BIPHENYLPHENOL POLYMERIZATION CATALYSTS

Field of Disclosure

[0001] Embodiments of the present disclosure are directed towards biphenylphenol polymerization catalysts, more specifically, supported biphenylphenol polymerization catalysts that may be utilized to make a polymer via a polymerization process in a single gas-phase or slurry-phase polymerization reactor.

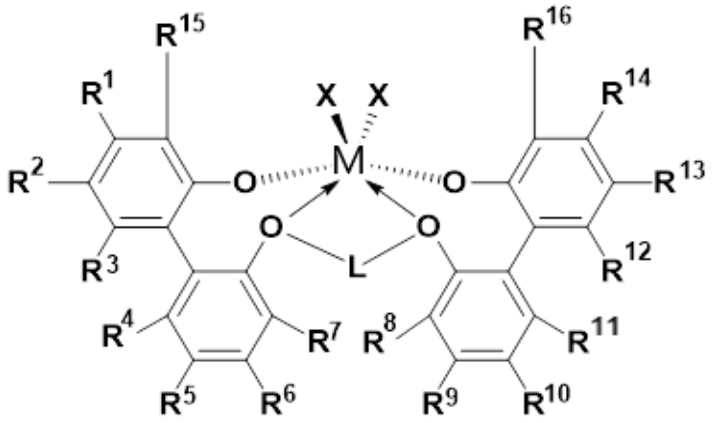
Background

[0002] Polymers may be utilized for a number of products including as films, fibers, nonwoven and/or woven fabrics, extruded articles, and/or molded articles, among others. Polymers can be made by reacting one or more types of monomer in a polymerization reaction in the presence of a polymerization catalyst.

Summary

[0003] The present disclosure provides the following, including:

[0004] A use of a supported biphenylphenol polymerization catalyst to make a polymer via a gas-phase polymerization process or 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.

[0005] A method of making a supported biphenylphenol polymerization catalyst, the method comprising: disposing the 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.

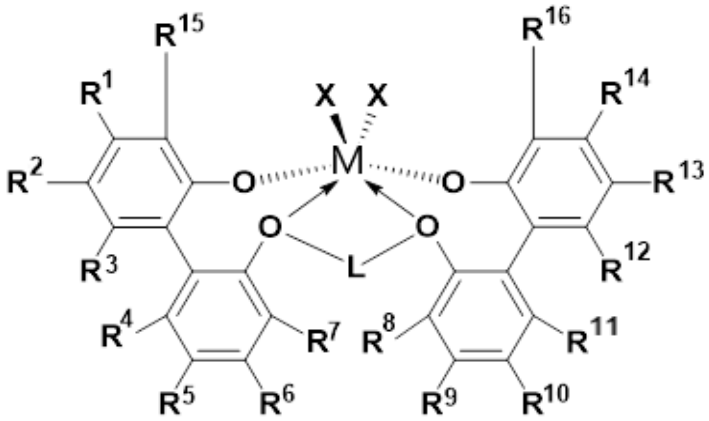
[0006] A method of making a polyethylene composition, the method comprising: polymerizing ethylene in a single gas-phase polymerization reactor under gas-phase polymerization conditions, respectively, in presence of the supported biphenylphenol polymerization catalyst to make the polyethylene composition without help from any other polymerization catalyst.

[0006a] In one aspect, there is provided 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 a supported biphenylphenol polymerization catalyst 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, further wherein the supported biphenylphenol polymerization catalyst is made according to the following method:

disposing 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

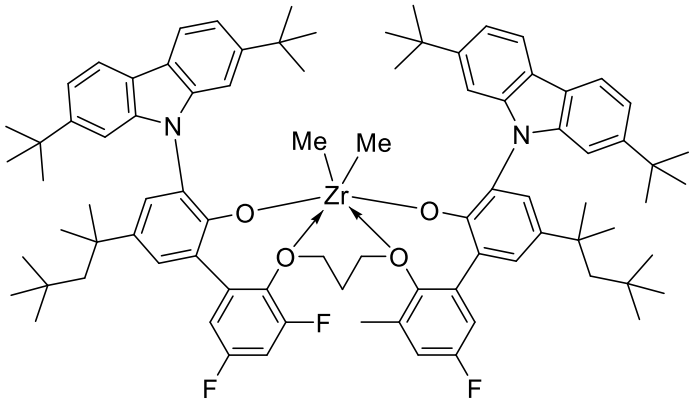
wherein M is Zr or Hf.

[0007] A method of making a polyethylene composition, the method comprising polymerizing ethylene in a single slurry-phase polymerization reactor under slurry-phase

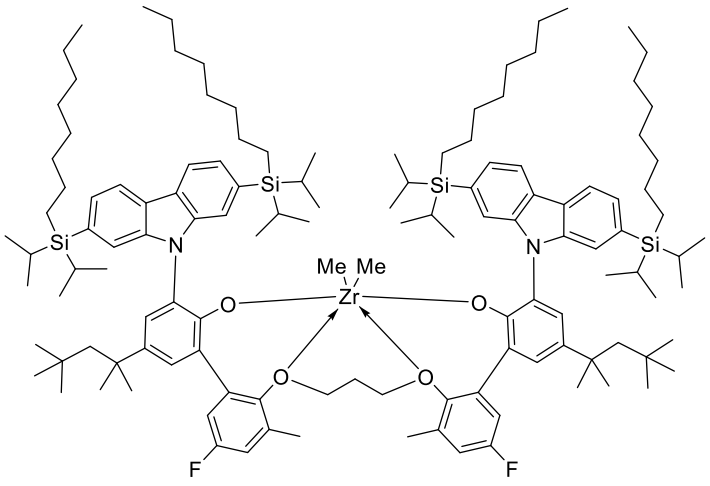
polymerization conditions in presence of the supported biphenylphenol polymerization catalyst to make the polyethylene composition without help from any other polymerization catalyst.

[0008] A biphenylphenol polymerization precatalyst selected from a group consisting of structures (i), (ii), (iii), (viii), and (v), as detailed herein.

[0008a] In another aspect, there is provided a biphenylphenol polymerization precatalyst selected from the group consisting of structures (i), (ii), and (v):

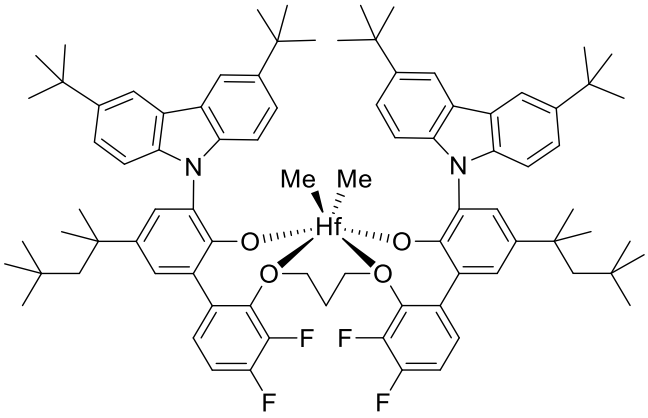


(i);



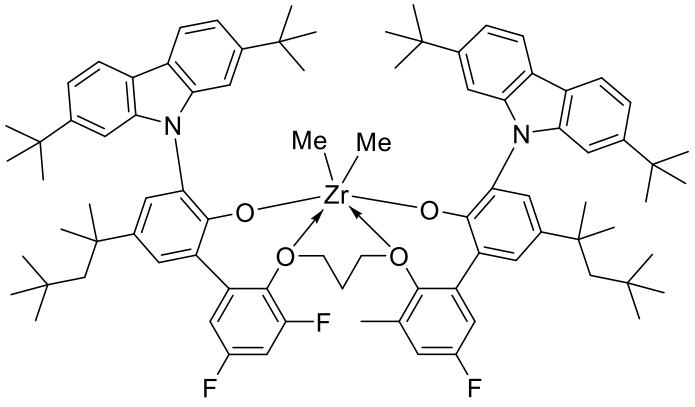
(ii);

and

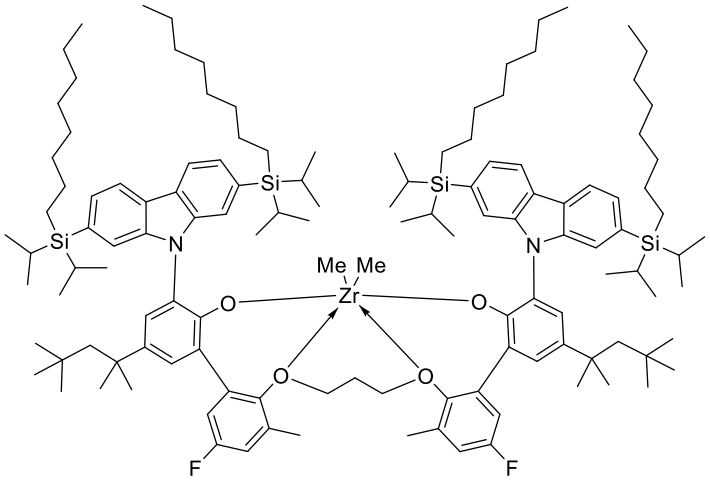


(v).

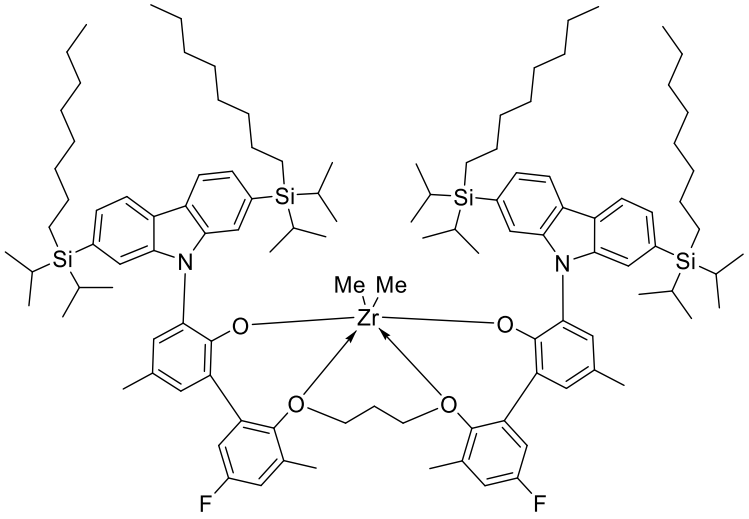
[0008b] In another aspect, there is provided a supported biphenylphenol polymerization catalyst made by the method of claim 1, wherein the biphenylphenol polymerization precatalyst of Formula I is selected from the biphenylphenol polymerization precatalyst of any of structures (i), (ii), (iii), (viii) or (v):



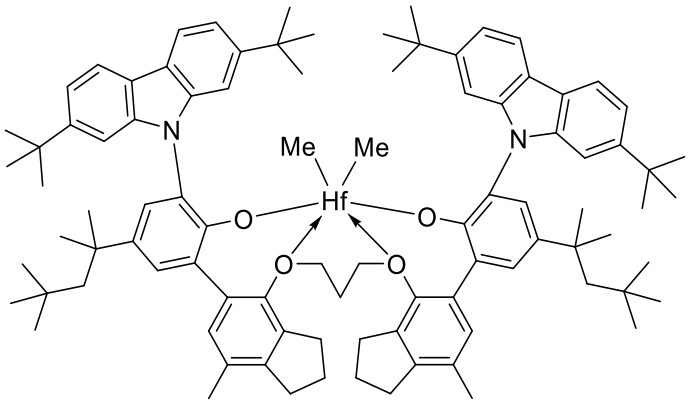
(i);



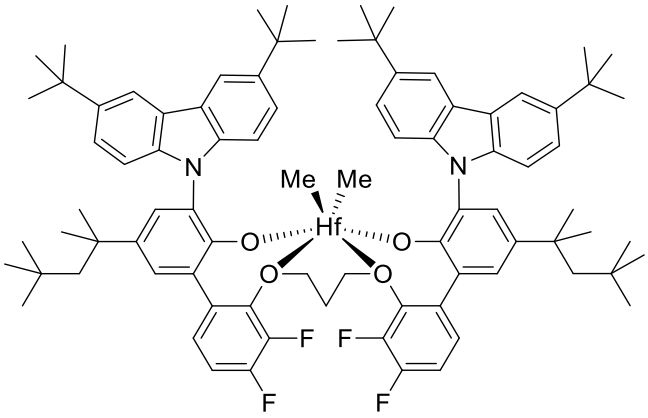
(ii);



(iii);



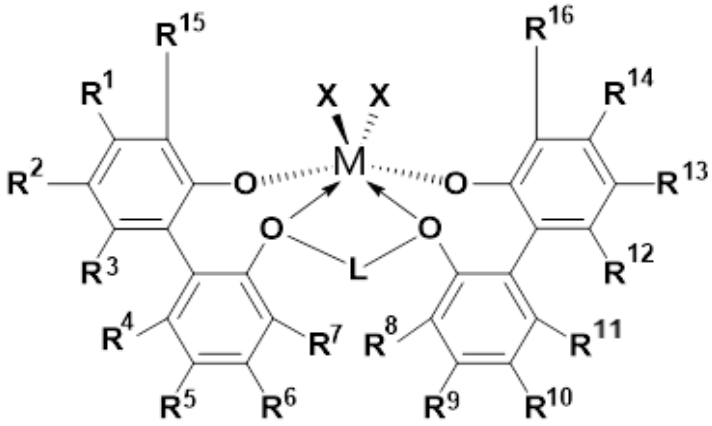
(viii); and



(v).

Detailed Description

[0009] The biphenylphenol polymerization precatalyst herein can be represented by the Formula I:



(Formula I)

[0010] wherein each of R^7 and R^8 independently is a C_1 alkyl, halogen, or a hydrogen;

[0011] wherein each of R^5 and R^{10} independently is a C_1 to C_{20} alkyl, aryl, aralkyl, halogen, or a hydrogen;

[0012] wherein each of R^4 and R^{11} independently is a halogen or a hydrogen;

[0013] wherein each of R^2 and R^{13} independently is a C_1 to C_{20} alkyl, aryl or aralkyl or a hydrogen;

[0014] 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;

[0015] 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;

[0016] wherein each of R^1, R^3, R^{12}, and R^{14} is a hydrogen;

[0017] 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;

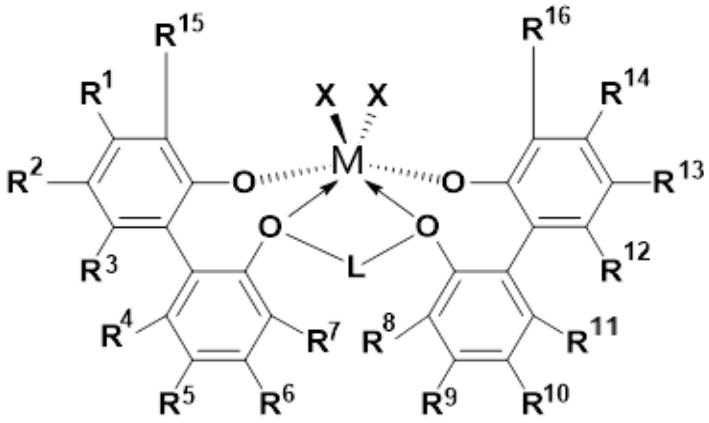
What is claimed is:

1. 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 a supported biphenylphenol polymerization catalyst 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, further wherein the supported biphenylphenol polymerization catalyst is made according to the following method:

disposing 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;

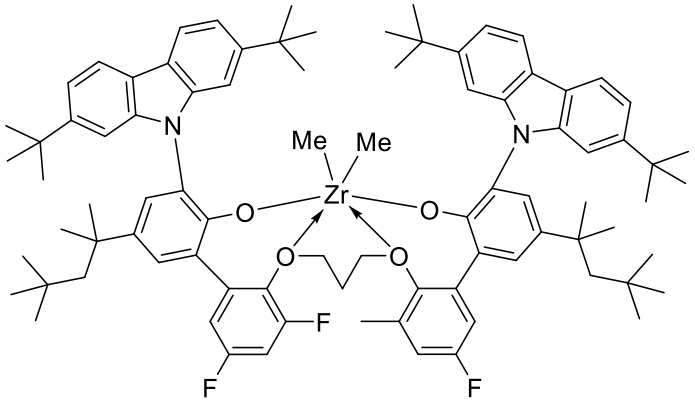
wherein each of R^6 and R^9 is a hydrogen or C_1-C_8 alkyl; optionally, R^6 can be linked with R^7 and R^8 can be linked to R^9 to form a cyclic structure;

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

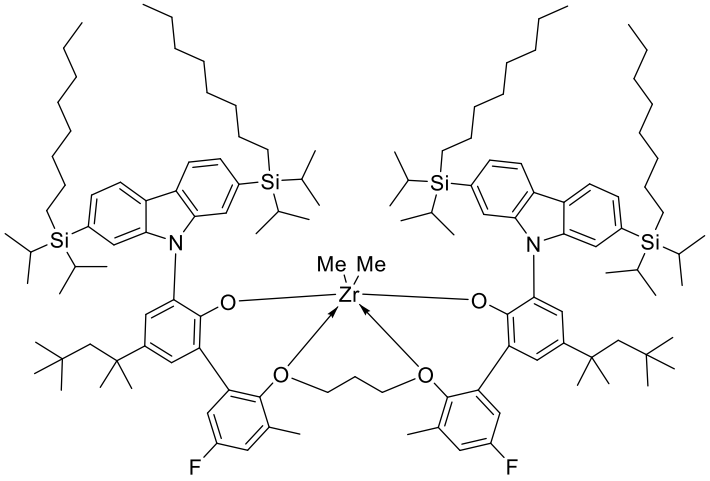
wherein M is Zr or Hf.

2. The method of claim 1 in which the bimodal polyethylene composition has a polydispersity index (PDI) in a range from 5 to 40 or 7 to 40.

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

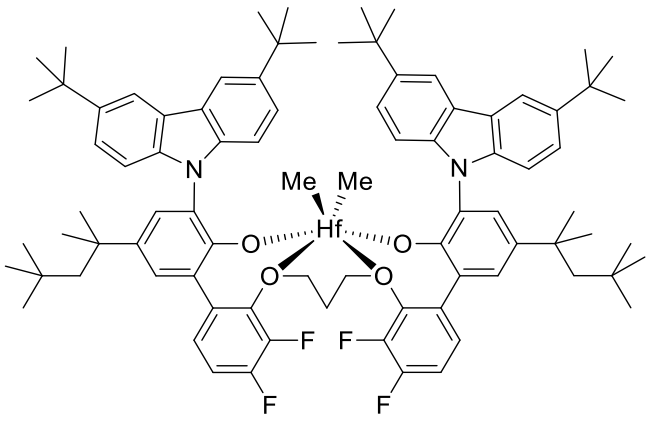


(i);



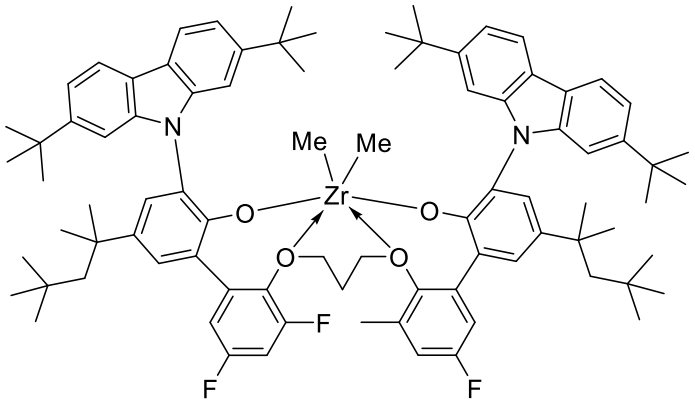
(ii);

and

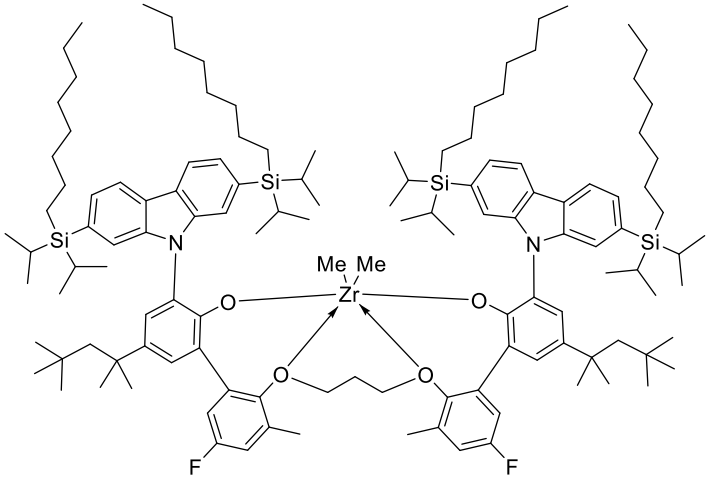


(v).

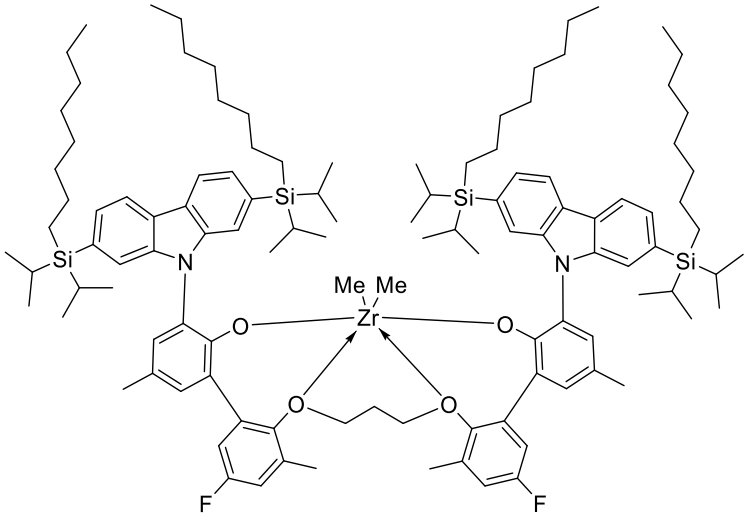
4. A supported biphenylphenol polymerization catalyst made by the method of claim 1, wherein the biphenylphenol polymerization precatalyst of Formula I is selected from the biphenylphenol polymerization precatalyst of any of structures (i), (ii), (iii), (viii) or (v):



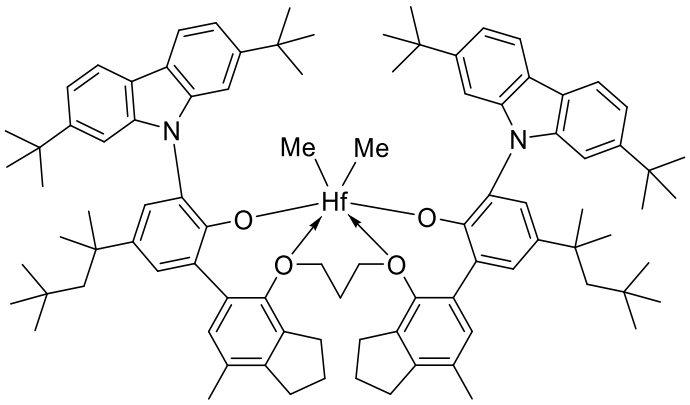
(i);



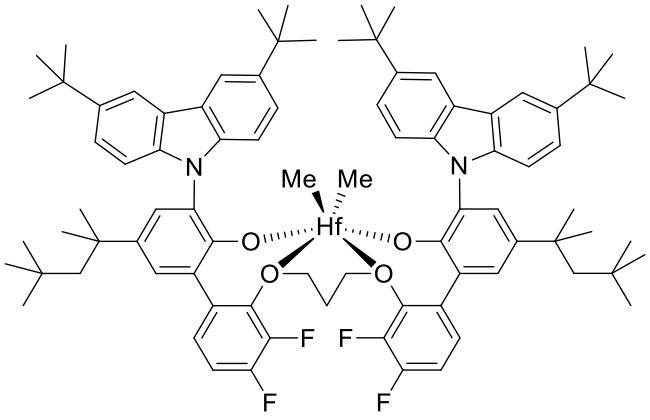
(ii);



(iii);



(viii); and



(v).