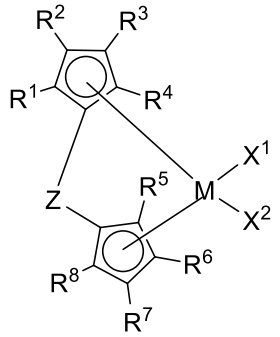
Claims

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 a Group IV metal, preferably 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 includes an alkylaluminium and/or a borate, preferably including an alkylaluminium and a borate.

2. The method according to claim 1, characterized in that a molar ratio of the alkylaluminium to the borate is (0.0001~5000):1, preferably (0.001~500):1, more preferably (0.005~50):1, and futher preferably (0.01~20):1.

3. The method according to claim 1 or 2, characterized in that the alkylaluminium has a general formula of AlR_3, wherein R is C_1-C_{10} alkyl, and preferably, 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.

4. The method according to any one of claims 1 to 3, characterized in that 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.

5. The method according to any one of claims 1 to 4, characterized in that the α-olefin is a C_4-C_{20} α-olefin, preferably a C_6-C_{14} α-olefin, more preferably 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, or preferably 1-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, preferably 60°C to 170°C.

7. The method according to any one of claims 1 to 6, 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, preferably 0.1:1~100:1.

8. The method according to any one of claims 1 to 7, 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, preferably 0.1:1~100:1.

9. The method according to any one of claims 1 to 8, characterized in that a mass ratio of the metallocene compound to the α-olefin is $(10^{-6}$-$10^{-3})$:1, preferably $(10^{-5}$-$10^{-4})$:1.

10. The method according to any one of claims 1 to 9, characterized in that in the formula (I), M is zirconium.

11. The method according to any one of claims 1 to 10, 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.

12. The method according to any one of claims 1 to 11, 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; preferably, 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.

13. The method according to any one of claims 1 to 12, characterized in that in the formula (I), Z is silicon that achieves valence saturation through a substituent; and preferably, the substituent is any one of C_1-C_{10} alkyl, C_1-C_{10} substituted alkyl and C_6-C_{18} aryl, preferably any one of C_1-C_6 alkyl, C_1-C_6 substituted alkyl and C_6-C_{12} aryl.