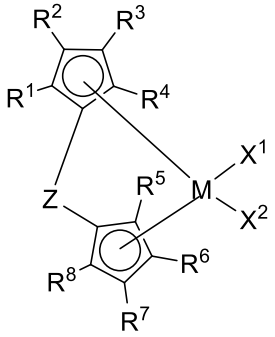
Claims

1. A method for preparing a poly-alpha-olefin with a high viscosity index, comprising subjecting an α-olefin to a polymerization reaction in the presence of a metallocene catalyst to obtain a poly-alpha-olefin,

wherein the polymerization reaction is carried out in the absence of a solvent;

the metallocene catalyst is formed of, or is formed by interaction between, a metallocene compound and an activator, wherein the metallocene compound has a structure as represented by formula (I):



Formula (I)

where M is titanium, zirconium or hafnium;

X^1 and X^2 are each independently selected from a group consisting of halogen, C_1-C_{10} alkyl, C_6-C_{10} aryl, C_1-C_{10} substituted alkyl and C_6-C_{10} substituted aryl, and optionally, one or more carbons in the alkyl or aryl are sustituted by heteroatoms;

R^1, R^2, R^3, R^4, R^5, R^6, $R^7$and R^8 are each independently selected from a group consisting of H, C_1-C_{20} alkyl, C_6-C_{20} aryl, C_1-C_{20} substituted alkyl and C_6-C_{20} substituted aryl, and optionally, one or more carbons in the alkyl or aryl are substituted by heteroatoms;

adjacent groups in R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 are optionally bonded to each other to form cyclopentadienyl-aryl with a five-membered ring to which they are connected; and

Z is silicon or carbon that achieves valence saturation through a substituent, wherein the substituent is any one of C_1-C_{20} alkyl, C_1-C_{20} substituted alkyl and C_6-C_{20} aryl; and

wherein the activator is an alkylaluminium and a borate; wherein a molar ratio of the alkylaluminium to the borate is (0.005~50):1;

wherein the alkylaluminium is selected from a group consisting of trimethylaluminum, triethylaluminum, triisopropylaluminum, tri-n-propylaluminum, triisobutylaluminum, tri-n-butylaluminum, triisoamylaluminum, tri-n-pentylaluminum, triisohexylaluminum, tri-n-hexylaluminum, triisoheptylaluminum, tri-n-heptylaluminum, triisooctylaluminum, tri-n-octylaluminum, triisononylaluminum, tri-n-nonylaluminum, triisodecylaluminum and tri-n-decylaluminum;

wherein the borate is selected from a group consisting of dimethylanilinium tetrakis(pentafluorophenyl)borate, diethylanilinium tetrakis(pentafluorophenyl)borate, dibutylanilinium tetrakis(pentafluorophenyl)borate, trimethylammonium tetrakis(pentafluorophenyl)borate, diethylammonium tetrakis(pentafluorophenyl)borate and tributylammonium tetrakis(pentafluorophenyl)borate.

2. The method according to claim 1, characterized in that the molar ratio of the alkylaluminium to the borate is (0.01~20):1.

3. The method according to claim 1 or 2, characterized in that the α-olefin is a C_4-C_{20} α-olefin.

4. The method according to claim 3, characterized in that the α-olefin is 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 1-tridecene, 1-tetradecene, 1-pentadecene, 1-hexadecene, 1-heptadecene, 1-octadecene, 1-nonadene and 1-eicosene.

5. The method according to claim 3, characterized in that the α-olefin is1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, 1-nonene, 1-decene, 1-undecene, 1-dodecene, 1-tridecene and 1-tetradecene.

6. The method according to any one of claims 1 to 5, characterized in that conditions

for the polymerization reaction include: a reaction temperature of 20°C to 200°C.

7. The method according to claim 6, characterized in that conditions for the polymerization reaction include: the reaction temperature of 60°C to 170°C.

8. The method according to any one of claims 1 to 7, characterized in that by calculating the alkylaluminium with Al and the metallocene compound with M, a molar ratio of the alkylaluminium to the metallocene compound is 0.1:1~1,000:1.

9. The method according to claim 8, characterized in that by calculating the alkylaluminium with Al and the metallocene compound with M, the molar ratio of the alkylaluminium to the metallocene compound is 0.1:1~100:1.

10. The method according to any one of claims 1 to 9, characterized in that by calculating the borate with B and the metallocene compound with M, a molar ratio of the borate to the metallocene compound is 0.1:1~1,000:1.

11. The method according to claim 10, characterized in that by calculating the borate with B and the metallocene compound with M, the molar ratio of the borate to the metallocene compound is 0.1:1~100:1.

12. The method according to any one of claims 1 to 11, characterized in that a mass ratio of the metallocene compound to the α-olefin is $(10^{-6}$-$10^{-3})$:1.

13. The method according to claim 12, characterized in that the mass ratio of the metallocene compound to the α-olefin is $(10^{-5}$-$10^{-4})$:1.

14. The method according to any one of claims 1 to 13, characterized in that in the formula (I), M is zirconium.

15. The method according to any one of claims 1 to 14, characterized in that in the formula (I), X^1 and X^2 are each independently selected from a group consisting of chlorine, C_1-C_4 alkyl or C_1-C_4 substituted alkyl, and optionally, one or more carbons in the alkyl are substituted by heteroatoms.

16. The method according to any one of claims 1 to 15, characterized in that in the formula (I), R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 are each independently selected from a group

consisting of H, C_1-C_{10} alkyl, C_6-C_{18} aryl, C_1-C_{10} substituted alkyl, C_6-C_{15} substituted aryl; and optionally, one or more carbons in the alkyl or aryl are substituted by heteroatoms.

17. The method according to claim 16, characterized in that in the formula (I), R^1, R^2, R^3, R^4, R^5, R^6, R^7 and R^8 are each independently selected from a group concsisting of H, C_1-C_6 alkyl, C_6-C_{12} aryl, C_1-C_6 substituted alkyl, and C_6-C_{10} substituted aryl; and optionally, one or more carbons in the alkyl or aryl are substituted by heteroatoms.

18. The method according to any one of claims 1 to 17, characterized in that in the formula (I), Z is silicon that achieves valence saturation through a substituent; wherein the substituent is any one of C_1-C_{10} alkyl, C_1-C_{10} substituted alkyl and C_6-C_{18} aryl.

19. The method according to claim 18, characterized in that the substituent is any one of C_1-C_6 alkyl, C_1-C_6 substituted alkyl and C_6-C_{12} aryl.