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(54) **Titre : REVETEMENT DE SOL RIGIDE DE POLYPROPYLENE, ININFLAMMABLE ET SANS HALOGENE, ET METHODE DE PREPARATION CONNEXE**
(54) **Title: HALOGEN-FREE FLAME-RETARDANT POLYPROPYLENE (PP) RIGID FLOORING AND PREPARATION METHOD THEREOF**

(57) **Abrégé/Abstract:**

The present disclosure provides a halogen-free flame-retardant polypropylene (PP) rigid flooring and a preparation method thereof, and belongs to the technical field of flame-retardant flooring. In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes the following raw materials in mass percentage: 10% to 45% of PP, 50% to 80% of an inorganic flame retardant, 1% to 15% of a toughening agent, 1% to 10% of a compatibilizer, 0.1% to 0.6% of an antioxidant, and 0.5% to 2% of a lubricant. The PP has desirable processing performance, acid and alkali resistance, chemical reagent resistance, and high- and low-temperature resistance; while a molecular structure of the PP does not contain chlorine, thus showing a high environmental protection performance. The PP as a raw material makes the PP rigid flooring exhibit light weight, high waterproof performance, desirable dimensional stability, excellent high- and low-temperature performance, and environmental friendliness. 50% to 80% of the inorganic flame retardant can give the PP rigid flooring high flame retardancy, such that there is an oxygen index of greater than 29% during combustion.

ABSTRACT OF THE DISCLOSURE

The present disclosure provides a halogen-free flame-retardant polypropylene (PP) rigid flooring and a preparation method thereof, and belongs to the technical field of flame-retardant flooring. In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes the following raw materials in mass percentage: 10% to 45% of PP, 50% to 80% of an inorganic flame retardant, 1% to 15% of a toughening agent, 1% to 10% of a compatibilizer, 0.1% to 0.6% of an antioxidant, and 0.5% to 2% of a lubricant. The PP has desirable processing performance, acid and alkali resistance, chemical reagent resistance, and high- and low-temperature resistance; while a molecular structure of the PP does not contain chlorine, thus showing a high environmental protection performance. The PP as a raw material makes the PP rigid flooring exhibit light weight, high waterproof performance, desirable dimensional stability, excellent high- and low-temperature performance, and environmental friendliness. 50% to 80% of the inorganic flame retardant can give the PP rigid flooring high flame retardancy, such that there is an oxygen index of greater than 29% during combustion.

HALOGEN-FREE FLAME-RETARDANT POLYPROPYLENE (PP) RIGID FLOORING AND PREPARATION METHOD THEREOF

[0001] The present application claims priority to the Chinese Patent Application No. CN2022116715719, filed with the China National Intellectual Property Administration (CNIPA) on December 26, 2022, and entitled "HALOGEN-FREE FLAME-RETARDANT POLYPROPYLENE (PP) RIGID FLOORING AND PREPARATION METHOD THEREOF", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of flame-retardant flooring, and in particular to a halogen-free flame-retardant polypropylene (PP) rigid flooring and a preparation method thereof.

BACKGROUND

[0003] With the rapid development of society, people have increasingly higher environmental protection requirements for indoor flooring materials. The most common indoor plastic flooring decoration material is polyvinyl chloride (PVC) flooring. The PVC flooring is widely used in homes, hotels, guesthouses, and commercial places due to desirable flame retardancy, high dimensional stability, diverse colors and patterns, and low price. However, the molecular structure of PVC contains chlorine atoms, which may produce toxic gases such as hydrogen chloride and dioxins during the molding, processing, and combustion. Furthermore, a large amount of plasticizers such as dioctyl terephthalate (DOTP) added to the PVC flooring can result in a greater impact on the environment.

[0004] Further restrictions on PVC products in developed countries from the Europe and America have led to the need of further development for environmental-friendly plastic flooring materials to meet people's demands for environmental protection performance.

SUMMARY

[0005] In view of this, an objective of the present disclosure is to provide a halogen-free flame-retardant PP rigid flooring and a preparation method thereof. In the present disclosure, the halogen-free flame-retardant PP rigid flooring has desirable environmental protection and flame retardancy.

[0006] To achieve the above objective, the present disclosure provides the following technical

solutions:

[0007] The present disclosure provides a halogen-free flame-retardant polypropylene (PP) rigid flooring, including the following raw materials in mass percentage:

- [0008]** PP 10% to 45%;
- [0009]** inorganic flame retardant 50% to 80%;
- [0010]** toughening agent 1% to 15%;
- [0011]** compatibilizer 1% to 10%;
- [0012]** antioxidant 0.1% to 0.6%; and
- [0013]** lubricant 0.5% to 2%.

[0014] Preferably, the halogen-free flame-retardant PP rigid flooring includes the following raw materials in mass percentage:

- [0015]** the PP 12% to 40%;
- [0016]** the inorganic flame retardant 50% to 75%;
- [0017]** the toughening agent 3% to 10%;
- [0018]** the compatibilizer 1% to 5%;
- [0019]** the antioxidant 0.1% to 0.5%; and
- [0020]** the lubricant 0.5% to 1.5%.

[0021] Preferably, the PP has a melt index of (1-15) g/10 min and a density of (0.89-0.91) g/cm³.

[0022] Preferably, the inorganic flame retardant is one or more selected from the group consisting of aluminum hydroxide, magnesium hydroxide, red phosphorus, aluminum oxide, magnesium oxide, and ferric oxide; and

[0023] the inorganic flame retardant has a particle size of 1,000 mesh to 5,000 mesh.

[0024] Preferably, the compatibilizer is one or more selected from the group consisting of a silane coupling agent, a titanate coupling agent, an aluminate coupling agent, and PP-grafted maleic anhydride;

[0025] the toughening agent is one or more selected from the group consisting of an ethylene-propylene random copolymer, a polyolefin elastomer (POE), styrene-ethylene-butylene-styrene (SEBS), and thermoplastic polyurethane (TPU);

[0026] the antioxidant is one or more selected from the group consisting of an antioxidant 1010, an antioxidant 168, an antioxidant 264, and an antioxidant 1076; and

[0027] the lubricant is one or more selected from the group consisting of paraffin wax, polyethylene (PE) wax, stearic acid, and calcium stearate.

[0028] The present disclosure further provides a preparation method of the halogen-free flame-retardant PP rigid flooring, including the following steps:

[0029] mixing the raw materials of the halogen-free flame-retardant PP rigid flooring to obtain a mixed material;

[0030] subjecting the mixed material to twin-screw extrusion molding to obtain an extruded sheet; and

[0031] subjecting the extruded sheet to hot-press molding and cutting to obtain the halogen-free flame-retardant PP rigid flooring.

[0032] Preferably, the hot-press molding includes: using the extruded sheet as an intermediate layer to allow the hot-press molding together with the PP integrated film and the PP balance layer; and

[0033] the hot-press molding is conducted at 150°C to 180°C under 10 bar to 100 bar for 20 min to 60 min.

[0034] Preferably, the surface of the PP integrated film is further subjected to coating after the hot-press molding is completed; and the coating includes applying a PP surface repair agent, a PP adhesion base oil, and a PP top oil in sequence.

[0035] Preferably, the twin-screw extrusion molding includes twin-screw extrusion at 170°C to 230°C and sheet molding at 200°C to 240°C.

[0036] Preferably, the halogen-free flame-retardant PP rigid flooring is further subjected to grooving after the cutting is completed, and a resulting grooved interlocking type is selected from the group consisting of an ordinary interlock and a push-down interlock.

[0037] The present disclosure provides a halogen-free flame-retardant PP rigid flooring, including the following raw materials in mass percentage: 10% to 45% of PP, 50% to 80% of an inorganic flame retardant, 1% to 15% of a toughening agent, 1% to 10% of a compatibilizer, 0.1% to 0.6% of an antioxidant, and 0.5% to 2% of a lubricant. The PP has desirable processing performance, acid and alkali resistance, chemical reagent resistance, and high- and low-temperature resistance; while a molecular structure of the PP does not contain chlorine, thus showing a high environmental protection performance. The PP as a raw material makes the PP rigid flooring exhibit light weight, high waterproof performance, desirable dimensional stability, excellent high- and low-temperature performance, and environmental friendliness. 50% to 80% of the inorganic flame retardant can give the PP rigid flooring high flame retardancy, such that there is an oxygen index of greater than 29% during combustion.

[0038] The present disclosure further provides a preparation method of the halogen-free flame-retardant PP rigid flooring. The preparation method has simple operations and a low cost, and is suitable for industrial mass production.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0039] The present disclosure provides a halogen-free flame-retardant polypropylene (PP) rigid flooring, including the following raw materials in mass percentage:

- [0040]** PP 10% to 45%;
- [0041]** inorganic flame retardant 50% to 80%;
- [0042]** toughening agent 1% to 15%;
- [0043]** compatibilizer 1% to 10%;
- [0044]** antioxidant 0.1% to 0.6%; and
- [0045]** lubricant 0.5% to 2%.

[0046] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 10% to 45%, preferably 12% to 40%, more further preferably 15% to 30% of the PP in mass percentage. The PP is preferably powder PP or granular PP. The PP has a melt index of preferably (1-15) g/10 min, more preferably (2-10) g/10 min, and a density of preferably (0.89-0.91) g/cm³, more preferably 0.9 g/cm³.

[0047] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 50% to 80%, preferably 50% to 75%, more further preferably 60% to 70% of the inorganic flame retardant in mass percentage. The inorganic flame retardant is preferably one or more selected from the group consisting of aluminum hydroxide, magnesium hydroxide, red phosphorus, aluminum oxide, magnesium oxide, and ferric oxide; and the inorganic flame retardant has a particle size of preferably 1,000 mesh to 5,000 mesh, more preferably 2,000 mesh to 4,000 mesh. The inorganic flame retardant is preferably the magnesium hydroxide or a mixture of the magnesium hydroxide and the aluminum hydroxide. When the inorganic flame retardant is the mixture of the magnesium hydroxide and the aluminum hydroxide, the magnesium hydroxide and the aluminum hydroxide are at a mass ratio of preferably (2-4):1, more preferably 3:1. The magnesium hydroxide and the mixture of the magnesium hydroxide and the aluminum hydroxide decompose and dehydrate to absorb a large amount of heat during the combustion, reducing the temperature of a material combustion zone to inhibit the combustion of the material. The water vapor produced after dehydration and vaporization dilutes solid particles produced and an oxygen content in the air, thus exhibiting a flame-retardant effect on the material. A metal oxide generated after decomposition covers a surface of the burning material, reducing heat conduction and radiation, thereby acting as a flame retardant while significantly reducing a smoke density.

[0048] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 1% to 15%, preferably 3% to 10%, more preferably 5% to 8% of the toughening agent in mass percentage. The toughening agent is preferably one or more selected from the group consisting of an ethylene-propylene random copolymer, a POE, SEBS, and TPU. The ethylene-propylene random

copolymer is preferably an ExxonMobil Vistamaxx elastomer, with a model of preferably Vistamaxx 3588FL, Vistamaxx 6102, or Vistamaxx 3980FL.

[0049] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 1% to 10%, preferably 1% to 5%, more preferably 2% to 4% of the compatibilizer in mass percentage. The compatibilizer is preferably one or more selected from the group consisting of a silane coupling agent, a titanate coupling agent, an aluminate coupling agent, and PP-grafted maleic anhydride.

[0050] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 0.1% to 0.6%, preferably 0.1% to 0.5%, more preferably 0.2% to 0.4% of the antioxidant in mass percentage. The antioxidant is preferably one or more selected from the group consisting of an antioxidant 1010, an antioxidant 168, an antioxidant 264, and an antioxidant 1076.

[0051] In the present disclosure, the halogen-free flame-retardant PP rigid flooring includes 0.5% to 2%, preferably 0.5% to 1.5%, more preferably 0.8% to 1.2% of the lubricant in mass percentage. The lubricant is preferably one or more selected from the group consisting of paraffin wax, PE wax, stearic acid, and calcium stearate.

[0052] In the present disclosure, the halogen-free flame-retardant PP rigid flooring has a thickness of preferably 3 mm to 10 mm, more preferably 5 mm to 8 mm.

[0053] In the present disclosure, the halogen-free flame-retardant PP rigid flooring has a PP integrated film preferably attached to an upper surface and a PP balance layer preferably attached to a lower surface; and a surface of the PP integrated film is preferably covered with a UV coating oil. The UV coating oil preferably includes a PP surface repair agent, a PP adhesion base oil, and a PP top oil.

[0054] The present disclosure further provides a preparation method of the halogen-free flame-retardant PP rigid flooring, including the following steps:

[0055] mixing the raw materials of the halogen-free flame-retardant PP rigid flooring to obtain a mixed material;

[0056] subjecting the mixed material to twin-screw extrusion molding to obtain an extruded sheet; and

[0057] subjecting the extruded sheet to hot-press molding and cutting to obtain the halogen-free flame-retardant PP rigid flooring.

[0058] In the present disclosure, the raw materials of the halogen-free flame-retardant PP rigid flooring are mixed to obtain a mixed material. The mixing is preferably conducted using a high speed mixer. The mixing is conducted at preferably 800 rpm to 1,200 rpm, more preferably 900 rpm to 1,000 rpm for preferably 10 min to 20 min, more preferably 15 min.

[0059] In the present disclosure, the mixed material after the mixing is in a powder form.

Preferably, the powder material is granulated to obtain a granular mixed material. A granulator for the granulation is preferably a parallel twin-screw granulator, with an L/D ratio of preferably 36 to 42. There is no special requirement on a granulation method, and granulation methods well known to those skilled in the art can be used.

[0060] In the present disclosure, the mixed material is subjected to twin-screw extrusion molding to obtain an extruded sheet. The twin-screw extrusion molding preferably includes twin-screw extrusion and sheet molding. A twin-screw extruder for the twin-screw extrusion has an L/D ratio of preferably 32 to 42. The twin-screw extruder has a main engine speed of preferably 30 rpm to 70 rpm, more preferably 40 rpm to 60 rpm and a feeding speed of preferably 10 rpm to 60 rpm, more preferably 20 rpm to 50 rpm. The twin-screw extrusion is conducted at 170°C to 230°C. Specifically, 9 temperature zones of the twin-screw extruder have temperatures of 180°C to 190°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 195°C to 205°C, 200°C to 210°C, and 200°C to 210°C.

[0061] In the present disclosure, the sheet molding is preferably conducted using a sheet mold. The sheet mold is at preferably 200°C to 240°C, more preferably 210°C to 230°C.

[0062] In the present disclosure, after the twin-screw extrusion molding is completed, the extruded sheet is preferably cooled. The cooling is preferably conducted using a multi-roller calendering cooling and setting machine at preferably 40°C to 100°C, more preferably 60°C to 80°C.

[0063] In the present disclosure, the extruded sheet is subjected to hot-press molding and cutting to obtain the halogen-free flame-retardant PP rigid flooring. The hot-press molding includes preferably: using the extruded sheet as an intermediate layer to allow the hot-press molding together with the PP integrated film and the PP balance layer.

[0064] In the present disclosure, the PP integrated film is preferably a PP film; and the PP balance layer includes the following raw materials: 100 parts of the PP, 1 part to 15 parts of the toughening agent, 0 parts to 50 parts of the magnesium hydroxide, 0 parts to 0.6 parts of the antioxidant, and 0.2 parts to 1 part of the lubricant. The PP balance layer has a thickness of preferably 0.1 mm to 1 mm, more preferably 0.4 mm to 0.8 mm; the PP balance layer is mainly used to keep the entire flooring flat during hot-press molding, thus making the flooring less likely to warp and deform.

[0065] In the present disclosure, the hot-press molding is conducted at preferably 150°C to 180°C, more preferably 160°C to 170°C under preferably 10 bar to 100 bar, more preferably 30 bar to 70 bar for preferably 20 min to 60 min, more preferably 30 min to 50 min.

[0066] In the present disclosure, the surface of the PP integrated film is further subjected to coating after the hot-press molding is completed: applying a PP surface repair agent, a PP adhesion base oil, and a PP top oil in sequence. A main component of the PP surface repair agent is a polar material

with PP-grafted maleic anhydride. The PP surface repair agent is applied at preferably (2-3) g/m², more preferably 2.5 g/m². After applying the PP surface repair agent, infrared baking is preferably conducted. The PP adhesion base oil has a solid content of preferably 90% to 95%.

[0067] In the present disclosure, main components of the PP adhesion base oil include one or more of PP, PP-grafted maleic anhydride, and an epoxy polar substance, and preferably further include a wear-resistant, anti-fouling, antibacterial, and scratch-resistant additive. The PP adhesion base oil has a solid content of preferably 90% to 95%. The PP adhesion base oil is preferably applied by coating. The PP adhesion base oil is applied at preferably (5-6) g/m², more preferably 5.5 g/m². After applying the PP adhesion base oil, UV curing is preferably conducted.

[0068] In the present disclosure, main components of the PP top oil include one or more of PP, PP-grafted maleic anhydride, and an epoxy polar substance, and preferably further include a wear-resistant, anti-impact, anti-fouling, antibacterial, and scratch-resistant additive. The PP top oil has a solid content of preferably 90% to 95%. The PP top oil is preferably applied by coating. The PP top oil is applied at preferably (9-11) g/m², more preferably 10 g/m². After applying the PP top oil, UV curing is preferably conducted.

[0069] In the present disclosure, there are no special requirements on a cutting method, and cutting methods well known to those skilled in the art can be used. The halogen-free flame-retardant PP rigid flooring is preferably further subjected to grooving after the cutting is completed, and a resulting grooved interlocking type is selected from the group consisting of an ordinary interlock and a push-down interlock.

[0070] The halogen-free flame-retardant PP rigid flooring and the preparation method thereof provided by the present disclosure are described in detail below in conjunction with the examples, but these examples should not be construed as limiting the protection scope of the present disclosure.

[0071] Example 1

[0072] A halogen-free flame-retardant PP rigid flooring included the following raw materials:

[0073] PP powder (PPH-045) 23.7 parts;

[0074] magnesium hydroxide (3,000 mesh) 65 parts;

[0075] PP-MAH 3 parts;

[0076] Vistamaxx 3588FL 7 parts;

[0077] antioxidant 1010 0.1 parts;

[0078] antioxidant 168 0.2 parts; and

[0079] stearic acid 1801 1 part.

[0080] The PP-MAH was purchased from COACE Chemical Co., Ltd.

[0081] A preparation method of the halogen-free flame-retardant PP rigid flooring included the following steps:

[0082] The raw materials mentioned above were weighed and mixed at high speed in a high speed mixer for 15 min, a resulting powdery mixture was added into a feeding hopper of the 75 parallel twin-screw sheet extrusion production line, and then a 3.5 mm to 5 mm thick sheet was extruded using a flat twin-screw extruder with an L/D ratio of 40; where 9 temperature zones of a 75 parallel twin-screw extruder had temperatures of 180°C to 190°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 190°C to 200°C, 195°C to 205 °C, 200°C to 210°C, and 200°C to 210°C; a sheet mold was at 210°C to 230°C; temperatures of a screen changer, a connecting section, a melt pump, and a connection section in the middle were 200°C to 210°C, 210°C to 220°C, 210°C to 220°C, and 210°C to 220°C, respectively; temperatures of a three-roller cooling and shaping calender were 40°C to 60°C, 60°C to 90°C, and 50°C to 70°C, respectively; and a feeding speed and a main screw speed of the 75 parallel twin-screw extruder were 30 rpm to 50 rpm and 50 rpm to 70 rpm, respectively. The extruded sheet was subjected to hot-press molding with a PP integrated film and a PP balance layer, coated with a surface repair agent, a PP adhesion base oil, and a PP top oil, and then cut by a saw, grooved, applied with a cushioned foam in sequence according to the size requirements to obtain a halogen-free flame-retardant PP rigid interlocking flooring.

[0083] Example 2

[0084] A halogen-free flame-retardant PP rigid flooring included the following raw materials:

[0085] PP powder (PPH-045)	29.7 parts;
[0086] magnesium hydroxide (3,000 mesh)	40 parts;
[0087] aluminum hydroxide (3,000 mesh)	20 parts;
[0088] PP-MAH	3 parts;
[0089] Vistamaxx 3588FL	6 parts;
[0090] antioxidant 1010	0.1 parts;
[0091] antioxidant 1076	0.2 parts; and
[0092] titanate coupling agent 201	1 part.

[0093] A preparation method of the halogen-free flame-retardant PP rigid flooring was the same as that in Example 1.

[0094] Example 3

[0095] PP powder (PPH-045)	17.7 parts;
[0096] magnesium hydroxide (1,250 mesh)	70 parts;
[0097] PP-MAH	3 parts;
[0098] Vistamaxx 6102	8 parts;

- [0099] antioxidant 1010 0.1 parts;
 [0100] antioxidant 168 0.2 parts; and
 [0101] stearic acid 1801 1 part.
- [0102] A preparation method of the halogen-free flame-retardant PP rigid flooring was the same as that in Example 1.
- [0103] **Example 4**
- [0104] PP granules (T30S) 12 parts;
 [0105] magnesium hydroxide (1,250 mesh) 75 parts;
 [0106] PP-MAH 3 parts;
 [0107] silane coupling agent 560 1 part;
 [0108] POE 8 parts; and
 [0109] stearic acid 1801 1 part.
- [0110] A preparation method of this example was basically the same as that of Example 1, a difference was that: after mixing based on the formula, the raw materials were granulated using a 75 parallel twin-screw granulator, and then a resulting granulated material was used to produce a sheet.
- [0111] **Comparative Example 1**
- [0112] For comparison, a commercially available PVC SPC stone-plastic interlock flooring was adopted from a manufacturer Zhangjiagang Elegant Home Technology Co., Ltd., with a specification model of 220 mm×1,210 mm×5.0 mm×0.3 mm. The samples of the examples and comparative example were all 220 mm×1,210 mm×5.0 mm×0.3 mm.
- [0113] **Comparative Example 2**
- [0114] The performances of the flooring samples obtained in the Examples and Comparative Examples were tested, and the results were shown in Table 1.
- [0115] Table 1 Performance test results of flooring samples obtained in Examples and Comparative Examples
- [0116]

Performance testing	Example 1	Example 2	Example 3	Example 4	Comparative Examples
Heating length change rate	-0.10	-0.11	-0.09	-0.08	-0.11
High-temperature warping (80°C*6 h)	Upward: 0.2 Downward: 0.6	Upward: 0.3 Downward: 0.8	Upward: 0 Downward: 0.5	Upward: 0.2 Downward: 0.5	Upward: 0.3 Downward: 1.0
Room-temperature warping (23°C)	Upward: 0.1 Downward: 0.6	Upward: 0.1 Downward: 0.7	Upward: 0.2 Downward: 0.5	Upward: 0.1 Downward: 0.6	Upward: 0.2 Downward: 0.7
Low-temperature warping (5°C)	Upward: 0 Downward: 0.7	Upward: 0.2 Downward: 0.4	Upward: 0.3 Downward: 0.7	Upward: 0.2 Downward: 0.6	Upward: 0.5 Downward: 0.9
Peel force	2.32	2.54	2.40	2.55	2.85

Interlocking tensile force	H:5.3 Z:6.9	H:5.5 Z:7.1	H:4.9 Z:6.5	H:4.8 Z:6.6	H:5.4 Z:7.1
Residual indentation	0.01	0.01	0.02	0.02	0.04
Substrate density (g/cm ³)	1.51	1.45	1.57	1.65	2.03
Thermal expansion coefficient	0.2×10 ⁻⁴	0.2×10 ⁻⁴	0.4×10 ⁻⁴	0.3×10 ⁻⁴	0.4×10 ⁻⁴
Flame-retardant grade (level)	B1	B1	B1	B1	B1
Oxygen index (%)	29	29	30	31	35
Smoke Density	306	312	288	271	614

[0117] The above performance test methods referred to standards ASTM F3261-17, EN ISO 16511, and GB/T 34440-2017.

[0118] As shown in Table 1, the halogen-free flame-retardant PP rigid flooring had desirable dimensional stability, high- and low-temperature performances, and mechanical properties, which were almost the same as those of commercially available PVC stone-plastic interlock flooring. However, the halogen-free flame-retardant PP rigid flooring showed better flame-retardant properties, did not contain chlorine, and was safe and environmental-friendly.

[0119] Comparative Example 2

[0120] PP powder (PPH-045) 49.7 parts;

[0121] magnesium hydroxide (3,000 mesh) 40 parts;

[0122] PP-MAH 3 parts;

[0123] Vistamaxx 3588FL 7 parts;

[0124] antioxidant 1010 0.1 parts; and

[0125] antioxidant 1076 0.2 parts.

[0126] The sample produced in this example failed to meet the flame-retardant requirements of the flooring after repeated tests.

[0127] Comparative Example 3

[0128] PP powder (PPH-045) 10.7 parts;

[0129] magnesium hydroxide (3,000 mesh) 82 parts;

[0130] Vistamaxx 3588FL 6 parts;

[0131] antioxidant 1010 0.1 parts;

[0132] antioxidant 1076 0.2 parts; and

[0133] stearic acid 1081 1 part.

[0134] The formula in this example was difficult to process and form. Even if a sheet was formed after granulation, its mechanical properties were highly poor to meet the requirements for flooring.

[0135] The above descriptions are merely preferred implementations of the present disclosure. It should be noted that a person of ordinary skill in the art may further make several improvements and modifications without departing from the principle of the present disclosure, but such

improvements and modifications should be deemed as falling within the protection scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A halogen-free flame-retardant polypropylene (PP) rigid flooring, comprising the following raw materials in mass percentage:

PP	10% to 45%;
inorganic flame retardant	50% to 80%;
toughening agent	1% to 15%;
compatibilizer	1% to 10%;
antioxidant	0.1% to 0.6%; and
lubricant	0.5% to 2%.

2. The halogen-free flame-retardant PP rigid flooring according to claim 1, comprising the following raw materials in mass percentage:

the PP	12% to 40%;
the inorganic flame retardant	50% to 75%;
the toughening agent	3% to 10%;
the compatibilizer	1% to 5%;
the antioxidant	0.1% to 0.5%; and
the lubricant	0.5% to 1.5%.

3. The halogen-free flame-retardant PP rigid flooring according to claim 1 or 2, wherein the PP has a melt index of (1-15) g/10 min and a density of (0.89-0.91) g/cm³.

4. The halogen-free flame-retardant PP rigid flooring according to claim 1 or 2, wherein the inorganic flame retardant is one or more selected from the group consisting of aluminum hydroxide, magnesium hydroxide, red phosphorus, aluminum oxide, magnesium oxide, and ferric oxide; and the inorganic flame retardant has a particle size of 1,000 mesh to 5,000 mesh.

5. The halogen-free flame-retardant PP rigid flooring according to claim 4, wherein the inorganic flame retardant is a mixture of the magnesium hydroxide and the aluminum hydroxide at a mass ratio of (2-4):1.

6. The halogen-free flame-retardant PP rigid flooring according to claim 1 or 2, wherein the compatibilizer is one or more selected from the group consisting of a silane coupling agent, a

titanate coupling agent, an aluminate coupling agent, and PP-grafted maleic anhydride;

the toughening agent is one or more selected from the group consisting of an ethylene-propylene random copolymer, a polyolefin elastomer (POE), styrene-ethylene-butylene-styrene (SEBS), and thermoplastic polyurethane (TPU);

the antioxidant is one or more selected from the group consisting of an antioxidant 1010, an antioxidant 168, an antioxidant 264, and an antioxidant 1076; and

the lubricant is one or more selected from the group consisting of paraffin wax, polyethylene (PE) wax, stearic acid, and calcium stearate.

7. The halogen-free flame-retardant PP rigid flooring according to claim 1 or 2, wherein the halogen-free flame-retardant PP rigid flooring has a PP integrated film attached to an upper surface and a PP balance layer attached to a lower surface; and a surface of the PP integrated film is covered with an ultraviolet (UV) coating oil.

8. The halogen-free flame-retardant PP rigid flooring according to claim 1 or 2, wherein the halogen-free flame-retardant PP rigid flooring has a thickness of 3 mm to 10 mm.

9. A preparation method of the halogen-free flame-retardant PP rigid flooring according to any one of claims 1 to 8, comprising the following steps:

mixing the raw materials of the halogen-free flame-retardant PP rigid flooring to obtain a mixed material;

subjecting the mixed material to twin-screw extrusion molding to obtain an extruded sheet; and
subjecting the extruded sheet to hot-press molding and cutting to obtain the halogen-free flame-retardant PP rigid flooring.

10. The preparation method according to claim 9, wherein the mixing is conducted at 800 rpm to 1,200 rpm for 10 min to 20 min.

11. The preparation method according to claim 9, wherein the hot-press molding comprises: using the extruded sheet as an intermediate layer to allow the hot-press molding together with the PP integrated film and the PP balance layer; and

the hot-press molding is conducted at 150°C to 180°C under 10 bar to 100 bar for 20 min to 60 min.

12. The preparation method according to claim 11, wherein the PP integrated film is a PP film; and the PP balance layer comprises the following raw materials: 100 parts of the PP, 1 part to 15 parts of the toughening agent, 0 parts to 50 parts of the magnesium hydroxide, 0 parts to 0.6 parts of the antioxidant, and 0.2 parts to 1 part of the lubricant.

13. The preparation method according to claim 12, wherein the PP balance layer has a thickness of 0.1 mm to 1 mm.

14. The preparation method according to claim 11, wherein the surface of the PP integrated film is further subjected to coating after the hot-press molding is completed; and the coating comprises applying a PP surface repair agent, a PP adhesion base oil, and a PP top oil in sequence.

15. The preparation method according to claim 14, wherein the PP surface repair agent is applied at (2-3) g/m²;

the PP adhesion base oil is applied at (5-6) g/m²; and

the PP top oil is applied at (9-11) g/m².

16. The preparation method according to claim 9, wherein the twin-screw extrusion molding comprises twin-screw extrusion at 170°C to 230°C and sheet molding at 200°C to 240°C.

17. The preparation method according to claim 16, wherein a twin-screw extruder for the twin-screw extrusion has a length/diameter (L/D) ratio of 32 to 42.

18. The preparation method according to claim 16, wherein the twin-screw extruder has a main engine speed of 30 rpm to 70 rpm and a feeding speed of 10 rpm to 60 rpm.

19. The preparation method according to claim 9, wherein the extruded sheet is further cooled at preferably 40°C to 100°C after the twin-screw extrusion molding is completed.

20. The preparation method according to claim 9, wherein the halogen-free flame-retardant PP rigid flooring is further subjected to grooving after the cutting is completed, and a resulting grooved interlocking type is selected from the group consisting of an ordinary interlock and a push-down interlock.