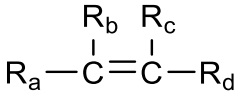
Claims

1. A grafting-modified polypropylene material for an insulating material, characterized in that, the grafting-modified polypropylene material comprises structural units derived from a polypropylene copolymer and structural units derived from an alkenyl-containing polymerizable monomer; the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.1 to 14 wt%, based on the weight of the grafting-modified polypropylene material;

the polypropylene copolymer has a melting temperature Tm of 120°C or higher;

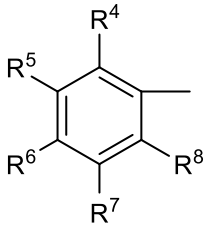
the polypropylene copolymer further has at least one of the following characteristics: the comonomer content is 0.5 to 40 mol%; the content of xylene solubles is 2 to 80 wt%; the comonomer content in the xylene solubles is 10 to 70 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.3 to 5;

wherein, the alkenyl-containing polymerizable monomer is at least one selected from a monomer having the structure represented by formula 1,



formula 1

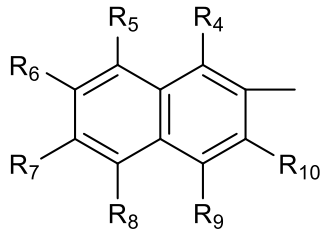
in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted alkyl; R_a is selected from a group represented by formula 2, a group represented by formula 3, a group represented by formula 4;



formula 2

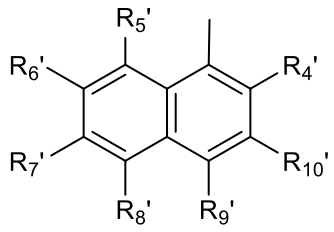
in the formula 2, R^4-R^8 are each independently selected from H, halogen,

hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group;



formula 3

in the formula 3, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group;



formula 4

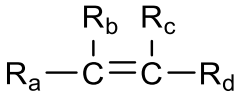
in the formula 4, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group.

2. A grafting-modified polypropylene material for an insulating material, characterized in that, the grafting-modified polypropylene material comprises structural units derived from a polypropylene copolymer and structural units derived from an alkenyl-containing polymerizable monomer; the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.1 to 6.04 wt%, based on the weight of the grafting-modified polypropylene material;

the polypropylene copolymer has a melting temperature Tm of 120°C or higher;

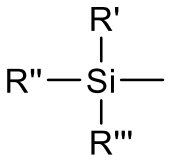
the polypropylene copolymer has at least one of the following characteristics: the comonomer content is 0.5 to 40 mol%; the content of xylene solubles is 2 to 80 wt%; the comonomer content in the xylene solubles is 10 to 70 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.3 to 5;

wherein, the alkenyl-containing polymerizable monomer is at least one selected from a monomer having the structure represented by formula 1,



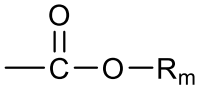
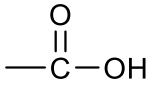
formula 1

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted alkyl; R_a is selected from a group represented by formula 5, a group represented by formula 6, a combination of a group represented by formula 6 and a group represented by formula 7, a heterocyclic group;



formula 5

in the formula 5, R', R'', R''' are each independently selected from substituted or unsubstituted C_1-C_{12} linear alkyl, substituted or unsubstituted C_3-C_{12} branched alkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} acyloxy;

 formula 6  formula 7

in the formula 6, R_m is selected from the following groups that are substituted or unsubstituted: C_1-C_{20} linear alkyl, C_3-C_{20} branched alkyl, C_3-C_{12} cycloalkyl, C_3-C_{12} epoxyalkyl, C_3-C_{12} epoxyalkylalkyl, the substituent group is at least one selected from halogen, amino and hydroxy;

the heterocyclic group is selected from imidazolyl, pyrazolyl, carbazolyl, pyrrolidinonyl, pyridyl, piperidinyl, caprolactam group, pyrazinyl, thiazolyl, purinyl, morpholinyl, oxazolinyl.

3. The grafting-modified polypropylene material as claimed in claim 1, wherein,

the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.2 to 7.5 wt%, based on the weight of the grafting-modified polypropylene material; and/or

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted C_1-C_6 alkyl; and/or

in the formula 2, R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy; and/or

in the formula 3, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy; and/or

in the formula 4, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy.

4. The grafting-modified polypropylene material as claimed in claim 2, wherein,

the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.2 to 6 wt%, or 0.8 to 5 wt%, or 0.5 to 6 wt%, based on the weight of the grafting-modified polypropylene material; and/or

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted C_1-C_6 alkyl; and/or

in the formula 5, R', R'', R''' are each independently selected from substituted or unsubstituted C_1-C_6 linear alkyl, substituted or unsubstituted C_3-C_6 branched alkyl, substituted or unsubstituted C_1-C_6 alkoxy, substituted or unsubstituted C_1-C_6 acyloxy.

5. The grafting-modified polypropylene material as claimed in claim 1 or claim 2, wherein, the polypropylene copolymer has at least one of the following characteristics: the comonomer content is 0.5 to 30 mol%, preferably 4 to 25 wt%, more preferably 4 to 22 wt%; the content of xylene solubles is 18 to 75 wt%, preferably 30 to 70 wt%, more preferably 30 to 67 wt%; the comonomer content in the xylene solubles is 10 to 50 wt%, preferably 20 to 35 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.5 to 3, preferably 0.8 to 1.3.

6. The grafting-modified polypropylene material as claimed in any one of claims 1-5, wherein, the polypropylene copolymer has at least one of the following characteristics: the melt flow rate under a load of 2.16 kg at 230°C is 0.01 to 60 g/10 min, preferably 0.05 to 35 g/10 min, and more preferably 0.5 to 15 g/10 min; the melting temperature Tm is 100°C or higher, preferably 110 to 180°C, more preferably 110 to 170°C, more further preferably 120 to 170°C, and

still more further preferably 120 to 166°C; the weight average molecular weight is preferably 20×10^4 to 60×10^4 g/mol.

7. The grafting-modified polypropylene material as claimed in any one of claims 1-6, wherein, the comonomer of the polypropylene copolymer is at least one selected from C_2-C_8 alpha-olefins other than propylene; preferably, the comonomer of the polypropylene copolymer is at least one selected from ethylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-heptene and 1-octene; further preferably, the comonomer of the polypropylene copolymer is ethylene and/or 1-butene; and still further preferably, the polypropylene copolymer consists of propylene and ethylene.

8. The grafting-modified polypropylene material as claimed in any one of claims 1-7, wherein, the grafting-modified polypropylene material is prepared by a solid phase grafting reaction of a polypropylene copolymer and an alkenyl-containing polymerizable monomer.

9. The grafting-modified polypropylene material as claimed in any one of claims 1-8, wherein, the grafting-modified polypropylene material has at least one of the following characteristics: the melt flow rate under a load of 2.16 kg at 230°C is 0.01 to 30 g/10 min, preferably 0.05 to 20 g/10 min, further preferably 0.1 to 10 g/10 min, and more preferably 0.2 to 8 g/10 min; the flexural modulus is 10 to 1250 MPa, preferably 20 to 1000 MPa, and more preferably 50 to 600 MPa; the elongation at break is ≥ 200%, preferably ≥ 300%.

10. The grafting-modified polypropylene material as claimed in any one of claims 1-9, wherein, the grafting-modified polypropylene material has at least one of the following characteristics:

- the working temperature of the grafting-modified polypropylene material is ≥

90°C, and preferably 90 to 160°C;

- the breakdown field strength E_g at 90°C of the grafting-modified polypropylene material is ≥ 180 kV/mm, and preferably 180 to 800 kV/mm;

- the breakdown field strength change rate ΔE/E, which is the difference ΔE between the breakdown field strength E_g at 90°C of the grafting-modified polypropylene material and the breakdown field strength E at 90°C of the polypropylene copolymer divided by the breakdown field strength E at 90°C of the polypropylene copolymer, is greater than 0.7%, preferably 0.8 to 50%, more preferably 2 to 35%, and further preferably 5 to 25%;

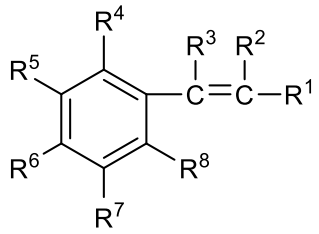
- the direct current volume resistivity ρ_{vg} at 90°C and 15 kV/mm field strength of the grafting-modified polypropylene material is ≥ 6×10^{12} Ω.m, preferably 6×10^{12} Ω.m to 1.0×10^{20} Ω.m;

- the ratio ρ_{vg}/ρ_v of the direct current volume resistivity ρ_{vg} at 90°C and 15 kV/mm field strength of the grafting-modified polypropylene material to the direct current volume resistivity ρ_v at 90°C and 15 kV/mm field strength of the polypropylene copolymer is greater than 1, preferably 1.1 to 50, more preferably 1.15 to 20, and further preferably 1.2 to 10.

11. The grafting-modified polypropylene material as claimed in claim 1, wherein, the grafting-modified polypropylene material is an aromatic olefin grafting-modified polypropylene material, the alkenyl-containing polymerizable monomer is a styrenic monomer, and the content of the structural units derived from the styrenic monomer and in a grafted state in the aromatic olefin grafting-modified polypropylene material is 0.5 to 14 wt%, preferably 1 to 7.5 wt%, and more preferably 1.5 to 5 wt%, based on the weight of the aromatic olefin grafting-modified polypropylene material;

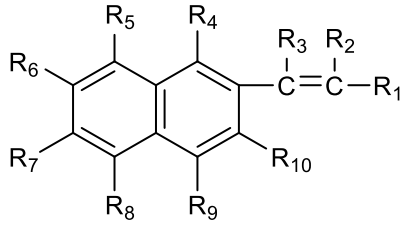
preferably, the styrenic monomer is at least one selected from a monomer having the structure represented by formula 8, a monomer having the structure

represented by formula 9 and a monomer having the structure represented by formula 10;



formula 8

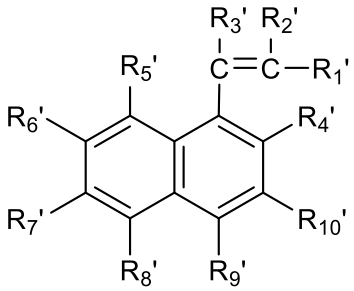
in the formula 8, R^1, R^2, R^3 are each independently selected from H, substituted or unsubstituted C_1-C_6 alkyl; R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R^1, R^2, R^3 are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy;



formula 9

in the formula 9, R_1, R_2, R_3 are each independently selected from H, substituted or unsubstituted C_1-C_6 alkyl; R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-

C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R_1, R_2, R_3 are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy;



formula 10

in the formula 10, R_1', R_2', R_3' are each independently selected from H, substituted or unsubstituted C_1-C_6 alkyl; R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R_1', R_2', R_3' are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy;

preferably, the styrenic monomer is at least one selected from styrene, α-methylstyrene, 1-vinyl naphthalene, 2-vinyl naphthalene, mono- or polysubstituted styrene, mono- or polysubstituted α-methylstyrene, mono- or polysubstituted 1-vinyl naphthalene and mono- or polysubstituted 2-vinyl naphthalene; the substituent group preferably is at least one selected from halogen,

hydroxy, amino, phosphoric group, sulfonic group, C_1-C_8 linear alkyl, C_3-C_8 branched alkyl or cycloalkyl, C_1-C_6 linear alkoxy, C_3-C_8 branched alkoxy or cycloalkoxy, C_1-C_8 linear ester group, C_3-C_8 branched ester group or cyclic ester group, C_1-C_8 linear amine group and C_3-C_8 branched amine group or cyclic amine group;

more preferably, the styrenic monomer is at least one selected from styrene, α-methylstyrene, 2-methylstyrene, 3-methylstyrene and 4-methylstyrene.

12. The grafting-modified polypropylene material as claimed in claim 11, wherein, the aromatic olefin grafting-modified polypropylene material has at least one of the following characteristics: the melt flow rate under a load of 2.16 kg at 230°C is 0.01 to 30 g/10 min, preferably 0.05 to 20 g/10 min, further preferably 0.1 to 10 g/10 min, and more preferably 0.2 to 8 g/10 min; the flexural modulus is 10 to 1250 MPa, preferably 20 to 1000 MPa, and more preferably 50 to 600 MPa; the elongation at break is ≥ 200%, preferably ≥ 300%.

13. The grafting-modified polypropylene material as claimed in claim 11, wherein, the aromatic olefin grafting-modified polypropylene material has at least one of the following characteristics:

- the working temperature of the aromatic olefin grafting-modified polypropylene material is ≥ 90°C, and preferably 90 to 160°C;
- the breakdown field strength E_g at 90°C of the aromatic olefin grafting-modified polypropylene material is ≥ 200 kV/mm, and preferably 200 to 800 kV/mm;
- the breakdown field strength change rate ΔE/E, which is the difference ΔE between the breakdown field strength E_g at 90°C of the aromatic olefin grafting-modified polypropylene material and the breakdown field strength E at 90°C of the polypropylene copolymer divided by the breakdown field strength E at 90°C

of the polypropylene copolymer, is a greater than 1.5%, preferably 1.6 to 40%, more preferably 5 to 30%, and further preferably 10 to 20%;

- the direct current volume resistivity ρ_{vg} at 90°C and 15 kV/mm field strength of the aromatic olefin grafting-modified polypropylene material is ≥ 1.0×10^{13} Ω.m, preferably 1.5×10^{13} Ω.m to 1.0×10^{20} Ω.m;

- the ratio ρ_{vg}/ρ_v of the direct current volume resistivity ρ_{vg} at 90°C and 15 kV/mm field strength of the aromatic olefin grafting-modified polypropylene material to the direct current volume resistivity ρ_v at 90°C and 15 kV/mm field strength of the polypropylene copolymer is greater than 1, preferably 1.5 to 50, more preferably 2 to 20, and further preferably 3 to 10.

14. A method for preparing a grafting-modified polypropylene material for an insulating material, the method comprising: subjecting a reaction mixture comprising a polypropylene copolymer and an alkenyl-containing polymerizable monomer to grafting reaction in the presence of an inert gas, to obtain the grafting-modified polypropylene material;

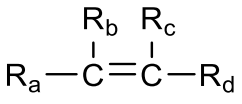
the conditions of the grafting reaction are such that: the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.1 to 14 wt%, based on the weight of the grafting-modified polypropylene material;

the polypropylene copolymer has a melting temperature Tm of 120°C or higher;

the polypropylene copolymer further has at least one of the following characteristics: the comonomer content is 0.5 to 40 mol%; the content of xylene solubles is 2 to 80 wt%; the comonomer content in the xylene solubles is 10 to 70 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.3 to 5;

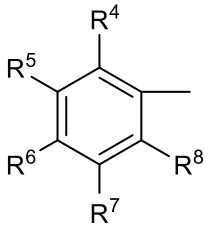
wherein, the alkenyl-containing polymerizable monomer is at least one

selected from a monomer having the structure represented by formula 1,



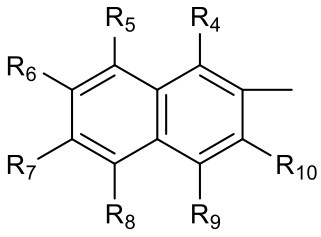
formula 1

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted alkyl; R_a is selected from a group represented by formula 2, a group represented by formula 3, a group represented by formula 4;



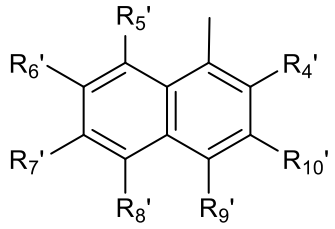
formula 2

in the formula 2, R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group;



formula 3

in the formula 3, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group;



formula 4

in the formula 4, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group.

15. A method for preparing a grafting-modified polypropylene material for an insulating material, the method comprising: subjecting a reaction mixture comprising a polypropylene copolymer and an alkenyl-containing polymerizable monomer to grafting reaction in the presence of an inert gas, to obtain the grafting-modified polypropylene material;

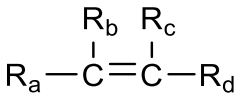
the conditions of the grafting reaction are such that: the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.1 to 6.04 wt%, based on the weight of the grafting-modified polypropylene material;

the polypropylene copolymer has a melting temperature Tm of 120°C or higher;

the polypropylene copolymer further has at least one of the following characteristics: the comonomer content is 0.5 to 40 mol%; the content of xylene solubles is 2 to 80 wt%; the comonomer content in the xylene solubles is 10 to 70 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.3 to 5;

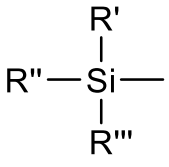
wherein, the alkenyl-containing polymerizable monomer is at least one

selected from a monomer having the structure represented by formula 1,



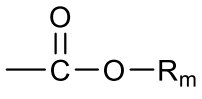
formula 1

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted alkyl; R_a is selected from a group represented by formula 5, a group represented by formula 6, a combination of a group represented by formula 6 and a group represented by formula 7, a heterocyclic group;

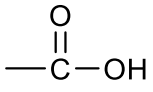


formula 5

in the formula 5, R', R'', R''' are each independently selected from substituted or unsubstituted C_1-C_{12} linear alkyl, substituted or unsubstituted C_3-C_{12} branched alkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} acyloxy;



formula 6



formula 7

in the formula 6, R_m is selected from the following groups that are substituted or unsubstituted: C_1-C_{20} linear alkyl, C_3-C_{20} branched alkyl, C_3-C_{12} cycloalkyl, C_3-C_{12} epoxyalkyl, C_3-C_{12} epoxyalkylalkyl, the substituent group is at least one selected from halogen, amino and hydroxy;

the heterocyclic group is selected from imidazolyl, pyrazolyl, carbazolyl, pyrrolidinonyl, pyridyl, piperidinyl, caprolactam group, pyrazinyl, thiazolyl, purinyl, morpholinyl, oxazolinyl.

16. The method as claimed in claim 14, wherein,

the conditions of the grafting reaction are such that: the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.2 to 7.5 wt%, based on the weight of the grafting-modified polypropylene material; and/or

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted C_1-C_6 alkyl; and/or

in the formula 2, R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy; and/or

in the formula 3, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy; and/or

in the formula 4, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy.

17. The method as claimed in claim 15, wherein,

the conditions of the grafting reaction are such that: the content of the structural units derived from the alkenyl-containing polymerizable monomer and in a grafted state in the grafting-modified polypropylene material is 0.2 to 6 wt%, or 0.8 to 5 wt%, or 0.5 to 6 wt%, based on the weight of the grafting-modified polypropylene material; and/or

in the formula 1, R_b, R_c, R_d are each independently selected from H and substituted or unsubstituted C_1-C_6 alkyl; and/or

in the formula 5, R', R'', R''' are each independently selected from substituted or unsubstituted C_1-C_6 linear alkyl, substituted or unsubstituted C_3-C_6 branched alkyl, substituted or unsubstituted C_1-C_6 alkoxy, substituted or unsubstituted C_1-C_6 acyloxy.

18. The method as claimed in claim 14 or claim 15, wherein, the polypropylene copolymer has at least one of the following characteristics: the

comonomer content is 0.5 to 30 mol%, or 4 to 25 wt%, or 4 to 22 wt%; the content of xylene solubles is 18 to 75 wt%, or 30 to 70 wt%, or 30 to 67 wt%; the comonomer content in the xylene solubles is 10 to 50 wt%, or 20 to 35 wt%; the intrinsic viscosity ratio of the xylene solubles to the polypropylene copolymer is 0.5 to 3, or 0.8 to 1.3.

19. The method as claimed in any one of claims 14-18, wherein, the polypropylene copolymer has at least one of the following characteristics: the melt flow rate under a load of 2.16 kg at 230°C is 0.01 to 60 g/10 min, preferably 0.05 to 35 g/10 min, and more preferably 0.5 to 15 g/10 min. The melting temperature Tm is 100°C or higher, preferably 110 to 180°C, more preferably 110 to 170°C, more further preferably 120 to 170°C, and still more further preferably 120 to 166°C. The weight average molecular weight is preferably 20×10^4 to 60×10^4 g/mol.

20. The method as claimed in any one of claims 14-19, wherein, the reaction mixture further comprises a free radical initiator;

preferably, the free radical initiator is selected from a peroxide-based free radical initiator and/or an azo-based free radical initiator;

the peroxide-based radical initiator is preferably at least one selected from the group consisting of dibenzoyl peroxide, dicumyl peroxide, di-tert-butyl peroxide, lauroyl peroxide, dodecyl peroxide, tert-butyl peroxybenzoate, diisopropyl peroxydicarbonate, tert-butyl peroxy(2-ethylhexanoate) and dicyclohexyl peroxydicarbonate; the azo-based radical initiator is preferably azobisisobutyronitrile and/or azobisisoheptonitrile.

21. The method as claimed in any one of claims 14-20, wherein, the reaction mixture further comprises at least one of the following components: a dispersant, an interfacial agent and an organic solvent, wherein the mass content of the

dispersant is 50-300% of the mass of the polypropylene copolymer, the mass content of the interfacial agent is 1-30% of the mass of the polypropylene copolymer, and the mass content of the organic solvent is 1-35% of the mass of the polypropylene copolymer.

22. The method as claimed in any one of claims 14-20, wherein, the preparation method comprises the following steps:

a. placing a polypropylene copolymer in a closed reactor, followed by inert gas replacement;

b. adding a free radical initiator and an alkenyl-containing polymerizable monomer to the closed reactor, and mixing with stirring;

c. optionally adding an interfacial agent and optionally swelling the reaction system;

d. optionally adding a dispersant, and heating the reaction system to the grafting reaction temperature, to carry out the grafting reaction;

e. after the end of the reaction, optionally filtering, and drying to obtain the grafting-modified polypropylene material.

23. The method as claimed in any one of claims 14-20, wherein, the preparation method comprises the following steps:

a. placing a polypropylene copolymer in a closed reactor, followed by inert gas replacement;

b. mixing an organic solvent and a free radical initiator, and adding the mixture to the closed reactor;

c. removing the organic solvent;

d. adding an alkenyl-containing polymerizable monomer, optionally adding an interfacial agent, and optionally swelling the reaction system;

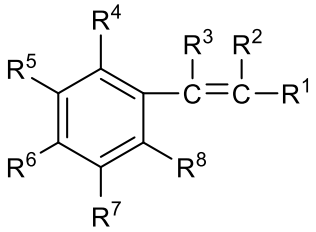
e. optionally adding a dispersant, and heating the reaction system to the grafting reaction temperature, to carry out the grafting reaction;

f. after the end of the reaction, optionally filtering, and drying to obtain the grafting-modified polypropylene material.

24. The method as claimed in any one of claims 14-23, wherein, the temperature of the grafting reaction is 30-130°C, and preferably 60-120°C; the time is 0.5-10 h, and preferably 1-5 h.

25. The method as claimed in claim 14, wherein, the grafting-modified polypropylene material is an aromatic olefin grafting-modified polypropylene material, the alkenyl-containing polymerizable monomer is a styrenic monomer, and the content of the structural units derived from the styrenic monomer and in a grafted state in the aromatic olefin grafting-modified polypropylene material is 0.5 to 14 wt%, preferably 1 to 7.5 wt%, and more preferably 1.5 to 5 wt%, based on the weight of the aromatic olefin grafting-modified polypropylene material;

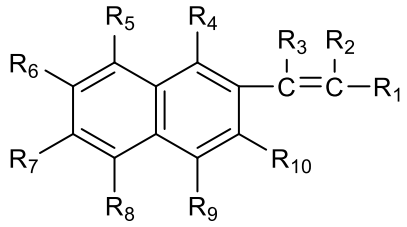
preferably, the styrenic monomer is at least one selected from a monomer having the structure represented by formula 8, a monomer having the structure represented by formula 9 and a monomer having the structure represented by formula 10;



formula 8

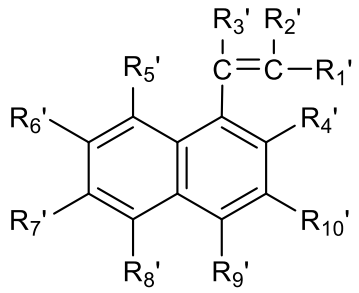
in the formula 8, R^1, R^2, R^3 are each independently selected from H, substituted or unsubstituted C_1-C_6 alkyl; R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group

is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R^1, R^2, R^3 are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R^4-R^8 are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy;



formula 9

in the formula 9, R_1, R_2, R_3 are each independently selected from H, substituted or unsubstituted C_1-C_6 alkyl; R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R_1, R_2, R_3 are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R_4-R_{10} are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy;



formula 10

in the formula 10, R_1', R_2', R_3' are each independently selected from H,

substituted or unsubstituted C_1-C_6 alkyl; R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, phosphoric group, sulfonic group, substituted or unsubstituted C_1-C_{12} alkyl, substituted or unsubstituted C_3-C_{12} cycloalkyl, substituted or unsubstituted C_1-C_{12} alkoxy, substituted or unsubstituted C_1-C_{12} ester group, substituted or unsubstituted C_1-C_{12} amine group, the substituent group is selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_{12} alkyl, C_3-C_{12} cycloalkyl, C_1-C_{12} alkoxy, C_1-C_{12} ester group, C_1-C_{12} amine group; preferably, R_1', R_2', R_3' are each independently selected from H, substituted or unsubstituted C_1-C_3 alkyl, R_4'-R_{10}' are each independently selected from H, halogen, hydroxy, amino, substituted or unsubstituted C_1-C_6 alkyl, substituted or unsubstituted C_1-C_6 alkoxy, the substituent group is selected from halogen, hydroxy, amino, C_1-C_6 alkyl, C_1-C_6 alkoxy;

preferably, the styrenic monomer is at least one selected from styrene, α-methylstyrene, 1-vinyl naphthalene, 2-vinyl naphthalene, mono- or polysubstituted styrene, mono- or polysubstituted α-methylstyrene, mono- or polysubstituted 1-vinyl naphthalene and mono- or polysubstituted 2-vinyl naphthalene; the substituent group preferably is at least one selected from halogen, hydroxy, amino, phosphoric group, sulfonic group, C_1-C_8 linear alkyl, C_3-C_8 branched alkyl or cycloalkyl, C_1-C_6 linear alkoxy, C_3-C_8 branched alkoxy or cycloalkoxy, C_1-C_8 linear ester group, C_3-C_8 branched ester group or cyclic ester group, C_1-C_8 linear amine group and C_3-C_8 branched amine group or cyclic amine group;

more preferably, the styrenic monomer is at least one selected from styrene, α-methylstyrene, 2-methylstyrene, 3-methylstyrene and 4-methylstyrene.

26. The method as claimed in claim 25, wherein,

the reaction mixture further comprises a free radical initiator, the mass ratio of the free radical initiator to the styrenic monomer is 0.1-10: 100, preferably 0.5-5: 100.

27. The method as claimed in claim 25, wherein, the mass ratio of the styrenic monomer to the polypropylene copolymer is 0.5-16: 100, preferably 1-12: 100, and more preferably 2-10: 100.

28. A grafting-modified polypropylene material for an insulating material obtained by the method as claimed in any one of claims 14-27.

29. Use of a grafting-modified polypropylene material as claimed in any one of claim 1-13 or obtained by the method as claimed in any one of claims 14-27 as an insulating material.

30. The grafting-modified polypropylene material for an insulating material as claimed in any one of claim 1-13, 28, or the use as claimed in claim 29, wherein, the insulating material is a cable insulating material; preferably a direct current cable insulating material.

31. The grafting-modified polypropylene material for an insulating material as claimed in any one of claim 1-13, 28, or the use as claimed in claim 29, wherein, the insulating material is a cable insulating layer material.

32. A cable, characterized in that the cable comprises: at least one conductor and at least one electrically insulating layer surrounding the conductor; wherein, the material of the electrically insulating layer is at least one grafting-modified polypropylene material as claimed in any one of claim 1-13, 28.

33. The cable as claimed in claim 32, wherein, the cable has at least one cable core, and each cable core comprises, in order from inside to outside: a conductor, an optional conductor shielding layer, an electrically insulating layer, an optional

electrically insulating shielding layer, an optional metal shielding layer.

34. The cable as claimed in claim 33, wherein, the cable further comprises an armor and/or a sheath layer.

35. The cable as claimed in claim 33, wherein, the cable further comprises a filling layer and/or a wrapping layer.

36. The cable as claimed in claim 32, wherein, the cable is a direct current cable or an alternating current cable; preferably the cable is a direct current cable.

37. An insulating material, characterized in that the insulating material comprises at least one grafting-modified polypropylene material as claimed in any one of claim 1-13, 28.

38. The insulating material as claimed in claim 33, wherein, the content of the at least one grafting-modified polypropylene material is 20 to 100 wt%, preferably 40 to 100 wt%, more preferably 60 to 100 wt%, further preferably 80 to 100 wt%, and more further preferably 90 to 100 wt%, based on the weight of the insulating material.

39. The insulating material as claimed in claim 37 or 38, wherein, the insulating material further comprises one or more selected from antioxidants, stabilizers, processing aids, flame retardants, water tree retarding additives, acid or ion scavengers, inorganic fillers, voltage stabilizers and copper inhibitors.