

HIGH-STRENGTH SELF-LUBRICATING POLYURETHANE PISTON SEALING BODY, AND PREPARATION METHOD THEREFOR

5 Technical field

The present invention relates to the field of polymer materials, in particular to a composition for preparing a piston sealing body, a piston sealing body prepared from the composition, and a method of preparing the piston sealing body. The piston sealing body may be used as a concrete piston sealing body for concrete pumping
10 device.

Background of the invention

Piston is a key core component of concrete pumping device (e.g., pump trucks, dragging pumps, and truck-mounted pumps) and it takes effects to seal cavities and
15 push concrete during concrete deliveries. Because delivered concrete has hard media, complex components, high pumping pressures and high requirements on sealing performances, the piston has to have good mechanical strength and wear resistance. At present, the pistons have short lifetime, frequent replacement and high operation cost.

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Existing piston sealing bodies mainly comprise two materials, rubber materials or polyurethane materials. The rubber pistons are formed, with nitrile rubber as main part, by adding a reinforcing agent, an anti-aging agent, a vulcanizing agent, and the like, and mixing and hot pressing them. China patent application CN201310234970.3 uses
25 nitrile rubber as the main material to prepare a piston for concrete pump trucks where the main raw materials include nitrile rubber, ethyl acetate, polyisocyanate and the like, and although fiber reinforced materials are added in the preparation process, the pump still has low strength and low hardness, with the maximum hardness of 85 A and the maximum tensile strength of 36 MPa, and thus it cannot meet market
30 demands.

US patent US10415556B2 relates to a portable pumping mechanism for pumping building materials or water, and US patent application US2010/0264635A1 relates to the vehicle structure of a concrete pump truck, neither of which relates to a method of
35 preparing piston materials. German patent application DE102005008242A relates to a method of preparing a foamed polyurethane material that, however, has a low tensile

strength, about 2 MPa, and thus it is not applicable for the preparation of polyurethane materials of piston heads.

Disclosures of the invention

5 One object of the present invention is to provide a high-strength self-lubricating polyurethane piston that solves the problems of existing polyurethane pistons of low strength and high wear. By adding specially treated fillers to a polymerization system, the strength and wear resistance of the piston are improved, thereby increasing the service life and reducing the replacement frequency.

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In one aspect, the present application provides a composition for preparing a piston sealing body, in parts by weight, comprising the following components: 100 parts of a polyurethane prepolymer, 10 to 20 parts of a chain extender, 5 to 10 parts of a surface-silylated ultrahigh-molecular-weight polyethylene powder, 1 to 1.5 parts of an
15 antioxidant, 1 to 2 parts of a surface-silylated alumina powder, and 1 to 3 parts of molybdenum disulfide or a sodiumized polytetrafluoroethylene powder.

In the present invention, “prepolymer” refers to a substance formed by preliminary polymerization of a monomer, which can be used in occasions where it is difficult for
20 monomers to be completely polymerized into polymers once, or where voids and cracks in the processing and molding of polymers are to be avoided. The present invention uses polyurethane prepolymer as the main material for preparing the piston sealing body.

25 “Polyurethane” is a generic name for polymers containing a certain amount of carbamate groups in the molecules. The polyurethane can be prepared with interactions of a mono- or poly-organic isocyanic acid (e.g., toluene diisocyanate (TDI) or a diphenylmethane diisocyanate (MDI)), with a polyol compound (e.g., polyether polyols or polyester polyols), and the formed polymer backbone contains a plurality of
30 repeating carbamate groups. The polyurethane prepolymer is a reactive semi-finished product obtained by reacting the poly-organic isocyanic acid and the polyol in a controlled ratio.

In certain embodiments, the polyurethane prepolymer is in a polyether type.

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In certain embodiments, the polyurethane prepolymer is selected from one or both of LF M2050 model and LF M2032 model.

5 In certain embodiments, the polyurethane prepolymer has one or more of the following features:

free MDI content: lower than 0.1 wt%, such as 0.01 wt% to 0.02 wt%, 0.02 wt% to 0.03 wt%, 0.03 wt% to 0.04 wt%, 0.04 wt% to 0.05 wt%, 0.05 wt% to 0.06 wt%, 0.06 wt% to 0.07 wt%, 0.07 wt% to 0.08 wt% or 0.08 wt% to 0.09 wt%;

10 isocyanate (-NCO) content: 3.0% to 5.0%, such as 3.0% to 3.5%, 3.5% to 4.0%, 4.0% to 4.5% or 4.5% to 5.0%;

viscosity: 120 to 500 cps, such as 120 to 150 cps, 150 to 200 cps, 200 to 300 cps, 300 to 400 cps or 400 to 500 cps.

15 In the present invention, "chain extender" refers to a substance capable of reacting with functional groups on a linear polymer chain to expand the molecular chain and increase the molecular weight, and it is commonly used for improving mechanical properties and process properties of polyurethane, polyester products and the like. In certain embodiments, the used chain extenders are alcohol chain extenders, e.g., aromatic alcohol chain extenders, such as 1,4-bis(2-hydroxyethoxy)benzene (HQEE).
20 In certain embodiments, the used chain extenders are amine chain extenders, e.g., diamine chain extenders, such as 3,3'-dichloro-4,4'-diaminodiphenylmethane.

The present invention adds fillers such as specially-modified ultrahigh-molecular-weight polyethylene powder, and alumina powder to a
25 polyurethane matrix to increase the mechanical strength of the polyurethane, and adds molybdenum disulfide or specially-treated polytetrafluoroethylene to the interior of a piston as self-lubricating particles to reduce the friction coefficient.

In certain embodiments, the ultrahigh-molecular-weight polyethylene powder used in
30 the present invention has a particle size of 30 to 50 μm , such as 30 to 35 μm , 35-40 μm , 40 to 45 μm or 45 to 50 μm .

In certain embodiments, the ultrahigh-molecular-weight polyethylene powder used in the present invention has a molecular weight (e.g. viscosity-average molecular weight)
35 of 4,000,000 to 5,000,000, such as 4,000,000 to 4,500,000 or 4,500,000 to 5,000,000.

In certain embodiments, the alumina powder used in the present invention has a particle size of 3000 to 5000 meshes, such as 3000 to 4000 meshes or 4000 to 5000 meshes.

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In certain embodiments, the antioxidants used in the present invention are hindered phenol antioxidants, such as antioxidant 1010.

10 In certain embodiments, the sodiumized polytetrafluoroethylene powder is polytetrafluoroethylene powder treated with sodium naphthalene.

In some embodiments, the sodiumized polytetrafluoroethylene powder has a particle size of 3 to 20 μm , such as 3 to 5 μm , 5 to 10 μm , 10 to 15 μm or 15 to 20 μm .

15 In certain embodiments, the composition, in parts by weight, comprises 10 to 11, 11 to 12, 12 to 13, 13 to 14, 14 to 15, 15 to 16, 16 to 17, 17 to 18, 18 to 19 or 19 to 20 parts of the chain extender.

20 In some embodiments, the composition, in parts by weight, comprises 5 to 6, 6 to 7, 7 to 8, 8 to 9 or 9 to 10 of the surface-silylated ultrahigh-molecular-weight polyethylene powder.

In some embodiments, the composition, in parts by weight, comprises 1 to 1.2, 1.2 to 1.3, 1.3 to 1.4 or 1.4 to 1.5 of the antioxidant.

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In some embodiments, the composition, in parts by weight, comprises 1 to 1.2, 1.2 to 1.5 or 1.5 to 2 of the surface-silylated alumina powder.

30 In some embodiments, the composition, in parts by weight, comprises 1 to 2 or 2 to 3 parts of the molybdenum disulfide or the sodiumized polytetrafluoroethylene powder.

The surface-silylated ultrahigh-molecular-weight polyethylene powder used in the present invention may be prepared according to a method comprising the following steps:

35 Step 1: oxidation treating an ultrahigh-molecular-weight polyethylene powder;

Step 2: reacting the oxidation-treated ultrahigh-molecular-weight polyethylene powder with a silane coupling agent.

The oxidation treatment in Step 1 may be conducted in a solution comprising
5 potassium permanganate and nitric acid. In certain embodiments, the solution is a mixed solution of a saturated potassium permanganate aqueous solution and a nitric acid aqueous solution (e.g., 50% to 60% nitric acid aqueous solutions). In certain
embodiments, the oxidation treatment comprises the steps: charging the
ultrahigh-molecular-weight polyethylene powder into the solution comprising
10 potassium permanganate and nitric acid (e.g., a mixed solution of a saturated potassium permanganate aqueous solution and a 50% nitric acid aqueous solution);
after heating (e.g., heating to 80 to 90 °C) and stirring (e.g., stirring for 30 to 40 min),
filtering them to obtain a powder; and then repeatedly washing the powder with
deionized water, and filtering and oven drying it.

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In Step 2, common silane coupling agents, such as silane coupling agent KH540,
silane coupling agent KH550, silane coupling agent KH560, and silane coupling agent
KH 570 may be used in the silylation reaction. In certain embodiments, the used
silane coupling agent is the silane coupling agent KH 550. The weight of the used
20 silane coupling agent may be 0.1% to 1% (e.g., 0.3% or 0.6%) of the weight of the
ultrahigh-molecular-weight polyethylene powder.

The silylation reaction may be conducted under the conditions of stirring (e.g., at a
speed of 1500 to 2000 rpm) and heating (e.g., at 70 to 80 °C). In certain embodiments,
25 the silylation treatment is conducted in a high speed mixer.

In certain embodiments, the silylation reaction comprises the steps: charging the
oxidation-treated ultrahigh-molecular-weight polyethylene powder into a high speed
mixer that is adjusted at a speed of 1500 rpm and at a temperature of 70 °C, and
30 dropwise adding the silane coupling agent KH550 in an amount of 0.3% or 0.6% by
weight of the powder to conduct a coupling treatment.

According to the present invention, the sodium naphthalene treatment may comprise

the following steps: adding the polytetrafluoroethylene powder into a sodium naphthalene treatment solution where the powder is fully immersed, stirring them for 10 to 15 minutes, filtering them, and washing them with tetrahydrofuran and deionized water several times until no smell of the sodium naphthalene treatment solution exists.

- 5 In certain embodiments, the sodium naphthalene treatment further comprises placing the sodiumized polytetrafluoroethylene powder in an oven for drying (e.g., drying at 100-110 °C for 100-150 hours), grinding and dispersing it.

10 In the present invention, the sodium naphthalene treatment solution is a solution obtained by dissolving or complexing equal molar amounts of sodium and naphthalene in an active ether, e.g., tetrahydrofuran.

In certain embodiments, the sodium naphthalene treatment solution is prepared according to the following method: under the protection of a nitrogen atmosphere,
15 naphthalene is weighed and charged into an active ether (e.g., tetrahydrofuran); after the naphthalene is completely dissolved, sodium is added thereto, and the mixture is sufficiently stirred so that the sodium is dissolved, to produce a sodium naphthalene treatment solution. In certain embodiments, the weight of the naphthalene is from 120 to 150 g (e.g., 128 g). In certain embodiments, the weight of the sodium is from 20 to
20 25 g (e.g., 23 g). In certain embodiments, the volume of the active ether (e.g., tetrahydrofuran) is 1 L.

The surface-silylated alumina powder used in the present invention may be prepared according to a method comprising the following steps: under the conditions of stirring
25 (e.g., at a speed of 2000 to 3000 rpm) and heating (e.g., at 70 to 80 °C), making alumina powder react with a silane coupling agent. In certain embodiments, the step is conducted in a high speed mixer. The silylation reaction may use common silane coupling agents such as silane coupling agent KH540, silane coupling agent KH550, silane coupling agent KH560, and silane coupling agent KH570. In certain
30 embodiments, the used silane coupling agent is the silane coupling agent KH550. The weight of the used silane coupling agent may be 1% to 5%, such as 2%, of the weight of the alumina powder.

In certain embodiments, the step comprises: charging the alumina powder into a high

speed mixer that is adjusted at a speed of 2000 rpm and at a temperature of 70 °C, and dropwise adding the coupling agent KH550 in an amount of 2% by weight of the powder to conduct a coupling treatment.

- 5 In one aspect, the present application provides use of the composition of any of the above for preparing a piston sealing body. In certain embodiments, the piston sealing body is a concrete piston sealing body.

In one aspect, the present application provides a piston sealing body that is prepared
10 by casting the composition of any of the above. In certain embodiments, the piston sealing body is a concrete piston sealing body.

The present application further provides a method of preparing the piston sealing body of the present invention, comprising casting the composition of any of the above.

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In certain embodiments, the method comprises the following steps:

- a) in parts by weight, weighing a polyurethane prepolymer, a chain extender, a surface-silylated ultrahigh-molecular-weight polyethylene powder, molybdenum disulfide or a sodiumized polytetrafluoroethylene powder, a surface-silylated alumina
20 powder and an antioxidant respectively;
- b) charging the polyurethane prepolymer, the surface-silylated ultrahigh-molecular-weight polyethylene powder, the molybdenum disulfide or the sodiumized polytetrafluoroethylene powder, and the surface-silylated alumina powder into tank A of a caster, mixing them uniformly and stirring them at a low speed of 650
25 rpm to 950 rpm (e.g., 700 rpm) by controlling temperatures at 80 to 100 °C (e.g., 90 °C);
- c) charging the chain extender into tank B of the caster, and by controlling temperatures at 110 to 120 °C (e.g., 115 °C), and after the chain extender is completely melted, adding the antioxidant while stirring at a high speed of 1500 to
30 2500 rpm (e.g., 1600 rpm);
- d) cleaning the cavity of a mold, spraying a release agent in the mold, and preheating it in an oven at 110 to 130 °C (e.g., 120 °C);
- e) mixing the liquids in tank A and tank B in a ratio controlled by the caster while

vacuuming, and after stirring at a high speed of 2000 to 3500 rpm, by keeping temperatures at 100 to 120 °C, casting them into the mold;

f) placing the mold in an oven for heating at 100 to 120 °C for 16 to 20 h, and conducting a demolding after the mold is taken out; and

5 g) machine processing the demolded blank, to obtain the piston sealing body of the present invention.

In certain embodiments, the surface silylated ultrahigh-molecular-weight polyethylene powder, the sodiumized polytetrafluoroethylene powder, and/or the surface silylated
10 alumina powder are prepared according to the methods described above.

The piston sealing body of the present invention may be used as a high-strength self-lubricating piston sealing body, having high mechanical strength whilst having excellent wear resistance and small friction coefficient, and it can greatly increase the
15 serve life of pistons. In certain embodiments, the piston sealing body has one or more of the following features:

tensile strength: ≥ 60 MPa;

elongation at break: $\geq 550\%$;

tear strength: ≥ 115 kN/m;

20 Shore hardness: 96-98 HA;

Akron abrasion: ≤ 0.025 cm³;

service life: above 550 h (which is improved by more than 50% than the serve life of pure polyurethane concrete pistons).

25 Methods that are commonly used in the art are used to test the performances of the piston sealing body. Exemplary test criteria are shown below:

Performance parameters	Reference standards or test methods
Shore hardness (HA)	GB/T 531.1
Tensile Strength (MPa)	GB/T 528
Elongation at break (%)	GB/T 528
Tear strength (kN/m)	GB/T 529
Akron abrasion (cm ³)	GB/T 1689

Further, the present application also provides a piston, comprising the piston seal

body of the present invention. In certain embodiments, the piston is a concrete piston.

Further, the present application also provides a delivery cylinder comprising the piston sealing body or piston of the present invention.

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Further, the present application also provides a concrete pumping device (e.g., pump trucks, dragging pumps, truck-loaded pumps), comprising the piston sealing body, piston, or delivery cylinder of the present invention.

10 FIG. 1 and FIG. 2 exemplarily show the structure of the concrete piston sealing body of the present invention. FIG. 1 is a sectional diagram, and FIG. 2 is a local schematic diagram of the section of FIG. 1.

In the figures, the numbers in the figures denote:

- 15 1-angle of inner ring of the lip opening of concrete piston relative to horizontal plane,
2-angle of lip opening of concrete piston relative to horizontal plane,
3-angle of outer slope of the lip opening of concrete piston relative to vertical direction,
4-side friction surface of concrete piston,
5-lubricating grease storage groove of concrete piston,
20 6-schematic diagram of ultrahigh-molecular-weight polyethylene powder, and
7-schematic diagram of alumina powder.

In certain embodiments, the concrete piston sealing body of the present invention has the following main dimensions:

- 25 angle of inner ring of lip opening relative to horizontal plane: 40-45°;
angle of lip opening relative to horizontal plan: 3-10°;
angle of outer slope of lip opening relative to vertical direction: 15-25°;
width of side friction surface: 10-15 mm;
depth of lubricating grease storage groove: 3-5 mm.

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The above piston sealing body is provided with a special oil storage groove that may take better lubricating effects.

Advantageous effects of the present invention

35 The piston sealing body of the present invention has one or more of the following

advantageous effects:

1. for the piston sealing body of the present invention, a simple production process is provided with low cost and stable quality;
2. for the piston sealing body of the present invention, a special filler treating process is adopted so that the ultrahigh-molecular-weight polyethylene powder, the polytetrafluoroethylene powder and the alumina powder are firmly bonded to the polyurethane matrix and uniformly dispersed;
3. the enhancing anti-friction particles of the piston sealing body of the present invention are uniformly distributed, which may increase the wear resistance;
4. the piston sealing body of the present invention has excellent mechanical properties and it can meet working conditions of concrete pumping under high pressures;
5. the piston sealing body of the present invention can realize self-lubrication at parts, such as sealing lip opening, contact surface with cylinder, and contact surface with concrete, to reduce friction coefficient and wear loss;
6. the self-lubricating particles in the interior of the piston sealing body of the present invention are uniformly distributed and they continue to achieve self-lubricating effect at a new friction surface.

Illustrations to drawings of the invention

FIG. 1 is a sectional diagram of a piston sealing body of the present invention, and FIG. 2 is a local schematic diagram of the section of FIG. 1. In the figures, the numbers denote:

- 1-angle of inner ring of the lip opening of piston relative to horizontal plane, 2-angle of lip opening of piston relative to horizontal plane, 3-angle of outer slope of the lip opening of piston relative to vertical direction, 4-side friction surface of concrete piston, 5-lubricating grease storage groove of piston, 6-schematic diagram of ultrahigh-molecular-weight polyethylene powder, and 7-schematic diagram of polytetrafluoroethylene powder, 8-schematic diagram of alumina powder.

Embodiments for carrying out the invention

Embodiments of the present invention will be described below in detail with reference to examples. However, it will be understood by a person skilled in the art that the following examples are only illustrative for the present invention, but should not be regarded to be limitative for the scope of the present invention. The examples where

particular conditions are not specified, are performed according to conventional conditions or conditions recommended by manufacturers. All the used reagents or instruments that are not indicated with manufacturers are conventional products that are commercially available.

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Example 1

- (1) 2500 g of a ultrahigh-molecular-weight polyethylene powder was charged into a mixed solution of a saturated potassium permanganate solution and a 50% nitric acid, and after heating to 80 °C and stirring for 30 min, they were filtered to obtain a powder;
10 then, the powder was repeatedly washed with deionized water and filtered; after oven drying, the powder was charged into a high speed mixer that was adjusted at a speed of 1500 rpm and at a temperature of 70 °C; 7.5 g of the coupling agent KH550 was dropwise added to conduct a coupling treatment;
- (2) 750 g of a polytetrafluoroethylene powder was placed in a sodium naphthalene
15 solution for full immersion and then stirred; the powder was repeatedly washed with tetrahydrofuran and filtered; after being placing in an oven to be dried for 150 h, they were ground and dispersed;
- (3) 250 g of an alumina powder was charged into a high-speed mixer that was adjusted at a speed of 2000 rpm, and at a temperature of 70 °C, 5 g of the coupling
20 agent KH550 was dropwise added to conduct a coupling treatment;
- (4) 25000 g of a prepolymer was added to tank A of a caster, and temperature was controlled at 90 °C; the above surface-treated ultrahigh-molecular-weight polyethylene powder, polytetrafluoroethylene powder and alumina powder were homogenously mixed into the prepolymer and stirred in a low speed 700 rpm;
- 25 (5) 3750 g of a chain extender was charged into tank B of the caster, and temperature was controlled at 115 °C; after the chain extender was fully molten, 250 g of an antioxidant was added thereto and stirred at a speed of 1600 rpm;
- (6) the cavity of a mold was cleaned and a release agent was sprayed in the mold; the mold was preheated in an oven at 120 °C;
- 30 (7) the liquids in tank A and tank B were mixed and vacuumed, and temperature was controlled at 120 °C; after stirring at a high speed of 2500 rpm, the liquids were cast

into the cavity of the mold;

(8) the mold was placed in an oven at 120 °C for 16 h, and it was demolded after being taken out;

(9) the demolded product blank was machine processed to produce a high-strength self-lubricating polyurethane piston.

Example 2

(1) 1250 g of a ultrahigh-molecular-weight polyethylene powder was charged into a mixed solution of a saturated potassium permanganate solution and a 50% nitric acid, and after heating to 80 °C and stirring for 30 min, they were filtered to obtain a powder; then, the powder was repeatedly washed with deionized water and filtered; after oven drying, the powder was charged into a high speed mixer that was adjusted at a speed of 1500 rpm and at a temperature of 70 °C; 7.5 g of the coupling agent KH550 was dropwise added to conduct a coupling treatment;

(2) 500 g of a polytetrafluoroethylene powder was placed in a sodium naphthalene solution for full immersion and then stirred; the powder was repeatedly washed with tetrahydrofuran and filtered; after being placing in an oven to be dried for 150 h, they were ground and dispersed;

(3) 250 g of an alumina powder was charged into a high-speed mixer that was adjusted at a speed of 2000 rpm, and at a temperature of 70 °C, 5 g of the coupling agent KH550 was dropwise added to conduct a coupling treatment;

(4) 25000 g of a prepolymer was added to tank A of a caster, and temperature was controlled at 90 °C; the above surface-treated ultrahigh-molecular-weight polyethylene powder, polytetrafluoroethylene powder and alumina powder were homogenously mixed into the prepolymer and stirred in a low speed 700 rpm;

(5) 3750 g of a chain extender was charged into tank B of the caster, and temperature was controlled at 115 °C; after the chain extender was fully molten, 250 g of an antioxidant was added thereto and stirred at a high speed of 1600 rpm;

(6) the cavity of a mold was cleaned and a release agent was sprayed in the mold; the mold was preheated in an oven at 120 °C;

(7) the liquids in tank A and tank B were mixed and vacuumed, and temperature was

controlled at 120 °C; after stirring at a high speed of 2500 rpm, the liquids were cast into the cavity of the mold;

(8) the mold was placed in an oven at 120 °C for 16 h, and it was demolded after being taken out;

- 5 (9) the demolded product blank was machine processed to produce a high-strength self-lubricating polyurethane piston.

Comparative Example 1

- (1) 25000 g of a prepolymer was added to tank A of a caster, and stirred at a low
10 speed 700 rpm and temperature was controlled at 90 °C;

(2) 3750 g of a chain extender was charged into tank B of the caster, and temperature was controlled at 115 °C; after the chain extender was fully molten, it was stirred at a high speed of 1600 rpm;

- (3) the cavity of a mold was cleaned and a release agent was uniformly sprayed in the
15 mold; the mold was preheated in an oven at 120 °C;

(4) the liquids in tank A and tank B were mixed and vacuumed, and temperature was controlled at 120 °C; after stirring at a high speed of 2500 rpm, the liquids were cast into the cavity of the mold;

- (5) the mold was placed in an oven at 120 °C for 16 h, and it was demolded after
20 being taken out;

(6) the demolded blank was machine processed to produce a high-strength self-lubricating polyurethane piston.

The mechanical performances, wear resistance and service time of the concrete piston sealing bodies prepared in Example 1, Example 2 and Comparative Example 1
25 were tested and the results are shown in Table 1:

Table 1 Performance test results of concrete positons prepared in the examples and the comparative example

Performance parameters	Reference standard	Example 1	Example 2	Comparative Example 1
Shore Hardness (HA)	GB/T531.1	97	98	93
Tensile	GB/T528	62	61	50

Strength (MPa)				
Elongation at Break (%)	GB/T528	570	556	450
Tear Strength (kN/m)	GB/T529	118	115	102
Akron abrasion (cm ³)	GB/T1689	0.022	0.025	0.045
Service life (h)	/	580	555	370

While the specific embodiments of the present invention have been described in detail, those skilled in the art will understand that: many modifications and variations made to the details are possible in light of the overall teachings that have been disclosed, and

5 such modifications and variations each are within the protection scope of the present invention. The full scope of the present invention is provided by the appended claims and any equivalents thereof.

Claims

1. A composition for preparing a piston sealing body, in parts by weight, comprising the following components: 100 parts of a polyurethane prepolymer, 10 to 20 parts of a chain extender, 5 to 10 parts of a surface-silylated ultrahigh-molecular-weight polyethylene powder, 1 to 1.5 parts of an antioxidant, 1 to 2 parts of a surface-silylated alumina powder, and 1 to 3 parts of molybdenum disulfide or a sodiumized polytetrafluoroethylene powder.

2. The composition of claim 1, wherein the polyurethane prepolymer is in a polyether type;

preferably, the polyurethane prepolymer is selected from one or both of LF M2050 model and LF M2032 model;

preferably, the polyurethane prepolymer has one or more of the following features:

(1) free MDI content: lower than 0.1 wt%;

(2) isocyanate (-NCO) content: 3.0% to 5.0%;

(3) viscosity: 120 to 500 cps.

3. The composition of claim 1 or 2, wherein the surface-silylated ultrahigh-molecular-weight polyethylene powder is prepared according to a method comprising the following steps:

Step 1: oxidation treating an ultrahigh-molecular-weight polyethylene powder;

Step 2: making the oxidation-treated ultrahigh-molecular-weight polyethylene powder react with a silane coupling agent;

preferably, the oxidation treatment in Step 1 is conducted in a solution comprising potassium permanganate and nitric acid;

preferably, the solution is a mixed solution of a saturated potassium permanganate aqueous solution and a nitric acid aqueous solution (e.g., 50% to 60% nitric acid aqueous solution);

preferably, Step 1 comprises: charging the ultrahigh-molecular-weight polyethylene powder into the solution comprising potassium permanganate and nitric acid; after heating and stirring, filtering them to obtain a powder; and then repeatedly washing the powder with deionized water, and filtering and oven drying it;

preferably, the silane coupling agent is selected from the group of silane coupling agent KH540, silane coupling agent KH550, silane coupling agent KH560, and silane

coupling agent KH 570;

preferably, the weight of the silane coupling agent is 0.1% to 1% of the weight of the ultrahigh-molecular-weight polyethylene powder.

4. The composition of any one of claims 1 to 3, wherein the sodiumized polytetrafluoroethylene powder is polytetrafluoroethylene powder treated with sodium naphthalene;

preferably, the polytetrafluoroethylene powder is treated by the following steps: adding the polytetrafluoroethylene powder into a sodium naphthalene treatment solution where it is fully immersed, stirring for 10 to 15 minutes, filtering, and washing the powder with tetrahydrofuran and deionized water several times until no smell of the sodium naphthalene treatment liquid exists;

preferably, the sodium naphthalene treatment further comprises, after placing the sodiumized polytetrafluoroethylene powder in an oven for drying, grinding and dispersing it.

5. The composition of any one of claims 1 to 4, wherein the surface-silylated alumina powder is prepared according to a method comprising the following steps: under the conditions of stirring and heating, making alumina powder react with a silane coupling agent;

preferably, the silane coupling agent is selected from the group of silane coupling agent KH540, silane coupling agent KH550, silane coupling agent KH560, and silane coupling agent KH570;

preferably, the weight of the silane coupling agent is 1% to 5% of the weight of the alumina powder.

6. The composition of any one of claims 1 to 5, having one or more of the following features:

(1) the chain extender is an alcohol chain extender or an amine chain extender, e.g., aromatic alcohol chain extenders or diamine chain extenders, such as 1,4-bis(2-hydroxyethoxy)benzene or 3,3'-dichloro-4,4'-diaminodiphenylmethane;

(2) the ultrahigh-molecular-weight polyethylene powder has a particle size of 30 to 50 μm ;

(3) the ultrahigh-molecular-weight polyethylene powder has a molecular weight of 4,000,000 to 5,000,000;

- (4) the alumina powder has a particle size of 3000 to 5000 meshes;
- (5) the antioxidant is a hindered phenol antioxidant, such as antioxidant 1010;
- (6) the sodiumized polytetrafluoroethylene powder has a particle size of 3 to 20 μm .

7. Use of the composition of any one of claims 1 to 6 for preparing a piston sealing body;

preferably, the piston sealing body is a concrete piston sealing body.

8. A piston sealing body that is prepared by casting the composition of any one of claims 1 to 7;

preferably, the piston sealing body is a concrete piston sealing body;

preferably, the piston sealing body has one or more of the following features:

tensile strength: ≥ 60 MPa;

elongation at break: $\geq 550\%$;

tear strength: ≥ 115 kN/m;

Shore hardness: 96-98 HA;

Akron abrasion: ≤ 0.025 cm^3 ;

service life: above 550 h.

9. A method of preparing a piston sealing body, comprising casting the composition of any one of claims 1 to 6;

preferably, the method comprises the following steps:

a) in parts by weight, weighing a polyurethane prepolymer, a chain extender, a surface-silylated ultrahigh-molecular-weight polyethylene powder, molybdenum disulfide or a sodiumized polytetrafluoroethylene powder, a surface-silylated alumina powder and an antioxidant respectively;

b) charging the polyurethane prepolymer, the surface-silylated ultrahigh-molecular-weight polyethylene powder, the molybdenum disulfide or the sodiumized polytetrafluoroethylene powder, and the surface-silylated alumina powder

into tank A of a caster, mixing them uniformly and stirring them at a low speed of 650 rpm to 950 rpm by controlling temperatures at 80 to 100 °C;

c) charging the chain extender into tank B of the caster, and temperature was controlled at 110 to 120 °C; after the chain extender is completely melted, adding the antioxidant while stirring at a high speed of 1500 to 2500 rpm;

d) cleaning the cavity of a mold, spraying a release agent in the mold, and preheating it in an oven at 110 to 130 °C;

e) mixing the liquids in tank A and tank B in a ratio controlled by the caster while vacuuming, and after stirring at a high speed of 2000 to 3500 rpm while keeping temperatures at 100 to 120 °C, casting the liquids into the mold;

f) placing the mold in an oven for heating at 100 to 120 °C for 16 to 20 h, and conducting a demolding after it is taken out; and

g) machine processing the demolded blank, to obtain the piston sealing body;

preferably, the surface silylated ultrahigh-molecular-weight polyethylene powder, the sodiumized polytetrafluoroethylene powder, and/or the surface silylated alumina powder are prepared according to the methods as defined in claims 3, 4, and/or 5.

10. A piston, comprising the piston sealing body of claim 8;

preferably, the piston is a concrete piston.

11. A delivery cylinder comprising the piston sealing body of claim 8 or the piston of claim 10.

12. A concrete pumping device (e.g., a pump truck, a dragging pump, or a truck-loaded pump), comprising the piston sealing body of claim 8, the piston of claim 10, or the delivery cylinder of claim 11.