Claims

1. A polypropylene composition comprising:

(a) 70-95% by weight of a crystalline homopolypropylene as component A, with an isotactic pentad fraction of 96% or more, preferably 97% or more; wherein the crystalline homopolypropylene forms a continuous matrix phase in the polypropylene composition; and

(b) 5-30% by weight of an ethylene-propylene elastic copolymer as component B, wherein based on the total weight of the ethylene-propylene elastic copolymer, the ethylene-propylene elastic copolymer contains 20-35% by weight, preferably 25-35% by weight of ethylene structural units, and 65-80% by weight, preferably 65-75% by weight, of propylene structural units; the ethylene-propylene elastic copolymer forms a dispersed rubber phase in said continuous matrix phase;

wherein the ratio of the melt mass flow rate of the crystalline homopolypropylene to that of the polypropylene composition measured at 230°C under a load of 2.16kg according to GB/T 3682.1-2018 is 0.5-2.0, preferably 0.9-1.5;

the polypropylene composition has a melt mass flow rate of 5-30g/10min at 230°C under a load of 2.16 kg according to GB/T 3682.1-2018;

the crystalline homopolypropylene has a melt mass flow rate of 10-100 g/10 min at 230°C under a load of 2.16 kg according to GB/T 3682.1-2018;

the molecular weight distribution Mw/Mn of the polypropylene composition is ≤5, as determined by gel permeation chromatography (GPC) analysis relative to polystyrene standards; and

the intrinsic viscosity of the polypropylene composition is 1.0-2.5 dL/g, as determined by a capillary detector.

2. The polypropylene composition according to claim 1, wherein when no orientation force acts, the rubber phase is spherical or nearly spherical particles, and the rubber phase particles have an average size of 0.03-3.0 μm, preferably 0.05-2.0 μm, more preferably 0.05-1.5 μm, as determined by SEM method.

3. The polypropylene composition according to claim 1 or 2, wherein after the orientation force acts, at least 50% of the rubber phase particles have an aspect ratio greater than 2, based on the total number of rubber phase particles in the SEM

photograph.

4. The polypropylene composition according to any one of claims 1-3, wherein the rubber phase can be deformed at least partially under the action of orientation force and form an oriented structure, wherein the orientation force refers to an external field force that can cause an object to be oriented, the orientation refers to the parallel alignment of the object along the direction of the external field force, the orientation force is, for example, tensile stress and/or shear stress, in particular, the force applied to the polypropylene composition by the process of preparing an article per se; the oriented structure means that the longitudinal axes formed by deformation and elongation of the rubber phase particles under the action of the orientation force are aligned parallel to each other along a certain direction; preferably, at least 80% of the rubber phase particles form an oriented structure, based on the total number of rubber phase particles in the SEM photograph.

5. The polypropylene composition according to any one of claims 1-4, wherein the polypropylene composition has a melt mass flow rate of 6-30g/10min, preferably 8.89-30g/10min at 230°C under a load of 2.16 kg according to GB/T 3682.1-2018.

6. The polypropylene composition according to any one of claims 1-5, wherein the intrinsic viscosity of the polypropylene composition is 1.4-2.4 dL/g, preferably 1.52-2.08 dL/g; and/or the intrinsic viscosity of xylene solubles in the polypropylene composition is 1.0-4.0 dL/g, preferably 1.11-3.65 dL/g; and/or the ratio of the intrinsic viscosity of xylene solubles to the intrinsic viscosity of the crystalline homopolypropylene in the polypropylene composition is 0.7-2.6, as determined by a capillary detector.

7. The polypropylene composition according to any one of claims 1-6, wherein the molecular weight distribution Mw/Mn of the polypropylene composition is ≤ 4.5, as determined by gel permeation chromatography (GPC) analysis relative to polystyrene standards.

8. The polypropylene composition according to any one of claims 1-7, wherein the polypropylene composition has a 60° angle gloss of ≥80%, preferably ≥85%, more

preferably ≥90%, wherein the 60° angle gloss is obtained by measuring injection molded specimen according to GB/T 8807-1988, and the specimen thickness is 2mm; preferably, the polypropylene composition further has a haze of ≤50%, more preferably ≤40%, as measured for the injection molded specimen having a thickness of 1 mm according to GB/T 2410-2008.

9. The polypropylene composition according to claim 8, wherein the polypropylene composition further has one or more, preferably all of the following properties:

1) parallel shrinkage ratio of ≤ 1.15, preferably ≤ 1.1, as measured for injection molded specimen according to GB/T 17037.4-2003;

2) vertical shrinkage ratio of ≤ 1.36, preferably ≤ 1.15, as measured for injection molded specimen according to GB/T 17037.4-2003;

3) flexural modulus of ≥ 1000MPa, preferably ≥ 1300MPa, more preferably ≥ 1400MPa, even more preferably ≥ 1450MPa, obtained by measuring injection molded specimen according to GB/T9341-2008;

4) Charpy notched impact strength at room temperature of ≥ 5kJ/m^2, preferably ≥ 6kJ/m^2, obtained by measuring injection molded specimen at 23°C according to GB/T 1043.1-2008; and

5) heat deformation temperature of ≥ 90°C, preferably ≥ 92°C, as measured for injection molded specimen according to GB/T 1634.2-2004.

10. The polypropylene composition according to any one of claims 1-9, wherein the polypropylene composition further comprises: (c) a nucleating agent as component C, which is preferably at least one selected from the group consisting of carboxylic acids and their metal salts, sorbitol, aryl phosphates, dehydroabietic acid and its salts, aromatic amides, aromatic amines, rare earth compounds, condensed ring compounds having a quasi-planar structure, and polymeric nucleating agents; wherein based on the total weight of the polypropylene composition, the content of the nucleating agent is preferably 0.05-0.3 wt%.

11. The polypropylene composition according to any one of claims 1-10, wherein the polypropylene composition further comprises other auxiliary, said other auxiliary is preferably at least one selected from the group consisting of antioxidants, antistatic agents and colorants, preferably, based on the total weight of the polypropylene

composition, the content of the other auxiliary is preferably 0.05-0.6% by weight, more preferably 0.1-0.3% by weight.

12. The polypropylene composition according to any one of claims 1-11, wherein the polypropylene composition is in the form of powders or pellets.

13. A method for the preparation of the polypropylene composition according to any one of claims 1-12, comprising the following steps:

(1) under the first olefin polymerization conditions, contacting and reacting propylene monomers with a stereoselective Ziegler-Natta catalyst, and removing the unreacted monomers from the mixture obtained after the contacting and reacting to obtain product a, said product a comprising component A; and

(2) under the second olefin polymerization conditions, contacting and reacting ethylene monomers and propylene monomers with the product a as obtained in step (1) under gas phase, and removing the unreacted monomers from the mixture obtained after the contacting and reacting to obtain product b comprising component A and component B as the polypropylene composition,

wherein in the reaction system, the molar ratio of ethylene/(ethylene+propylene) is 0.1-0.4 mol/mol, and

hydrogen is used as a molecular weight regulator and the hydrogen/ethylene ratio is 0.02-0.70 mol/mol.

14. The method according to claim 13, wherein the stereoselective Ziegler-Natta catalyst comprises:

(i) a solid catalyst component, containing a product obtained from the reaction of a magnesium source, a titanium source and an internal electron donor; wherein the internal electron donor is preferably selected from the group consisting of monocarboxylic acid esters, dicarboxylic acid esters, phosphoric acid ester compounds, diether compounds and combinations thereof; the magnesium source is, for example, selected from magnesium halide, magnesium alcoholate, or halogenated alcoholate and magnesium halide adduct carrier, preferably spherical magnesium halide adduct; the titanium source is, for example, one or more selected from the titanium compounds represented by the general formula $Ti(OR)_{4-m}X_m$, wherein m is an integer of 0-4, preferably an integer of 1-4, R is a C_1-C_{20} alkyl, preferably a C_1-C_{10}

alkyl, X is halogen, preferably chlorine;

(ii) an organoaluminum compound, preferably an alkylaluminum compound, more preferably at least one selected from the group consisting of triethylaluminum, tri-n-butylaluminum, triisobutylaluminum, tri-n-hexylaluminum, diethylaluminum monochloride, di-n-butylaluminum monochloride, diisobutylaluminum monochloride, di-n-hexylaluminum monochloride, ethylaluminum dichloride, n-butylaluminum dichloride, isobutylaluminum dichloride and n-hexylaluminum dichloride, further preferably at least one selected from triethylaluminum, tri-n-butylaluminum and triisobutylaluminum; and

(iii) optionally an external electron donor, preferably an organosilicon compound, more preferably an organosilicon compound having the general formula $R_nSi(OR')_{4-n}$, where $0<n\leq3$, R is selected from hydrogen atom, halogen, alkyl, cycloalkyl, aryl and haloalkyl, and R' is selected from alkyl, cycloalkyl, aryl and haloalkyl; wherein more preferably, the external electron donor is at least one selected from the group consisting of tetramethoxysilane, tetraethoxysilane, trimethylmethoxysilane, trimethylethoxysilane, trimethylphenoxysilane, dimethyldimethoxysilane, dimethyldiethoxysilane, methyl tert-butyldimethoxysilane, methylisopropyldimethoxysilane, diphenoxydimethoxysilane, diphenyldiethoxysilane, phenyltrimethoxysilane, phenyltriethoxysilane, vinyltrimethoxysilane, cyclohexylmethyldimethoxysilane, dicyclopentyldimethoxysilane, diisopropyldimethoxysilane, diisobutyldimethoxysilane, 2-ethylpiperidinyl-2-tert-butyldimethoxysilane, (1,1,1-trifluoro-2-propyl)-2-ethylpiperidinyldimethoxysilane, and (1,1,1-trifluoro-2-propyl)-methyldimethoxysilane;

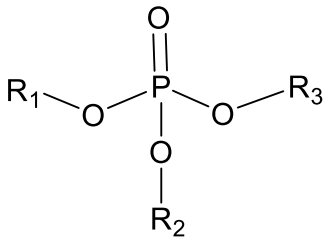
preferably, the catalyst has been subjected to pre-complexation and/or pre-polymerization treatments.

15. The method according to claim 14, wherein the internal electron donor is selected from a monocarboxylic acid ester and/or a dicarboxylic acid ester, preferably at least one selected from the group consisting of benzoate, malonate, phthalate and succinate, more preferably alkyl phthalate, further preferably diisobutyl phthalate and/or dioctyl phthalate.

16. The method according to claim 14, wherein the internal electron donor is an

internal electron donor compounded by a phosphoric acid ester compound and a diether compound; preferably, the molar ratio of the amount of the diether compound to that of the phosphoric acid ester compound is 1:(0.02-0.25), more preferably 1:(0.04-0.15);

wherein the phosphoric acid ester compound is preferably at least one selected from the phosphoric acid ester compounds represented by formula (1),



formula (1)

wherein R_1, R_2 and R_3 are each independently selected from C_1-C_4 linear or branched alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} alkaryl or C_7-C_{20} aralkyl;

more preferably, the phosphoric acid ester compound is at least one selected from the group consisting of trimethyl phosphate, triethyl phosphate, tributyl phosphate, triphenyl phosphate, tricresyl phosphate, triisopropylphenyl phosphate, trimethoxy phenyl phosphate, phenyl dimethyl phosphate, cresyl dibutyl phosphate, cumyl dimethyl phosphate, cumyl diethyl phosphate, cumyl dibutyl phosphate, phenyl xylyl phosphate, phenyl diisopropylphenyl phosphate, p-cresyl dibutyl phosphate, m-cresyl dibutyl phosphate, p-cumyl dimethyl phosphate, p-cumyl diethyl phosphate, p-tert-butylphenyl dimethyl phosphate and o-cresyl p-di-tert-butylphenyl phosphate;

wherein the diether compound is preferably at least one selected from the diether compounds represented by formula (2),

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

wherein R^1 and R^2 are each independently selected from hydrogen, C_1-C_{20} linear or branched alkyl, C_3-C_{20} cycloalkyl, C_6-C_{20} aryl, C_7-C_{20} aralkyl or C_7-C_{20} alkaryl, R^3 and R^4 are each independently selected from C_1-C_{10} alkyl;

more preferably, the diether compound is at least one selected from the group consisting of 2-(2-ethylhexyl)-1,3-dimethoxypropane, 2-isopropyl-1,3-dimethoxypropane, 2-butyl-1,3-dimethoxypropane, 2-sec-butyl-1,3-dimethoxypropane, 2-cyclohexyl-1,3-dimethoxypropane, 2-phenyl-1,3-dimethoxypropane, 2-(2-phenylethyl)-1,3-dimethoxypropane,

2-(2-cyclohexylethyl)-1,3-dimethoxypropane,
2-(p-chlorophenyl)-1,3-dimethoxypropane, 2-(diphenylmethyl)-1,3-dimethoxypropane,
2,2-dicyclohexyl-1,3-dimethoxypropane, 2,2-dicyclopentyl-1,3-dimethoxypropane,
2,2-diethyl-1,3-dimethoxypropane, 2,2-dipropyl-1,3-dimethoxypropane,
2,2-diisopropyl-1,3-dimethoxypropane, 2,2-dibutyl-1,3-dimethoxypropane,
2-methyl-2-propyl-1,3-dimethoxypropane, 2-methyl-2-benzyl-1,3-dimethoxypropane,
2-methyl-2-ethyl-1,3-dimethoxypropane, 2-methyl-2-isopropyl-1,3-dimethoxypropane,
2-methyl-2-phenyl-1,3-dimethoxypropane,
2-methyl-2-cyclohexyl-1,3-dimethoxypropane,
2,2-bis(2-cyclohexylethyl)-1,3-dimethoxypropane,
2-methyl-2-isobutyl-1,3-dimethoxypropane,
2-methyl-2-(2-ethylhexyl)-1,3-dimethoxypropane,
2,2-diisobutyl-1,3-dimethoxypropane, 2,2-diphenyl-1,3-dimethoxypropane,
2,2-dibenzyl-1,3-dimethoxypropane, 2,2-bis(cyclohexylmethyl)-1,3-dimethoxypropane,
2-isobutyl-2-isopropyl-1,3-dimethoxypropane,
2-(1-methylbutyl)-2-isopropyl-1,3-dimethoxypropane,
2-isopropyl-2-isopentyl-1,3-dimethoxypropane,
2-phenyl-2-isopropyl-1,3-dimethoxypropane,
2-phenyl-2-sec-butyl-1,3-dimethoxypropane,
2-benzyl-2-isopropyl-1,3-dimethoxypropane,
2-cyclopentyl-2-isopropyl-1,3-dimethoxypropane,
2-cyclopentyl-2-sec-butyl-1,3-dimethoxypropane,
2-cyclohexyl-2-isopropyl-1,3-dimethoxypropane,
2-cyclohexyl-2-sec-butyl-1,3-dimethoxypropane,
2-isopropyl-2-sec-butyl-1,3-dimethoxypropane,
2-cyclohexyl-2-cyclohexylmethyl-1,3-dimethoxypropane and
9,9-dimethoxymethylfluorene.

17. The method according to any one of claims 14-16, wherein the molar ratio of the magnesium source in terms of magnesium element, the titanium source in terms of titanium element and the internal electron donor is 1: (20-150): (0.1-0.9), preferably 1: (30- 120): (0.15-0.6); and/or the amount ratio of the solid catalyst component to the organoaluminum compound in terms of titanium/aluminum molar ratio is 1:(25-100); and/or the weight ratio of the organoaluminum compound to the external electron

donor is (0-150):1, preferably (2-150):1, more preferably (3-10):1.

18. The method according to any one of claims 13-17, wherein in step (1), the first olefin polymerization conditions are liquid phase polymerization conditions or gas phase polymerization conditions; the liquid phase polymerization conditions include: a polymerization temperature of 0-150°C, preferably 40-100°C; and a polymerization pressure higher than the saturated vapor pressure of propylene at the corresponding polymerization temperature; the gas phase polymerization conditions include: a polymerization temperature of 0-150°C, preferably 40-100°C; and a polymerization pressure greater than or equal to normal pressure, preferably at 0.5-2.5 MPa; preferably, the hydrogen/propylene ratio used in step (1) is 0.0010-0.0060 mol/mol.

19. The method according to any one of claims 13-18, wherein in the reaction system of step (2), the molar ratio of ethylene/(ethylene+propylene) is 0.1-0.3 mol/mol, preferably 0.15-0.25 mol/mol; and/or the temperature of olefin gas phase polymerization is 40-100°C, preferably 60-80°C; and the pressure is 0.6-1.4 MPa, preferably 1.0-1.3 MPa; and/or the hydrogen/ethylene ratio is 0.04-0.54 mol/mol.

20. The method according to any one of claims 13-19, wherein the method further comprises step (3): subjecting the product b obtained in step (2) and a nucleating agent and optionally other auxiliaries to mixing, preferably further pelletization.

21. An article, preferably an injection molded article, prepared by the polypropylene composition according to any one of claims 1-12, wherein at least a part of the rubber phase, preferably at least 80% of the rubber phase particles are deformed and form an oriented structure, in particular, both at a position within 10% of the thickness from the article surface and at a position of the core part beyond 10% of the thickness from the article surface, the rubber phase is deformed, elongated and forms an oriented structure; wherein, preferably, more than 50% of the rubber phase particles at a position within 10% of the thickness from the article surface have an aspect ratio greater than or equal to 4; and more than 50% of the rubber phase particles at a position of the core part beyond 10% of the thickness from the article surface have an aspect ratio greater than or equal to 2, based on the total number of the rubber phase particles at the corresponding position in the SEM photograph.

22. The article according to claim 21, wherein the article is a product or a part of the product used in electrical appliances, homes, packaging, automobiles, toys or medicine field, for example, housings for home appliances, automotive interior parts, children's toys, home storage products or medical disposable syringes.