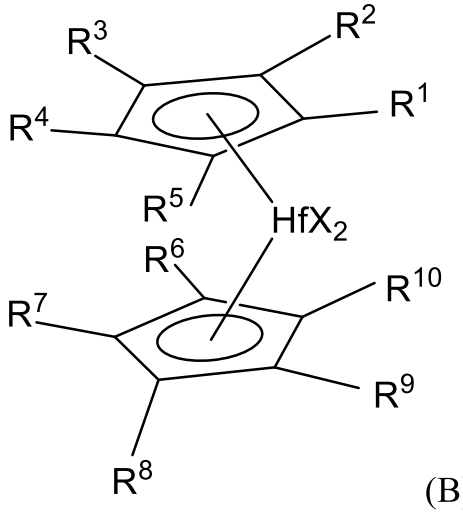
Claims

1. A catalyst compound represented by the formula (B):



(B)

where:

each R^1, R^2, R^3, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is, independently, hydrogen, alkoxide, a C_1 to C_{40} substituted or unsubstituted hydrocarbyl group or is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$ where R^{20} is a C_1 to C_4 hydrocarbyl (preferably methyl), and each R' is independently a C_1 to C_{20} substituted or unsubstituted hydrocarbyl, provided that at least one R' is not H, and provided that at least one of R^1, R^2, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$; and

each X is, independently, a univalent anionic ligand, or two X are joined and bound to the metal atom to form a metallocycle ring, or two X are joined to form a chelating ligand, a diene ligand, or an alkylidene ligand, where X is not fluorine.

2. The catalyst compound of claim 1, wherein each R^1, R^2, R^4 and R^5 is independently hydrogen, alkoxide or a C_1 to C_{40} substituted or unsubstituted hydrocarbyl group;

R^3 is independently hydrogen, alkoxide or a C_1 to C_{40} substituted or unsubstituted hydrocarbyl group or is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$ where R^{20} is a C_1 to C_4 hydrocarbyl (preferably CH_2), and each R' is independently a C_1 to C_{20} substituted or unsubstituted hydrocarbyl, provided that at least one R' is not H;

each R^6, R^7, R^8, and R^{10} is independently hydrogen, alkoxide or a C_1 to C_{40} substituted or unsubstituted hydrocarbyl group;

R^9 is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$ where R^{20} is hydrogen, or a C_1 to C_4 hydrocarbyl (preferably CH_2), and each R' is independently a C_1 to C_{20} substituted or unsubstituted hydrocarbyl,

provided that at least one R' is not H..

3. The catalyst compound of claim 1, wherein R^9 and R^3 are, independently, $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$ where R^{20} is a C_1 to C_4 hydrocarbyl (preferably CH_2), and each R' is independently a C_1 to C_{20} substituted or unsubstituted hydrocarbyl, provided that at least one R' is not H.

4. The catalyst compound of claim 1, 2 or 3, wherein each X is independently selected from non-fluorine halides, aryls and C_1 to C_5 alkyl groups.

5. The catalyst compound of claim 1, 2, 3, or 4, wherein each R^1, R^2, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is independently hydrogen, or a substituted C_1 to C_{12} hydrocarbyl group or an unsubstituted C_1 to C_{12} hydrocarbyl group, preferably hydrogen, methyl, ethyl, propyl, butyl, pentyl, hexyl, or an isomer thereof or is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$ where R^{20} is independently a methyl, ethyl, propyl, or butyl group (preferably a CH_2 group) , preferably $-CH_2-CMe_3$, or $-CH_2-SiMe_3$, and provided that at least one of R^1, R^2, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is $-R^{20}-SiR'_3$ or $-R^{20}-CR'_3$.

6. The catalyst compound of claim 1, 2, 3, or 4, wherein at least one of R^6 to R^{10} and optionally at least one of R^1 to R^5 are, independently, $-R^{20}-CMe_3$, or $-R^{20}-SiMe_3$ where R^{20} is independently a methyl, ethyl, propyl, or butyl group, preferably $-CH_2-CMe_3$, or $-CH_2-SiMe_3$.

7. The catalyst compound of claim 1, 2, 3, 4, 5 or 6, wherein R^{20} is CH_2.

8. The catalyst compound of claim 1, 2, 3, 4, 5 or 6, wherein at least one of R^1, R^2, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is $-CH_2-SiMe_3$.

9. The catalyst compound of claim 1, 2, 3, 4, 5 or 6, wherein at least one of R^1, R^2, R^4, R^5, R^6, R^7, R^8, R^9 and R^{10} is $-CH_2-SiMe_3$ and each X is independently Cl, Br, or Me.

10. A catalyst system comprising activator and the catalyst of any of claims 1 to 10.

11. The catalyst system of claim 10, wherein the activator comprises alumoxane or non-coordinating anion.

12. The catalyst system of claim 10 or 11, wherein the catalyst system further comprises a support, preferably where the support material does not contain fluorine.

13. A process to polymerize olefins comprising contacting one or more olefins with the catalyst system of any of claims 10 to 12.

14. The process of claim 13, wherein the olefins and catalyst system are contacted in the gas phase.

15. The process of claim 13, wherein the olefins and catalyst system are contacted in the slurry phase.

16. The process of claim 13, wherein the olefins and catalyst system are contacted in the solution phase.

17. The process of claim 13, wherein the olefins and catalyst system are contacted in a slurry loop reactor.

18. The process of any of claims 13 to 17, wherein the polymerization is a continuous process.

19. The process of any of claims 13 to 18, wherein the catalyst compound comprises one or more of: $(Me_3SiCH_2Cp)_2HfCl_2$; $(Me_3SiCH_2Cp)_2HfMe_2$; $(Cp)(Me_3SiCH_2Cp)HfCl_2$; $(Cp)(Me_3SiCH_2Cp)HfMe_2$; $(PrCp)(Me_3SiCH_2Cp)HfCl_2$; $(Me_4Cp)(Me_3SiCH_2Cp)HfCl_2$; and $(Me_5Cp)(Me_3SiCH_2Cp)HfCl_2$.

20. The process of any of claims 13 to 19, wherein the activator comprises alumoxane.

21. The process of any of claims 13 to 20, wherein the olefins comprise ethylene and optionally one more C3 to C20 alpha olefins.

22. The process of any of claims 13 to 21, wherein the activator comprises a non-coordinating anion activator.

23. The process of claim 22, wherein activator is represented by the formula:

$$(Z)_d^+ (A^{d-})$$

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

24. The process of claim 22, wherein activator is represented by the formula:

$$(Z)_d^+ (A^{d-})$$

wherein A^{d-} is a non-coordinating anion having the charge d-; d is an integer from 1 to 3, and Z is a reducible Lewis acid represented by the formula: (Ar_3C^+), where Ar is aryl or aryl substituted with a heteroatom, a C_1 to C_{40} hydrocarbyl, or a substituted C_1 to C_{40} hydrocarbyl.

25. The process of any of claims 13 to 22, wherein the activator is one or more of: N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate, triphenylcarbenium tetrakis(pentafluorophenyl)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-dimethylanilinium tetrakis(perfluoronaphthyl)borate, N,N-diethylanilinium tetrakis(perfluoronaphthyl)borate, N,N-dimethyl-(2,4,6-trimethylanilinium) tetrakis(perfluoronaphthyl)borate, and triphenylcarbenium tetrakis(perfluoronaphthyl)borate.

26. The process any of claims 13 to 25, wherein the process occurs at a temperature of from 0°C to 300°C, at a pressure in the range of from 0.35 MPa to 10 MPa, and at a time up to 300 minutes.

27. The process any of claims 13 to 26, wherein the process occurs in the absence of fluorine.

28. The process any of claims 13 to 27, wherein the polymer produced has less than 100 ppm of fluorine.