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(54) COMPOSITE MATERIAL

(57) The present invention relates to a composite material, which is characterized in that a raw material of the composite material includes polyethylene; a shrinkage rate R is 0.2 to 0.7; a standard heat shrinkage strength σ_r is 0.5 to 3.5 N/mm^2; and an anti-mould level is less than level 2. The present application has good shrinkage performance and better antibacterial and anti-mould effects, so the present application has a wide range of applications.

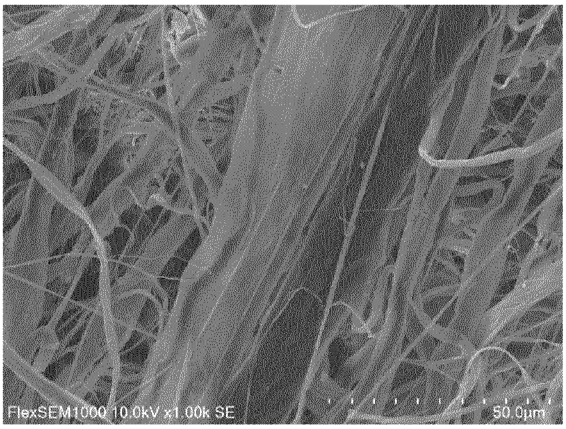

FIG. 1

Processed by Luminess, 75001 PARIS (FR)

Description

TECHNICAL FIELD

[0001] The present invention relates to the technical field of flash spinning, and in particular, relates to a composite material prepared by a flashing evaporation technology.

BACKGROUND

[0002] Since the outbreak of the novel coronavirus pneumonia epidemic in early 2020, solving the problems of research and development of new high-quality emergency protective materials has become an urgent task. As a research project with equal emphasis on urgency, importance and universality, fibers for emergency protection have received extensive attention from the fiber and product industry across the country and even the world. From Alpha to Lambda, in just over a year and a half, the Greek letters used to name the novel coronavirus are almost half used unconsciously, and the mutation speed of the novel coronavirus is surprising. However, at present, the research and development of protective clothing for novel epidemic viruses in China and the world is far from enough. The development of antibacterial and antiviral protective clothing, reusable protective clothing, and protective materials with high barrier, high comfort and high strength has become the focus of research and development of many scientific research institutions and enterprises. The flash spinning technology was invented by the American scientist DuPont in the 1960s. It is a method of preparing high-tech non-woven fabrics. The non-woven fabrics prepared by this method combine the characteristics of paper, film and fabric simultaneously, have the characteristics of low weight, high strength, water proofing, breathability, tear resistance, puncture resistance, etc., has a wide range of applications, is especially suitable for application in personal protection, medical packaging, national defense, construction, printing and other fields. However, the technology is relatively complex, and products are mainly imported from the United States. Especially in the face of the cutthroat environment, China urgently needs to make breakthroughs in this field. The project team started to set up the project of flash evaporation in 2018, and it has generated sales sofar. It mainly uses polyethylene as a raw material, which is dissolved by a solvent and then subjected to flash spinning. A prepared flashing evaporation material has a wider applicable range compared with traditional products. Meanwhile, in view of the technical problems of relatively poor shrinkage and low tear strength of existing flashing evaporation materials, there are also technical problems of poor anti-mould and antibacterial effects. Through the improvement of a spinning polymer raw material as well as the choice of spinning solvents and spinning temperatures, the performance of the flash evaporation materials is improved to expand its application range.

SUMMARY

[0003] The present invention aims to overcome the deficiencies in the prior art and provides a composite material prepared by a flash evaporation technology.

[0004] The purpose of this invention is implemented through the following technical solutions.

[0005] A composite material is characterized in that a raw material of the composite material includes polyethylene;

a shrinkage rate R is 0.2 to 0.7;
a standard heat shrinkage strength σ_r is 0.5 to 3.5 N/mm^2;
the shrinkage rate R = $[(L_0-L_1)/L_0]$;
the standard heat shrinkage strength σ_r = $[F_r/S]$ * [actual gram weight / 50 g/m^2];
an anti-mould level is less than level 2; and
symbols in formulas are respectively as follows:
L_0 is an initial length of a sample, (a unit is mm);
S is an initial cross-sectional area of the sample (a unit is mm^2);
L_1 is a length of the sample after heat shrinkage (a unit is mm); and
F_r is a heat shrinkage force (a unit is N).

[0006] The shrinkage rate R of the composite material ranges from 0.2 to 0.3.

[0007] The shrinkage rate R of the composite material ranges from 0.3 to 0.4.

[0008] The shrinkage rate R of the composite material ranges from 0.4 to 0.5.

[0009] The shrinkage rate R of the composite material ranges from 0.5 to 0.6.

[0010] The shrinkage rate R of the composite material ranges from 0.6 to 0.7.

[0011] The standard heat shrinkage strength σ_r of the composite material is 0.5 to 1.5 N/mm^2.

[0012] The standard heat shrinkage strength σ_r of the composite material is 1.5 to 2.5 N/mm^2.

[0013] The standard heat shrinkage strength σ_r of the composite material is 2.5 to 3.5 N/mm^2.

[0014] The standard tear strength P of the composite material is 7 to 12 KN/m.

$$P = [F/d] * [\text{actual gram weight} / 50\ g/m^2];$$

F is an average tear force (a unit is N); and
d is a thickness of the sample (a unit is mm).

[0015] The standard tear strength P of the composite material is 7 to 8.5 KN/m.

[0016] The standard tear strength P of the composite material is 8.5 to 10 KN/m.

[0017] The standard tear strength P of the composite material is 10 to 12 KN/m.

[0018] The anti-mould level of the composite material is level 0.

[0019] The anti-mould level of the composite material is level 1.

[0020] The raw material of the composite material further includes composite chlorosulfonated polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture is 6% to 8%.

[0021] The composite chlorosulfonated polyethylene is composed of a cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles, wherein a mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene is 11% to 13%.

[0022] A production method for a composite material includes the following technical solutions.

[0023] First, spinning raw materials are dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution is subjected to flash spinning at 180°C to 240°C, flash evaporation fibers are laid into a mesh, and finally hot pressing process is conducted by hot rollers to obtain the composite material prepared by a flash evaporation method. The hot rollers are used for the hot pressing process, specifically, an upper hot roller and a lower hot roller are used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller is 5°C to 10°C; and both T_{upper} and T_{lower} are less than 135°C. Tangents of two sides of the upper hot roller form an angle α, and the angle α is 100° to 140°.

[0024] The spinning raw materials are composite chlorosulfonated polyethylene and polyethylene.

[0025] A mass fraction of the spinning raw materials in the spinning solution is 10% to 15%.

[0026] The spinning solvent is selected from a mixture of several of aromatic hydrocarbons, aliphatic hydrocarbons, alicyclic hydrocarbons, unsaturated hydrocarbons, halogenated hydrocarbons, alcohols, esters, ethers, ketones, nitriles, amides, fluorocarbons.

[0027] The spinning solvent is a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane.

[0028] A preparation method of composite chlorosulfonated polyethylene particles includes the following specific steps: first, a porous boron nitride nanosheet is dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate are added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture is then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product is then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles are subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0029] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution is 5% to 20%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution is 1% to 15%; the boron nitride has a porous layered structure and is used as an adsorption carrier, and the purpose of alkali treatment on a surface is for subsequent adsorption with metal ions in a copper sulfate and zinc sulfate mixed solution; a specific surface area of the porous boron nitride nanosheet is 400 to 2500 m^2/g, and the porous boron nitride nanosheet has mesopores of 0.3 to 15 nm, has micropores of 0.5 to 1.5 nm, and has a total pore volume of 0.2 to 2.4 ml/g, where the mesopores account for 20% to 90% of the total pore volume. In the present application, the purpose of the first-step calcination is mainly to produce zinc oxide, and the purpose of the second-step calcination is mainly to produce cuprous oxide. These are the purposes of calcination by steps, and are mainly to produce different products.

[0030] A mass ratio of the copper sulfate to the zinc sulfate is (1: 2) to (1: 5).

[0031] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet is (1: 2) to (1: 5).

[0032] A mass fraction of the primary product in the boric acid solution is 3% to 6%.

[0033] A mass fraction of a boric acid in the boric acid solution is 10% to 20%.

[0034] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles is 11% to 13%.

[0035] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles is 0.5% to 1%.

[0036] An anti-mould and antibacterial functional material has anti-mould and antibacterial effects by carrying zinc borate doped with cuprous oxide on a boron nitride substrate and penetrating the zinc borate doped with the cuprous oxide into cell walls of microorganisms. The porous boron nitride nanosheet has larger specific surface area and porous characteristics, so the porous boron nitride nanosheet has slow release anti-mould and antibacterial effects. The present application has better anti-mould and antibacterial effects than those of pure mixing of raw materials (cuprous oxide and zinc borate). When the mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene is relatively low, the distribution thereof tends to be in a uniform state, and the probability of mutual contact in the composite chlorosulfonated polyethylene becomes lower, so a certain tear force can be significantly withstood, a more stress effect can be absorbed, and the movement between polymer molecules can be reduced when a final product is stressed, which delay the generation of cracks and have a significant positive impact on improving the properties such as tear strength of the final product. When the mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene is relatively high, the cuprous oxide/zinc borate porous boron nitride nanosheet is prone to local agglomeration, which destroys a balanced distribution structure of the product and leads to poor performance, thereby failing to achieve an expected purpose. This is the reason why the mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles is selected to be in the range of 11% to 13% in the present application. For parameters of the hot pressing process, when ΔT is greater than 10°C, because the hot light temperature difference between two sides is large, the stress of fiber tissue is large, the shrinkage rate becomes larger, the shrinkage strength becomes larger, and the tear strength becomes smaller When the angle α is greater than 140°, an area of a surface coating the hot rollers is small, the roller surface heat setting time is small, and stress release is insufficient, so the shrinkage rate and the shrinkage strength become larger, and the tear strength becomes smaller.

[0037] The chlorosulfonated polyethylene is a white or yellow elastomer, is soluble in aromatic hydrocarbons and chlorinated hydrocarbons and insoluble in aliphatics and alcohols, can only be swelled but not dissolved in ketones and ethers, and has excellent ozone resistance and atmospheric aging resistance, chemical corrosion resistance, etc., good physical and mechanical properties, aging resistance, heat and low temperature resistance, oil resistance, flame resistance and abrasive resistance. Due to good elasticity, the shrinkage performance of the product can be improved, which is one of the important factors for selection of this raw material in the present application. At the same time, the chlorosulfonated polyethylene is dissolved in the aromatic hydrocarbons and the chlorinated hydrocarbons, which is similar to the dissolution of the raw material polyethylene of the flash spinning of the present application in the spinning solvent.

[0038] A production method of a flash-spinning modified functional material includes the following technical solutions.

[0039] First, spinning raw materials are dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution, where a mass fraction of the spinning raw materials in the spinning solution is 11.5% to 13.5%; then the spinning solution is subjected to flash spinning at 185°C to 250°C, flash evaporation fibers are laid into a mesh, and finally hot pressing process is conducted by hot rollers to obtain the flash-spinning modified functional material.

[0040] The hot rollers are used for the hot pressing process, specifically, an upper hot roller and a lower hot roller are used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller is 5°C to 10°C; and both T_{upper} and T_{lower} are less than 135°C. Tangents of two sides of the upper hot roller form an angle α, and the angle α is 100° to 140°.

[0041] The spinning raw materials are composite chlorosulfonated polyethylene and polypropylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polypropylene mixture is 6% to 8%.

[0042] The spinning solvent is a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane.

[0043] Compared with the prior art, the present invention has the following positive effects.

[0044] The addition of the chlorosulfonated polyethylene in the present application can improve the shrinkage performance of the product, and the addition of the cuprous oxide/zinc borate porous boron nitride nanosheet can significantly improve the lasting antibacterial and anti-mould effects of the product. Therefore, the present application has a wide range of applications.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045]

FIG. 1 shows an SEM image of a product of Example 3.

FIG. 2 shows an SEM image of a product of Comparative Example 7.

FIG. 3 shows a schematic diagram of hot pressing of a hot roller of the present application.

[0046] Signs in the drawings are as follows: 1 Upper hot roller, 2 Lower hot roller.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0047] Specific embodiments of a composite material of the present invention are provided below.

I. Test of shrinkage rate R and standard heat shrinkage strength σ_r

[0048] For the test of shrinkage rate and heat shrinkage strength, see the national standard GB/T 34848-2017 (Determination of shrinkage character for heat-shrinkable films). The basic process of the test is as follows.

[0049] An initial size length of a sample is L_0 (a unit is centimeter), and an initial cross-sectional area of the sample is S (a unit is square millimeter). After the sample is heated and then cooled to a temperature of 40°C when a maximum heat shrinkage force is reached, a size of the sample after heat shrinkage is L_1 (a unit is centimeter), the maximum heat shrinkage force is F_r (a unit is Newton), and a maximum force that occurs during a cooling process is a cold shrinkage force denoted by F_c (a unit is Newton). For samples, 10 samples are taken, averaged and then normalized, according to the formula: the standard heat shrinkage strength $\sigma_r = [F_r/S] * [\text{actual gram weight} / 50\ g/m^2]$, to obtain the standard heat shrinkage strength of the sample.

II. Test of standard tear strength P

[0050] For the test of tear strength, see the standard GB/T16578.1-2008/ISO6363-1:1983 (Plastics-Film and sheeting-Determination of tear resistance-Part 1: Trouser tear method), and the basic process of the test is as follows.

[0051] At a test speed of 200 mm/min, an average force required to make cracks penetrate samples is denoted by F. For samples, 10 samples are taken, averaged and then normalized, according to the formula: the standard tear strength $P = [F/d] * [\text{actual gram weight} / 50\ g/m^2]$; F is an average tear force (a unit is Newton); and d is a thickness of the sample (a unit is millimeter).

III. Test of whiteness W

[0052] For the test of whiteness, see the national standard GB/T22880-2008 (Paper and board-Determination of CIE whiteness, D65/10° outdoor daylight), and under the conditions specified in the standard, the whiteness is obtained by measuring CIE tristimulus values.

IV. Test of anti-mould level AMA

[0053] For the test of anti-mould level, see the standard GB/T 24346-2009 (Textiles-Evaluation for anti-mould activity), and specific test conditions are as follows.

[0054] Strains used in the anti-mould test are *Aspergillus niger* CGMCC 3.5487, *Chaetomium globosum* CGMCC 3.3601, *Penicillium funiculosum* CGMCC3.3875, *Trichoderma viride* CGMCC 3.2941.

[0055] Anti-mould performance constant temperature and humidity environment parameters: 28°C ± 1°C, 90% ± 2%; culture time of 28 days.

V. Test of antibacterial rate A

[0056] For the test of antibacterial rate, see the standard GB/T 20944.2-2007 (Textiles-Evaluation for antibacterial activity-Part 2: Absorption method), and specific test conditions are as follows.

[0057] Strains used in the antibacterial test are *Staphylococcus aureus, Klebsiella pneumoniae* and *Escherichia coli.*

[0058] Culture conditions: 37°C ± 2°C, 90% ± 2%; culture time of 18 to 24 hours.

[0059] The antibacterial rate (i.e., bacteriostasis rate) means that more than 95% means having antibacterial properties, and more than 99% means having a better antibacterial function.

Example 1

[0060] A production method for a composite material included the following technical solutions.

[0061] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 200°C, flash evaporation fibers were laid

into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller 1 and a lower hot roller 2 were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 6°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 120°, where the angle α was specifically shown in FIG. 3.

[0062] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 6%.

[0063] A mass fraction of the spinning raw materials in the spinning solution was 12%.

[0064] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0065] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps: first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at 400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0066] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 6%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0067] A mass ratio of the copper sulfate to the zinc sulfate was 1: 2.

[0068] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 2.

[0069] A mass fraction of the primary product in the boric acid solution was 3%.

[0070] A mass fraction of a boric acid in the boric acid solution was 12%.

[0071] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 11%.

[0072] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.5%.

[0073] Data of product test performance of this Example 1 are shown in Table 1.

Example 2

[0074] A production method for a composite material included the following technical solutions.

[0075] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 205°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 7°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 122°.

[0076] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 6.5%.

[0077] A mass fraction of the spinning raw materials in the spinning solution was 12.5%.

[0078] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0079] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps:

[0080] first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0081] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 8%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0082] A mass ratio of the copper sulfate to the zinc sulfate was 1: 2.5.

[0083] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 2.5.

[0084] A mass fraction of the primary product in the boric acid solution was 3.5%.

[0085] A mass fraction of a boric acid in the boric acid solution was 12%.

[0086] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 11.5%.

[0087] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.6%.

[0088] Data of product test performance of this Example 2 are shown in Table 1.

Example 3

[0089] A production method for a composite material included the following technical solutions.

[0090] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0091] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0092] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0093] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0094] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps:

[0095] first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0096] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 10%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0097] A mass ratio of the copper sulfate to the zinc sulfate was 1: 3.5.

[0098] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 3.5.

[0099] A mass fraction of the primary product in the boric acid solution was 5%.

[0100] A mass fraction of a boric acid in the boric acid solution was 12%.

[0101] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12%.

[0102] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.7%.

[0103] Data of product test performance of this Example 3 are shown in Table 1.

[0104] A product of this Example 3 was placed in a normal temperature environment for 1 year, specifically, a temperature was 25 ± 2°C; and a humidity was humidity (60±5)% RH. An anti-mould level of the sample was re-tested to be level 1, an antibacterial rate thereof was 98.2%, and antibacterial and anti-mould properties thereof had a relatively low drop, and the sample had long-term antibacterial and anti-mould effects.

Example 4

[0105] A production method for a composite material included the following technical solutions.

[0106] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 215°C, flash evaporation fibers were laid

into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 126°.

[0107] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7.5%.

[0108] A mass fraction of the spinning raw materials in the spinning solution was 13.5%.

[0109] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0110] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps: first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0111] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 12%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0112] A mass ratio of the copper sulfate to the zinc sulfate was 1:4.

[0113] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 4.

[0114] A mass fraction of the primary product in the boric acid solution was 5%.

[0115] A mass fraction of a boric acid in the boric acid solution was 12%.

[0116] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12.5%.

[0117] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.8%.

[0118] Data of product test performance of this Example 4 are shown in Table 1.

Example 5

[0119] A production method for a composite material included the following technical solutions.

[0120] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 220°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 128°.

[0121] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 8%.

[0122] A mass fraction of the spinning raw materials in the spinning solution was 14%.

[0123] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0124] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps:

[0125] first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0126] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 5% to 20%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0127] A mass ratio of the copper sulfate to the zinc sulfate was 1: 5.

[0128] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 5.

[0129] A mass fraction of the primary product in the boric acid solution was 6%.

[0130] A mass fraction of a boric acid in the boric acid solution was 12%.

[0131] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 13%.

[0132] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.8%.

[0133] Data of product test performance of this Example 5 are shown in Table 1.

Comparative Example 1

[0134] A production method for a composite material included the following technical solutions.

[0135] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0136] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0137] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0138] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratio thereof was 6: 5: 4: 3: 1: 1.

[0139] Composite chlorosulfonated polyethylene particles were composed of a cuprous oxide, a zinc borate, a compatibilizer and chlorosulfonated polyethylene particles, wherein a mass fraction of a mixture of the cuprous oxide, the zinc borate and a porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12%.

[0140] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.7%.

[0141] A mass ratio of the cuprous oxide to the zinc borate was 1: 3.5.

[0142] A mass ratio of the zinc borate to the porous boron nitride nanosheet was 1: 3.5.

[0143] Data of product test performance of this Comparative Example 1 are shown in Table 1.

[0144] A product of this Comparative Example 1 was placed in a normal temperature environment for 1 year, specifically, a temperature was 25 ± 2°C; and a humidity was humidity (60±5)% RH. An anti-mould level of the sample was retested to be level 4, an antibacterial rate thereof was 78.2%, and antibacterial and anti-mould properties thereof had a very significant drop, and the sample no longer had antibacterial and anti-mould effects.

Comparative Example 2

[0145] A production method for a composite material included the following technical solutions.

[0146] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0147] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0148] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0149] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratio thereof was 6: 5: 4: 3: 1: 1.

[0150] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps:

[0151] first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then zinc sulfate was added to the sodium hydroxide solution, filtration and separation were conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a zinc borate/porous boron nitride nanosheet; finally, the zinc borate/porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0152] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 10%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0153] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 3.5.

[0154] A mass fraction of the primary product in the boric acid solution was 5%.

[0155] A mass fraction of a boric acid in the boric acid solution was 12%.

[0156] A mass fraction of the zinc borate/porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12%.

[0157] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.7%.

[0158] Data of product test performance of this Comparative Example 2 are shown in Table 1.

Comparative Example 3

[0159] A production method for a composite material included the following technical solutions.

[0160] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0161] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0162] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0163] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0164] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0165] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 8%.

[0166] Data of product test performance of this Comparative Example 3 are shown in Table 1.

Comparative Example 4

[0167] A production method for a composite material included the following technical solutions.

[0168] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0169] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0170] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0171] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0172] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0173] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 9%.

[0174] Data of product test performance of this Comparative Example 4 are shown in Table 1.

Comparative Example 5

[0175] A production method for a composite material included the following technical solutions.

[0176] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0177] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0178] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0179] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0180] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0181] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 10.5%.

[0182] Data of product test performance of this Comparative Example 5 are shown in Table 1.

Comparative Example 6

[0183] A production method for a composite material included the following technical solutions.

[0184] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0185] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0186] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0187] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0188] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0189] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 13.5%.

[0190] Data of product test performance of this Comparative Example 6 are shown in Table 1.

Comparative Example 7

[0191] A production method for a composite material included the following technical solutions.

[0192] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0193] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0194] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0195] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratio thereof was 6: 5: 4: 3: 1: 1.

[0196] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0197] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 14.5%.

[0198] Contrasting an SEM image of a product, the SEM of Example 3 is FIG. 1; the SEM of Comparative Example 7 is FIG. 2. When the cuprous oxide/zinc borate porous boron nitride nanosheet is relatively high, it can be seen from FIG. 3 for SEM test that the content thereof in a final product is relatively high, which cannot achieve an expected purpose. However, it can be seen from FIG. 1 of the SEM of Example 3 that the distribution thereof is uniform and no agglomeration occurs.

[0199] Data of product test performance of this Comparative Example 7 are shown in Table 1.

Comparative Example 8

[0200] A production method for a composite material included the following technical solutions.

[0201] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute val ue ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0202] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0203] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0204] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratio thereof was 6: 5: 4: 3: 1: 1.

[0205] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3, and a difference only lied in that:

[0206] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 16%.

[0207] Data of product test performance of this Comparative Example 8 are shown in Table 1.

Comparative Example 9

[0208] A production method for a composite material included the following technical solutions.

[0209] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0210] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0211] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0212] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0213] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps:

[0214] first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0215] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 10%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0216] A mass ratio of the copper sulfate to the zinc sulfate was 1: 0.5.

[0217] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 3.5.

[0218] A mass fraction of the primary product in the boric acid solution was 5%.

[0219] A mass fraction of a boric acid in the boric acid solution was 12%.

[0220] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12%.

[0221] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.7%.

[0222] Data of product test performance of this Comparative Example 9 are shown in Table 1.

Comparative Example 10

[0223] A production method for a composite material included the following technical solutions.

[0224] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0225] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0226] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0227] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0228] A preparation method of composite chlorosulfonated polyethylene particles included the following specific steps: first, a porous boron nitride nanosheet was dispersed in a sodium hydroxide solution by microwave stirring for alkali treatment, then copper sulfate and zinc sulfate were added to the sodium hydroxide solution separately, filtration and separation are conducted to obtain a mixture, the mixture was then ground, subjected to first-step calcination at 130°C to 150°C for 0.5 to 1 hour, and then heated for second-step calcination at 550°C to 700°C for 1 to 2 hours, to prepare a primary product; second, the primary product was then added to a boric acid solution, filtered and separated, ground, and then subjected to third-step calcination at400°C to 500°C for 2 to 4 hours to obtain a cuprous oxide/zinc borate porous boron nitride nanosheet; finally, the cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles were subjected to melt extrusion and granulation to obtain composite chlorosulfonated polyethylene.

[0229] For the porous boron nitride nanosheet, a mass fraction of boron nitride in the sodium hydroxide solution was 10%, and a mass fraction of sodium hydroxide in the sodium hydroxide solution was 5%.

[0230] A mass ratio of the copper sulfate to the zinc sulfate was 1: 1.

[0231] A mass ratio of the zinc sulfate to the porous boron nitride nanosheet was 1: 3.5.

[0232] A mass fraction of the primary product in the boric acid solution was 5%.

[0233] A mass fraction of a boric acid in the boric acid solution was 12%.

[0234] A mass fraction of the cuprous oxide/zinc borate porous boron nitride nanosheet in the composite chlorosulfonated polyethylene particles was 12%.

[0235] A mass fraction of the compatibilizer in the composite chlorosulfonated polyethylene particles was 0.7%.

[0236] Data of product test performance of this Comparative Example 10 are shown in Table 1.

Comparative Example 11

[0237] A production method for a composite material included the following technical solutions.

[0238] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid

into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 13°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0239] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0240] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0241] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratio thereof was 6: 5: 4: 3: 1: 1.

[0242] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3.

[0243] Data of product test performance of this Comparative Example 11 are shown in Table 1.

Comparative Example 12

[0244] A production method for a composite material included the following technical solutions.

[0245] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 2°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0246] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0247] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0248] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0249] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3.

[0250] Data of product test performance of this Comparative Example 12 are shown in Table 1.

Comparative Example 13

[0251] A production method for a composite material included the following technical solutions.

[0252] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 150°.

[0253] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0254] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0255] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0256] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3.

[0257] Data of product test performance of this Comparative Example 13 are shown in Table 1.

Comparative Example 14

[0258] A production method for a composite material included the following technical solutions.

[0259] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the composite material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 90°.

[0260] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0261] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0262] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0263] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3.

[0264] Data of product test performance of this Comparative Example 14 are shown in Table 1.

Example 6

[0265] A production method of a flash-spinning modified functional material included the following technical solutions.

[0266] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 200°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the flash-spinning modified functional material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 6°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α,and the angle α was 120°.

[0267] The spinning raw materials were composite chlorosulfonated polyethylene and polypropylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polypropylene mixture was 6%.

[0268] A mass fraction of the spinning raw materials in the spinning solution was 12%.

[0269] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0270] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 1.

[0271] Data of product test performance of this Example 11 are shown in Table 1.

Example 7

[0272] A production method of a flash-spinning modified functional material included the following technical solutions.

[0273] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 210°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the flash-spinning modified functional material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 7°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 122°.

[0274] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 7%.

[0275] A mass fraction of the spinning raw materials in the spinning solution was 13%.

[0276] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1: 1.

[0277] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 3.

[0278] Data of product test performance of this Example 7 are shown in Table 1.

Example 8

[0279] A production method of a flash-spinning modified functional material included the following technical solutions.

[0280] First, spinning raw materials were dissolved in a spinning solvent to be dispersed and dissolved to obtain a spinning solution; then the spinning solution was subjected to flash spinning at 220°C, flash evaporation fibers were laid into a mesh, and finally hot pressing process was conducted by hot rollers to obtain the flash-spinning modified functional material. The hot rollers were used for the hot pressing process, specifically, an upper hot roller and a lower hot roller were used for hot pressing, and an absolute value ΔT of a difference between a surface temperature T_{upper} of the upper hot roller and a surface temperature T_{lower} of the lower hot roller was 8°C; and both T_{upper} and T_{lower} were less than 135°C. Tangents of two sides of the upper hot roller formed an angle α, and the angle α was 124°.

[0281] The spinning raw materials were composite chlorosulfonated polyethylene and polyethylene; and a mass fraction of the composite chlorosulfonated polyethylene in a composite chlorosulfonated polyethylene and polyethylene mixture was 8%.

[0282] A mass fraction of the spinning raw materials in the spinning solution was 14%.

[0283] The spinning solvent was a mixture of 1-pentene, trichlorofluoromethane, dichloromethane, cyclopentane, 2,3 dihydrodecafluoropentane, and 1,1,1,3,3-pentafluorobutane; and a weight ratiothereof was 6: 5: 4: 3: 1 : 1.

[0284] A preparation method of composite chlorosulfonated polyethylene particles was the same as that of Example 5.

[0285] Data of product test performance of this Example 8 are shown in Table 1.

Table 1 Table for test data of products

	R	σ_r N/mm^2	P KN/m	W	AMA Level	A %
Example 1	0.33	1.02	8.1	82%	1	99.1%
Example 2	0.39	1.55	8.9	83%	1	99.2%
Example 3	0.45	2.11	9.7	87%	0	99.3%
Example 4	0.51	2.73	10.6	88%	0	99.4%
Example 5	0.58	3.45	11.7	89%	0	99.5%
Comparative Example 1	0.41	1.44	8.2	80%	3	90.1%
Comparative Example 2	0.42	1.61	9.4	91%	2	95.5%
Comparative Example 3	0.22	0.34	6.1	79%	2	96.5%
Comparative Example 4	0.24	0.46	6.7	80%	2	97.8%
Comparative Example 5	0.27	0.70	7.6	81%	1	98.4%
Comparative Example 6	0.57	3.35	11.5	90%	0	99.6%
Comparative Example 7	0.54	3.14	10.8	91%	0	99.7%
Comparative Example 8	0.52	2.86	10.1	92%	0	99.890
Comparative Example 9	0.43	2.05	9.5	70%	0	99.4%
Comparative Example 10	0.46	2.15	9.6	74%	0	99.3%
Comparative Example 11	0.62	3.68	6.1	85%	0	99.1%
Comparative Example 12	0.18	0.35	11.9	82%	0	98.8%
Comparative Example 13	0.64	3.75	5.7	83%	0	99.2%
Comparative Example 14	0.16	0.31	12.4	84%	0	98.7%
Example 6	0.31	1.1	8.2	84%	1	99.2%
Example 7	0.45	2.11	10.4	86%	1	99.5%
Example 8	0.61	3.63	11.9	88%	0	99.7%

[0286] The above are only the preferred embodiments of the present invention. It should be pointed out that for those of ordinary skill in the art, without departing from the concept of the present invention, several improvements and modifications can also be made, and these improvements and modifications should also be regarded as are within the protection scope of the present invention.

Claims

1. A composite material, wherein a raw material of the composite material comprises polyethylene; a shrinkage rate R is 0.2 to 0.7; a standard heat shrinkage strength σ_r is 0.5 to 3.5 N/mm^2; an anti-mould level is less than level 2,

where the shrinkage rate $R = [(L_0-L_1)/L_0]$; the standard heat shrinkage strength $\sigma_r = [F_r/S]$ * [actual gram weight / 50 g/m^2]; and symbols in formulas are respectively as follows: L_0 is an initial length of a sample; S is an initial cross-sectional area of the sample; L_1 is a length of the sample after heat shrinkage; and F_r is a heat shrinkage force.

2. The composite material as claimed in claim 1, wherein the shrinkage rate R of the composite material ranges from 0.2 to 0.3.

3. The composite material as claimed in claim 1, wherein the shrinkage rate R of the composite material ranges from 0.3 to 0.4.

4. The composite material as claimed in claim 1, wherein the shrinkage rate R of the composite material ranges from 0.4 to 0.5.

5. The composite material as claimed in claim 1, wherein the shrinkage rate R of the composite material ranges from 0.5 to 0.6.

6. The composite material as claimed in claim 1, wherein the shrinkage rate R of the composite material ranges from 0.6 to 0.7.

7. The composite material as claimed in claim 1, wherein the standard heat shrinkage strength of the composite material is 0.5 to 1.5 N/mm^2.

8. The composite material as claimed in claim 1, wherein the standard heat shrinkage strength of the composite material is 1.5 to 2.5 N/mm^2.

9. The composite material as claimed in claim 1, wherein the standard heat shrinkage strength of the composite material is 2.5 to 3.5 N/mm^2.

10. The composite material as claimed in claim 1, wherein a standard tear strength P of the composite material is 7 to 12 KN/m, where P = [F/d] * [actual gram weight / 50 g/m^2]; symbols in the formula are respectively as follows: F is an average tear force; and d is a thickness of the sample.

11. The composite material as claimed in claim 10, wherein the standard tear strength P of the composite material is 7 to 8.5 KN/m.

12. The composite material as claimed in claim 10, wherein the standard tear strength P of the composite material is 8.5 to 10 KN/m.

13. The composite material as claimed in claim 10, wherein the standard tear strength P of the composite material is 10 to 12 KN/m.

14. The composite material as claimed in claim 1, wherein the anti-mould level of the composite material is level 0.

15. The composite material as claimed in claim 1, wherein the anti-mould level of the composite material is level 1.

16. The composite material as claimed in claim 1, wherein the raw material of the composite material further comprises composite chlorosulfonated polyethylene; and the composite chlorosulfonated polyethylene is composed of a cuprous oxide/zinc borate porous boron nitride nanosheet, a compatibilizer and chlorosulfonated polyethylene particles.

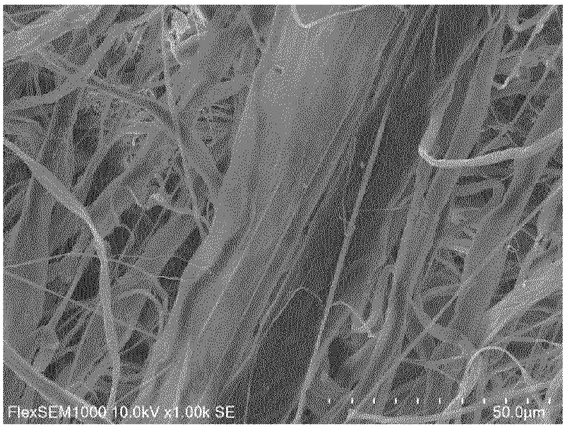

FIG. 1

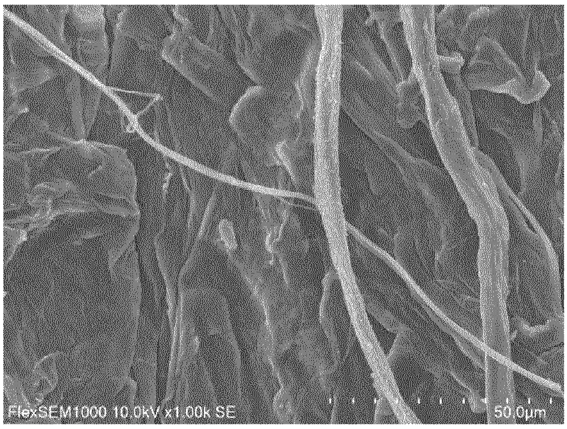

FIG. 2

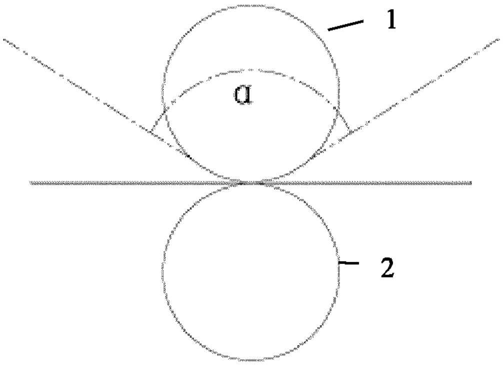

FIG.3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/134235

A. CLASSIFICATION OF SUBJECT MATTER

D01D 5/11(2006.01)i；D01F 6/04(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D01D5/11, D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNKI, CNABS, CNTXT, VEN, ISI WEB OF SCIENCE: 氯磺化聚乙烯, 聚乙烯, PE, 聚烯烃, 聚丙烯, 收缩率, 热缩强度, 热收缩强度, 热收缩, 闪蒸, 氮化硼, 抗菌, 防霉, 杀菌, 灭菌, flash spinning, chlorosulfonat+, polyethylene, polyolefin, polypropylene, boron nitride, heat shrink,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007077519 A (MITSUI CHEMICALS INC.) 29 March 2007 (2007-03-29) description, embodiment 1	1-16
A	CN 103757735 A (JIANGSU SHENTAI SCIENCE AND TECHNOLOGY DEVELOPMENT CO., LTD.) 30 April 2014 (2014-04-30) entire document	1-16
A	CN 111016374 A (BINHAI POWER SUPPLY BRANCH CO., STATE GRID JIANGSU ELECTRIC POWER CO.) 17 April 2020 (2020-04-17) entire document	1-16
A	EP 0357364 A2 (E. I. DU PONT DE NEMOURS AND CO.) 07 March 1990 (1990-03-07) entire document	1-16
A	CN 1042741 A (DUPONT DE NEMOURS, INC.) 06 June 1990 (1990-06-06) entire document	1-16
A	CN 110387053 A (GUANGDONG ANDELI NEW MATERIALS CO., LTD.) 29 October 2019 (2019-10-29) entire document	1-16

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search **21 June 2022**	Date of mailing of the international search report **29 June 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/134235

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 60021925 D1 (E. I. DU PONT DE NEMOURS AND COMPANY) 15 September 2005 (2005-09-15) entire document	1-16
A	JP 05295613 A (ASAHI CHEMICAL INDUSTRY CO., LTD.) 09 November 1993 (1993-11-09) entire document	1-16

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/134235

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
JP	2007077519	A	29 March 2007	US	2007059347	A1	15 March 2007
				EP	1764427	A2	21 March 2007
CN	103757735	A	30 April 2014	None			
CN	111016374	A	17 April 2020	None			
EP	0357364	A2	07 March 1990	KR	910003168	A	27 February 1991
				CA	1335917	C	13 June 1995
CN	1042741	A	06 June 1990	AU	4093589	A	08 March 1990
				JP	H02139408	A	29 May 1990
				MX	166941	B	15 February 1993
				CA	1338408	C	18 June 1996
				US	5032326	A	16 July 1991
				DE	68907824	D1	02 September 1993
				EP	0357381	A2	07 March 1990
				RU	1838464	C	30 August 1993
				KR	900003434	A	26 March 1990
CN	110387053	A	29 October 2019	None			
DE	60021925	D1	15 September 2005	EP	1343928	A1	17 September 2003
				JP	2004515663	A	27 May 2004
				WO	0248437	A1	20 June 2002
JP	05295613	A	09 November 1993	None			

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- GB 348482017 T **[0048]**
- GB 228802008 T **[0052]**
- GB 243462009 T **[0053]**
- GB 2094422007 T **[0056]**