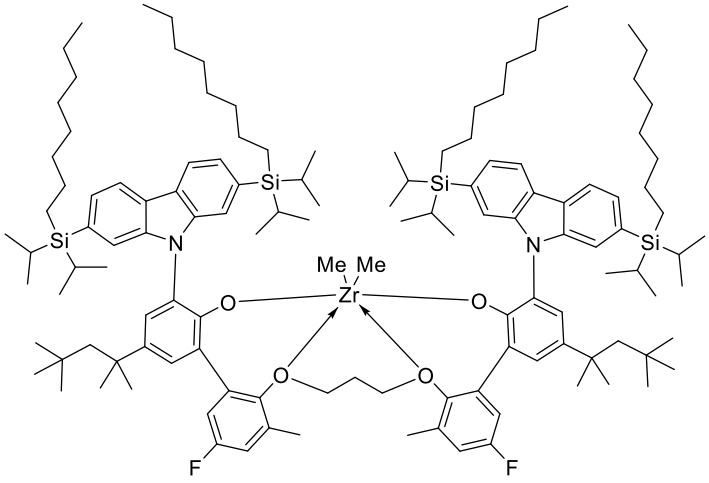


(v).

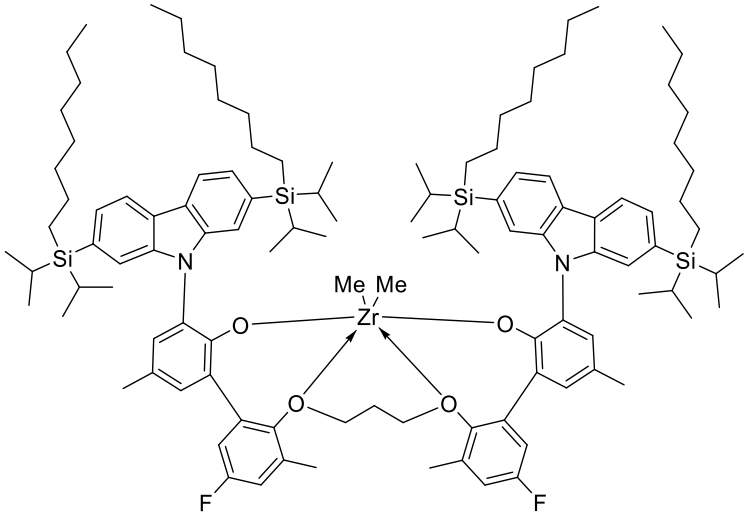
14. A supported biphenylphenol polymerization catalyst made by the method of claim 8, wherein the biphenylphenol polymerization precatalyst of Formula I is selected from the biphenylphenol polymerization precatalyst of any of structures (i), (ii), (iii), (viii) or (v).



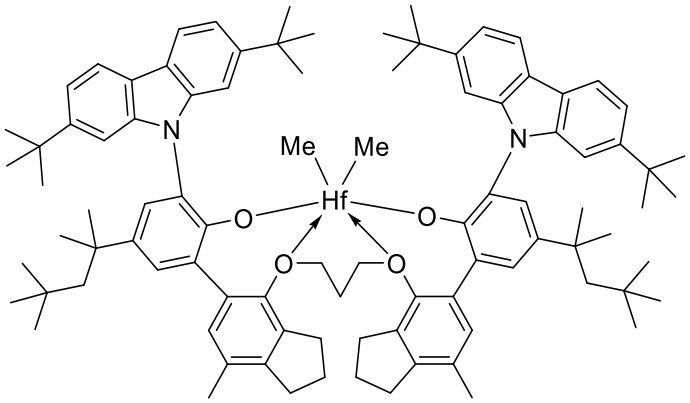
(i);



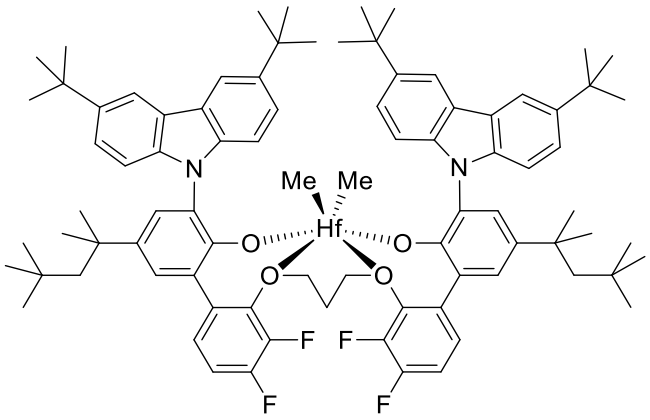
(ii);



(iii);



(viii); and



(v).