What is claimed is:

1. A catalyst component for olefin polymerization, comprising a reaction product of:

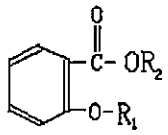
(1) an adduct represented by general formula (I): $MgX_2 \cdot m(R'OH) \cdot nE \cdot qH_2O$;

(2) at least one titanium compound represented by general formula (II): $Ti(OR)_{4-k}X_k$; and

(3) at least one electron donor compound a and at least one electron donor compound b;

wherein,

in the general formula (I), X is Cl or Br; R′ is a C_1-C_4 alkyl; E is at least one o-alkoxybenzoate represented by general formula (III):

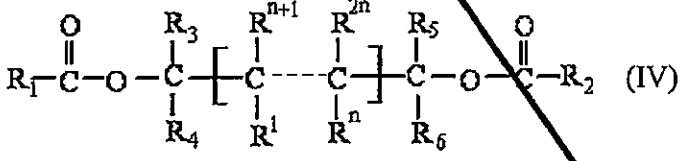


(III)

wherein R_1 and R_2 are independently chosen from C_1-C_{12} linear or branched alkyl, C_3-C_{10} cycloalkyl, C_4-C_{10} cycloalkylalkyl, C_6-C_{10} aryl, C_7-C_{10} alkaryl and C_7-C_{10} aralkyl; m ranges from 1.0 to 5.0; n ranges from 0 to 0.5; and q ranges from 0 to 0.8;

in the general formula (II), R is a C_1-C_{20} alkyl, X is a halogen, and k is 0, 1, 2, 3, or 4;

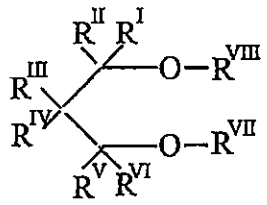
the at least one electron donor compound a is chosen from esters of diol represented by general formula (IV):



(IV)

wherein R_1 and R_2 are independently chosen from C_1-C_{10} linear or branched alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, and C_7-C_{20} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy; R_3-R_6 and R^1-R^{2n} are independently chosen from hydrogen, halogen, substituted or unsubstituted linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, C_7-C_{20} alkaryl, C_7-C_{20} aralkyl, C_2-C_{10} alkenyl, C_{10}-C_{20} fused aryl, and ester group, each of R_3-R_6 and R^1-R^{2n} comprises optionally one or more heteroatoms as a substitution of a carbon atom or a hydrogen atom or the both, said heteroatom being chosen from N, O, S, Si, P, and halogen, and one or more of R_3-R_6 and R^1-R^{2n} are optionally linked to form a ring; and n is an integer ranging from 0 to 10;

the at least one electron donor compound b is chosen from diether compounds represented by general formula (V):



(V)

wherein R^{I}, R^{II}, R^{III}, R^{IV}, R^{V}, and R^{VI} are independently chosen from hydrogen, halogen, linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, and C_7-C_{20} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy; R^{VII} and $R^{\square}$ are independently chosen from linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkaryl, and C_7-C_{20} aralkyl; and the R^{I} to R^{VI} groups are optionally linked to form a ring; and

the molar ratio of the electron donor compound a to the electron donor compound b ranges from 0.55 to 50.

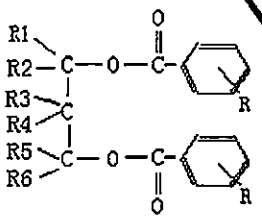
2. The catalyst component of claim 1, wherein in the general formula (I), m ranges from 1.5 to 3.5, and n ranges from 0 to 0.2.

3. The catalyst component of claim 1, wherein in the general formula (I), m ranges from 1.5 to 3.5, and n is 0 or ranges from 0.005 to 0.2.

4. The catalyst component of claim 1, wherein in the general formula (III), R_1 and R_2 are independently chosen from methyl, ethyl, n-propyl, isopropyl, n-butyl, and isobutyl.

5. The catalyst component of any of claims 1 to 4, wherein the adduct represented by the general formula (I) is of spherical shape.

6. The catalyst component of any of claims 1 to 5, wherein the electron donor compound a is an ester of diol represented by general formula (VI):



(VI)

wherein R_1-R_6 are independently chosen from hydrogen and linear or branched C_1-C_{20} alkyl, R is independently chosen from hydrogen, halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy.

7. The catalyst component of any of claims 1 to 6, wherein the electron donor compound b is a 1,3-diether represented by general formula (VII):

$$R^1R^2C(CH_2OR^3)\,(CH_2OR^4) \qquad \text{(VII)}$$

wherein R^1 and R^2 are independently chosen from C_1-C_{18} alkyl, C_3-C_{18} cycloalkyl, C_7-C_{18}

cycloalkylalkyl, C_6-C_{18} aryl and C_7-C_{18} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy, and R^1 and R^2 are optionally linked to form a ring; R^3 and R^4 is independently a C_1-C_{10} alkyl.

8. The catalyst component of any of claims 1 to 7, wherein the molar ratio of the electron donor a to the electron donor b ranges from 0.60 to 10.

9. The catalyst component of any of claims 1 to 8, wherein the catalyst component is of spherical shape.

10. A process for the preparation of the catalyst component according to any of claims 1 to 9, comprising the steps of

(A) suspending the adduct represented by the general formula (I) in the titanium compound represented by the general formula (II) or a mixture of the titanium compound and an inert solvent, and optionally maintaining a period of time;

(B) slowly heating the above suspension to a temperature of from 90°C to 130°C with stirring, and adding thereto the electron donor compound a and the electron donor compound b during the heating or after the temperature reaches the target value;

(C) continuously stirring for 0.5 to 3 hours, and then separating the liquid from the solids;

(D) treating the solids from step (C) with the titanium compound represented by the general formula (II) or a mixture of the titanium compound and an inert solvent at 90 to 130°C for 0.5 to 3h, and then separating the liquid from the solids;

(E) optionally, repeating the titanium compound treatment of step (D) one or more times; and

(F) washing the solids from step (D) or (E), if present, with an inert solvent and then drying, to obtain the solid catalyst component.

11. The process of claim 10, having at least one of the following features:

- step (A) is carried out by suspending the adduct of the general formula (I) in the titanium compound of the general formula (II) or a mixture of the titanium compound and an inert hydrocarbon solvent prechilled to a temperature of from -40°C to 0°C, and then maintaining optionally at that temperature for 5min to 2h;

- in step (A), the concentration of the adduct in the resultant suspension is lower than 200g/L;

- step (B) is carried out by heating slowly the suspension from step (A) to 90°C to 130°C with stirring, and adding thereto the electron donor compound a and the electron donor compound b during the heating or after the temperature reaches the target value, wherein the electron donor compounds a and b may be added together, separately, or stepwise;

- in step (B), the electron donor compound a or the electron donor compound b or the both are added after the temperature of the suspension have reached above 30°C;

- step (C) is carried out by stirring the mixture from step (B) for 0.5 to 3 hours, then stopping the stirring, and separating the liquid from the solids;

- step (D) is carried out by treating the solids from step (C) with the titanium compound of the general formula (II) or a mixture of the titanium compound and an inert hydrocarbon solvent at 90 to 130°C with stirring for 0.5 to 3h, then stopping the stirring, and separating the liquid from the solids;

- the process comprises step (E), i.e., repeating the titanium compound treatment of step (D) one or more times;

- the titanium compounds used in step (A), step (D), and optional step (E) are the same or different, the molar number of the total titanium compounds used in said steps ranges from 20 to 200 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the molar number of the titanium compound used in step (A) ranges from 4 to 50 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the electron donor a is used in an amount ranging from 0.04 to 0.6 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the electron donor b is used in an amount ranging from 0.01 to 0.5 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the total amount of the electron donor a and the electron donor b ranges from 0.1 to 0.8 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2; and

- the molar ratio of the electron donor a to the electron donor ranges from 0.60 to 10.

12. A catalyst for the polymerization of an olefin of formula CH_2=CHR, in which R is hydrogen, or an alkyl or aryl having 1 to 6 carbon atoms, comprising a reaction product of the following components:

(1) the catalyst component of any of claims 1 to 10;

(2) at least one alkyl aluminum compound as a cocatalyst; and

(3) optionally, at least one external electron-donor compound.

13. The catalyst of claim 12, having at least one of the following features:

- the alkyl aluminum compound is a compound of general formula AlR_nX_{3-n}, in which R is independently hydrogen or a C_1-C_{20} hydrocarbon radical; X is independently a halogen; and n has a value meeting $0<n\leq 3$;

- the alkyl aluminum compound is used in such an amount that the molar ratio of Al/Ti ranges from 5 to 2000;

- the external electron donor compound is used in such an amount that the molar ratio of Al/ED ranges from 2 to 1000; and

- the external electron donor compound is a silicon compound of general formula

$R^1_aR^2_bSi(OR^3)_c$, wherein a and b are an integer ranging from 0 to 2, c is an integer ranging from 1 to 3, and (a+b+c) =4; R^1, R^2, and R^3 are independently C_1-C_{18} hydrocarbon radical, optionally containing a heteroatom.

14. A process for polymerizing olefin, comprising contacting an olefin of formula CH_2=CHR, in which R is H, or an alkyl or aryl having 1 to 6 carbon atoms, and optionally another kind of said olefin as a comonomer, and optionally a diene as a second comonomer, with the catalyst of claim 12 or 13 under polymerization conditions; and recovering the resultant polymer.

15. The process of claim 14 used to produce directly a low ash polypropylene in a polymerization reactor.

16. The process of claim 15, wherein the molar ratio of Al/Ti in the used catalyst ranges from 10 to 300.

17. The process of claim 16, wherein the molar ratio of Al/Ti in the used catalyst ranges from 20 to 200.

18. The process of any of claims 15 to 17, wherein no external electron donor is used.

19. The process of any of claims 15 to 17, wherein the external electron donor is used, and it is an organic silicon compound used in such an amount that the molar ratio of Al/ED ranges from 5 to 500.

20. The process of claim 19, wherein the external electron donor is used in such an amount that the molar ratio of Al/ED ranges from 10 to 200.

21. The process of any of claims 15 to 20, wherein the resultant polypropylene has an ash content of lower than 100ppm, preferably lower than 50ppm, and more preferably lower than 30ppm.

What is claimed is:

1. A catalyst component for olefin polymerization, comprising a reaction product of:

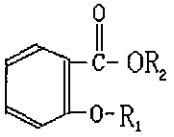
(1) an adduct represented by general formula (I): $MgX_2 \cdot m(R'OH) \cdot nE \cdot qH_2O$;

(2) at least one titanium compound represented by general formula (II): $Ti(OR)_{4-k}X_k$; and

(3) at least one electron donor compound a and at least one electron donor compound b;

wherein,

in the general formula (I), X is Cl or Br; R′ is a C_1-C_4 alkyl; E is at least one o-alkoxybenzoate represented by general formula (III):

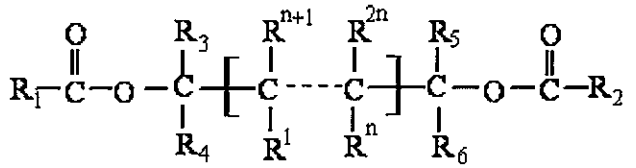


(III)

wherein R_1 and R_2 are independently chosen from C_1-C_{12} linear or branched alkyl, C_3-C_{10} cycloalkyl, C_4-C_{10} cycloalkylalkyl, C_6-C_{10} aryl, C_7-C_{10} alkaryl and C_7-C_{10} aralkyl; m ranges from 1.0 to 5.0; n ranges from 0 to 0.5; and q ranges from 0 to 0.8;

in the general formula (II), R is a C_1-C_{20} alkyl, X is a halogen, and k is 0, 1, 2, 3, or 4;

the at least one electron donor compound a is chosen from esters of diol represented by general formula (IV):

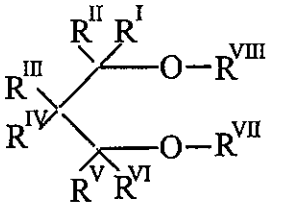


(IV)

wherein R_1 and R_2 are independently chosen from C_1-C_{10} linear or branched alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, and C_7-C_{20} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy; R_3-R_6 and R^1-R^{2n} are independently chosen from hydrogen, halogen, substituted or unsubstituted linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, C_7-C_{20} alkaryl, C_7-C_{20} aralkyl, C_2-C_{10} alkenyl, C_{10}-C_{20} fused aryl, and ester group, each of

R_3-R_6 and R^1-R^{2n} comprises optionally one or more heteroatoms as a substitution of a carbon atom or a hydrogen atom or the both, said heteroatom being chosen from N, O, S, Si, P, and halogen, and one or more of R_3-R_6 and R^1-R^{2n} are optionally linked to form a ring; and n is an integer ranging from 0 to 10;

the at least one electron donor compound b is chosen from diether compounds represented by general formula (V):



(V)

wherein R^I, R^{II}, R^{III}, R^{IV}, R^V, and R^{VI} are independently chosen from hydrogen, halogen, linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_4-C_{20} cycloalkylalkyl, C_6-C_{20} aryl, and C_7-C_{20} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy; R^{VII} and $R^{\square}$ are independently chosen from linear or branched C_1-C_{20} alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkaryl, and C_7-C_{20} aralkyl; and the R^I to R^{VI} groups are optionally linked to form a ring; and

the molar ratio of the electron donor compound a to the electron donor compound b ranges from 0.55 to 50.

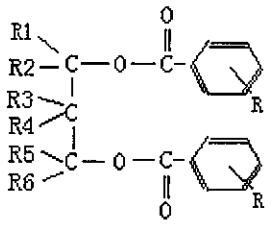
2. The catalyst component of claim 1, wherein in the general formula (I), m ranges from 1.5 to 3.5, and n ranges from 0 to 0.2.

3. The catalyst component of claim 1, wherein in the general formula (I), m ranges from 1.5 to 3.5, and n is 0 or ranges from 0.005 to 0.2.

4. The catalyst component of claim 1, wherein in the general formula (III), R_1 and R_2 are independently chosen from methyl, ethyl, n-propyl, isopropyl, n-butyl, and isobutyl.

5. The catalyst component of any of claims 1 to 4, wherein the adduct represented by the general formula (I) is of spherical shape.

6. The catalyst component of any of claims 1 to 5, wherein the electron donor compound a is an ester of diol represented by general formula (VI):



(VI)

wherein R_1-R_6 are independently chosen from hydrogen and linear or branched C_1-C_{20} alkyl, R is independently chosen from hydrogen, halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy.

7. The catalyst component of any of claims 1 to 6, wherein the electron donor compound b is a 1,3-diether represented by general formula (VII):

$$R^1R^2C(CH_2OR^3)(CH_2OR^4) \qquad \text{(VII)}$$

wherein R^1 and R^2 are independently chosen from C_1-C_{18} alkyl, C_3-C_{18} cycloalkyl, C_4-C_{18} cycloalkylalkyl, C_6-C_{18} aryl and C_7-C_{18} aralkyl, the aryl ring or cycloalkyl ring of which is optionally further substituted by a substituent chosen from halogen, C_1-C_6 alkyl and C_1-C_6 alkoxy, and R^1 and R^2 are optionally linked to form a ring; R^3 and R^4 is independently a C_1-C_{10} alkyl.

8. The catalyst component of any of claims 1 to 7, wherein the molar ratio of the electron donor a to the electron donor b ranges from 0.60 to 10.

9. The catalyst component of any of claims 1 to 8, wherein the catalyst component is of spherical shape.

10. A process for the preparation of the catalyst component according to any of claims 1 to 9, comprising the steps of

(A) suspending the adduct represented by the general formula (I) in the titanium compound represented by the general formula (II) or a mixture of the titanium compound and an inert solvent, and optionally maintaining a period of time;

(B) slowly heating the above suspension to a temperature of from 90°C to 130°C with stirring, and adding thereto the electron donor compound a and the electron donor compound b during the heating or after the temperature reaches the target value;

(C) continuously stirring for 0.5 to 3 hours, and then separating the liquid from the solids;

(D) treating the solids from step (C) with the titanium compound represented by the general formula (II) or a mixture of the titanium compound and an inert solvent at 90 to 130°C for 0.5 to 3h, and then separating the liquid from the solids;

(E) optionally, repeating the titanium compound treatment of step (D) one or more times; and

(F) washing the solids from step (D) or (E), if present, with an inert solvent and then drying, to obtain the solid catalyst component.

11. The process of claim 10, having at least one of the following features:

- step (A) is carried out by suspending the adduct of the general formula (I) in the titanium compound of the general formula (II) or a mixture of the titanium compound and an inert hydrocarbon solvent prechilled to a temperature of from -40°C to 0°C, and then maintaining optionally at that temperature for 5min to 2h;

- in step (A), the concentration of the adduct in the resultant suspension is lower than 200g/L;

- step (B) is carried out by heating slowly the suspension from step (A) to 90°C to 130°C with stirring, and adding thereto the electron donor compound a and the electron donor compound b during the heating or after the temperature reaches the target value, wherein the electron donor compounds a and b may be added together, separately, or stepwise;

- in step (B), the electron donor compound a or the electron donor compound b or the both are added after the temperature of the suspension have reached above 30°C;

- step (C) is carried out by stirring the mixture from step (B) for 0.5 to 3 hours, then stopping the stirring, and separating the liquid from the solids;

- step (D) is carried out by treating the solids from step (C) with the titanium compound of the general formula (II) or a mixture of the titanium compound and an inert hydrocarbon solvent at 90 to 130°C with stirring for 0.5 to 3h, then stopping the stirring, and separating the liquid from the solids;

- the process comprises step (E), i.e., repeating the titanium compound treatment of step (D) one or more times;

- the titanium compounds used in step (A), step (D), and optional step (E) are the same or different, the molar number of the total titanium compounds used in said steps ranges from 20 to 200 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the molar number of the titanium compound used in step (A) ranges from 4 to 50 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the electron donor a is used in an amount ranging from 0.04 to 0.6 moles,

relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the electron donor b is used in an amount ranging from 0.01 to 0.5 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2;

- the total amount of the electron donor a and the electron donor b ranges from 0.1 to 0.8 moles, relative to 1 mole of the adduct of the general formula (I) in terms of MgX_2; and

- the molar ratio of the electron donor a to the electron donor ranges from 0.60 to 10.

12. A catalyst for the polymerization of an olefin of formula CH_2=CHR, in which R is hydrogen, or an alkyl or aryl having 1 to 6 carbon atoms, comprising a reaction product of the following components:

(1) the catalyst component of any of claims 1 to 10;

(2) at least one alkyl aluminum compound as a cocatalyst; and

(3) optionally, at least one external electron-donor compound.

13. The catalyst of claim 12, having at least one of the following features:

- the alkyl aluminum compound is a compound of general formula AlR_nX_{3-n}, in which R is independently hydrogen or a C_1-C_{20} hydrocarbon radical; X is independently a halogen; and n has a value meeting $0<n\leq 3$;

- the alkyl aluminum compound is used in such an amount that the molar ratio of Al/Ti ranges from 5 to 2000;

- the external electron donor compound is used in such an amount that the molar ratio of Al/ED ranges from 2 to 1000; and

- the external electron donor compound is a silicon compound of general formula $R^1_aR^2_bSi(OR^3)_c$, wherein a and b are an integer ranging from 0 to 2, c is an integer ranging from 1 to 3, and (a+b+c) =4; R^1, R^2, and R^3 are independently C_1-C_{18} hydrocarbon radical, optionally containing a heteroatom.

14. A process for polymerizing olefin, comprising contacting an olefin of formula CH_2=CHR, in which R is H, or an alkyl or aryl having 1 to 6 carbon atoms, and optionally another kind of said olefin as a comonomer, and optionally a diene as a second comonomer, with the catalyst of claim 12 or 13 under polymerization conditions; and recovering the resultant polymer.

15. The process of claim 14 used to produce directly a low ash polypropylene in a polymerization reactor.

16. The process of claim 15, wherein the molar ratio of Al/Ti in the used catalyst

ranges from 10 to 300.

17. The process of claim 16, wherein the molar ratio of Al/Ti in the used catalyst ranges from 20 to 200.

18. The process of any of claims 15 to 17, wherein no external electron donor is used.

19. The process of any of claims 15 to 17, wherein the external electron donor is used, and it is an organic silicon compound used in such an amount that the molar ratio of Al/ED ranges from 5 to 500.

20. The process of claim 19, wherein the external electron donor is used in such an amount that the molar ratio of Al/ED ranges from 10 to 200.

21. The process of any of claims 15 to 20, wherein the resultant polypropylene has an ash content of lower than 100ppm.

22. The process of any of claims 15 to 20, wherein the resultant polypropylene has an ash content of lower than 50ppm.

23. The process of any of claims 15 to 20, wherein the resultant polypropylene has an ash content of lower than 30ppm.