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(54) LYOCELL MATERIAL, FILTER FOR SMOKING ARTICLE, SMOKING ARTICLE, AND METHODS OF PREPARING THE SAME

(57) The disclosure relates to a lyocell material, and a filter for a smoking article, including the lyocell material, and a smoking article. The lyocell material and the filter for a smoking article, according to the disclosure, may replace conventional cellulose acetate materials and filters for a smoking article that include the same.

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Description

Technical Field

[0001] The disclosure relates to a lyocell material, a filter including the same, a smoking article, and methods of manufacturing the same.

Background Art

[0002] Until now, cellulose acetate fibers have been mainly used as materials for cigarette filters. Cellulose acetate is known to be a biodegradable material, but filters for smoking articles, which consist of cellulose acetate, remain in their original form for one to two years after being buried in soil, and it takes a considerable amount of time until they are completely biodegraded. Considering the amount and toxicity of tobacco products that are discarded and left in the living environment as well as being collected and landfilled as waste after being used for smoking, it is necessary to further improve the biodegradability of filters for smoking articles. Accordingly, lyocell, which is more environmentally friendly, has recently been chosen as a replacement material for cellulose acetate.

Disclosure of Invention

Technical Problem

[0003] One purpose of the disclosure is to provide a lyocell material that may replace commercialized cellulose acetate for a filter for a smoking article.

[0004] Another purpose of the disclosure is to provide a lyocell material for a filter of a smoking article, which is environmentally friendly in its manufacturing process and has excellent biodegradability when discarded.

[0005] Another purpose of the disclosure is to provide a lyocell filter for a smoking article.

[0006] Another purpose of the disclosure is to provide a smoking article (for example, a cigarette) including a lyocell filter.

Solution to Problem

[0007] According to an aspect of the disclosure, a lyocell material, a filter including the same, and a smoking article may be provided.

[0008] The lyocell material may include one or more lyocell multifilaments.

[0009] The lyocell multifilament may include one or more lyocell monofilaments.

[0010] According to an aspect of the disclosure, a lyocell material may be provided, which includes crimped lyocell multifilaments and has a shape stability of crimps of 20 % to 60%.

[0011] In some embodiments, the crimped lyocell multifilament include one or more monofilaments. The crimped lyocell multifilament may be considered as a lyocell multifilament in the disclosure.

[0012] In addition, according to another aspect of the disclosure, a filter for a lyocell smoking article may be provided, which includes a lyocell material having a shape stability of crimps of 20 % to 60 %.

[0013] According to another aspect of the disclosure, a smoking article including the lyocell material or filter may be provided.

[0014] According to another aspect of the disclosure, methods of manufacturing the lyocell material, a filter including the same, and a smoking article may be provided.

[0015] As used herein, 'smoking article' may refer to an article capable of generating aerosols, such as a tobacco (cigarette), cigar, and the like. In this regard, the smoking article may include an aerosol-generating material or an aerosol-forming substrate. In addition, the smoking article may include solid materials based on tobacco raw materials, such as reconstituted tobacco leaves, tobacco sticks, and reconstituted tobacco. In addition, smoking materials may include volatile compounds.

[0016] Unless otherwise specifically defined in this specification, when the properties of the lyocell material or the filter for a smoking article, and components or compositions thereof, are affected by temperature, the temperature at which such properties are determined or measured may be room temperature. In this regard, the room temperature is a temperature in a state which is not particularly cooled or heated, and may be, for example, a temperature of 10 to 35 °C, particularly 15 to 35 °C, 20 to 30 °C, or about 25 °C.

[0017] As used herein, the term "crimp" may refer to a configuration of waves, curls, or undulations imparted to a material, such as a fiber, (mono)filament, multifilament, and/or yarn inherently or through mechanical, thermal, and/or chemical processes. Crimp may be characterized by having a periodic deviation from a straight axis along the length of the material, fiber, filament, multifilament, and/or yarn. In a material, fiber, filament, multifilament, and/or yarn, one crimp may

be defined as one repeating unit of the periodic deviation. The presence of crimp affects properties of a material and fabrics made from that material, such as elasticity, bulk, resilience, and texture.

[0018] As used herein, the term "degree of polymerization" (DPw) may refer to the number of monomer units and/or repeating units in a macromolecule or polymer or oligomer molecule. The degree of polymerization may be expressed as Mn/M0, wherein Mn is a number average molecular weight of the macromolecule or polymer or oligomer molecule and M0 is a molecular weight of the monomer or repeating unit.

[0019] As used herein, "lyocell multifilament" may refer to a multifilament made of cellulose. In particular, the lyocell multifilament may be a (multi)filament and/or fiber made of cellulose derived or mainly derived from wood pulp, in particular a semi-synthetic (multi)filament and/or fiber.

[0020] As used herein, "lyocell tow" includes or is composed of at least one lyocell multifilament.

[0021] As used herein, "tenacity" refers to an ultimate tensile strength per unit linear density or per unit mass of a filament or fiber. This is a measure of the ability of a fiber to withstand tension or tensile force without breaking. The tenacity is expressed in units of force per unit linear density, such as cN/tex. A higher tenacity value indicates a stronger fiber. The tenacity is measured by dividing a breaking load of a filament or fiber by its mass per unit length.

[0022] As used herein, "average tenacity" refers to an average tensile strength of a filament or fiber per linear density or per unit mass. This is a measure of the ability of a fiber to withstand tension or tensile force without breaking. The average tenacity is expressed in units of force per unit linear density, such as cN/tex. The average tenacity is measured by dividing a breaking load of a filament or fiber by its mass per unit length, wherein the tenacity is measured for at least two filaments and an average value of the tenacity for these filaments is taken as the average tenacity. For example, the average tenacity is an average of values measured for 20 monofilaments, an average of values measured for 50 monofilaments, or an average of values measured for 100 monofilaments.

[0023] As used herein, "shape stability" relates to the ability of a material (for example, a lyocell material) to maintain its original shape and/or dimensions under various environmental and force conditions (for example, chemical or physical actions). One factor that may affect shape stability is moisture absorbed into the fibers, filaments, or threads forming the material. The better and higher the shape stability of the material, the less shrinkage it will experience during processing and handling, and it will be able to maintain its original size and shape even after being washed and stretched multiple times.

[0024] As used herein, "elongation" of a fiber or filament refers to a length by which the fiber or filament is extended until it breaks, which is expressed as a percentage (%) to the original length of the fiber. The elongation (%) is calculated by dividing the difference between the final length at which the fiber or filament was broken and its original length by the original length and then multiplying this ratio by 100. Here, "average elongation" refers to an average value of the elongations of at least two fibers or filaments. For example, the average elongation is an average of values measured for 20 monofilaments, an average of values measured for 50 monofilaments, or an average of values measured for 100 monofilaments.

[0025] As used herein, "opened lyocell material" refers to a lyocell material and/or lyocell fibers and/or lyocell multifilaments that have been separated, uncoiled, unspooled, loosened, or unwrapped from their original compressed and/or rolled state.

[0026] As used herein, "non-circular cross-section" may refer to a cross-sectional shape that deviates from a standard circular shape. For example, the cross-sectional shape may have a Y-shaped cross-section, a rectangular cross-section, a star-shaped cross-section, a leaf-shaped cross-section, a hexagonal cross-section, a polygonal cross-section, and the like. The non-circular cross-section may include three or more protrusions, and preferably may include three protrusions. Here, "protrusion" may refer to a distinct, extended segment or arm extending outward from the central core or junction point of the cross-section of a monofilament. A non-circular cross-section including three protrusions may be referred to as a "Y-shaped cross-section." Lyocell tow may have a Y-shaped cross-section for use in a cigarette filter.

[0027] In some embodiments, a lyocell multifilament include one or more monofilaments, and one or more of the monofilaments may have a non-circular cross-section.

[0028] In some embodiments, the lyocell multifilament include one or more monofilaments, and all of the monofilaments may have a non-circular cross-section.

[0029] Hereinafter, the disclosure is described in more detail.

[0030] The disclosure relates to a lyocell material. The lyocell material may be used in a smoking article, and although not particularly limited, the lyocell material may be used in a filter for a smoking article.

[0031] According to an aspect, a lyocell material is provided, which includes crimped lyocell multifilaments and has a shape stability of crimps of 20 % to 60 %. In some embodiments, the tenacity of one or more monofilaments included in the lyocell multifilament may be 2.65 cN/tex to 7.06 cN/tex (0.3 g/de to 0.8 g/de).

[0032] In some embodiments, the average tenacity of monofilaments included in the lyocell multifilament may be 2.65 cN/tex to 7.06 cN/tex (0.3 g/de to 0.8 g/de).

[0033] In some embodiments, an elongation of one or more monofilaments included in a lyocell multifilament may be 5 % to 10 %.

[0034] In some embodiments, the average elongation of monofilaments included in the lyocell multifilament may be 5 % to 10 %.

[0035] In some embodiments, the number of crimps may be 3.94 ea/cm to 19.69 ea/cm (10 ea/inch to 50 ea/inch).

[0036] In some embodiments, the number of crimps may be 9.84 ea/inch to 11.81 ea/cm (25 ea/inch to 30 ea/inch).

[0037] In some embodiments, a single fineness of the lyocell multifilament may be 1.67 to 8.89 dtex (1.5 to 8.0 denier).

[0038] Exemplary lyocell material may have a total fineness of 1,667 to 6,111 tex (15,000 to 55,000 denier).

[0039] In some embodiments, the shape stability of crimps may be calculated by Equation 1:

Equation 1

$$\text{Shape Stability of Crimps (\%)} = (L_0 - L_b)/(L_0 - L) * 100$$

wherein, in Equation 1, L represents a length of a monofilament measured under a condition of initial load (0.01 cN/tex), L_0 represents a length of a monofilament measured under a condition of 5 cN/tex load, and L_b represents a length of a monofilament measured under a condition of restoration (0.01 cN/tex) after the 5 cN/tex load is removed.

[0040] In some embodiments, the shape stability of crimps may be 25 % to 55 %.

[0041] In some embodiments, a moisture content of a lyocell multifilament may be 200 % to 350 %.

[0042] In some embodiments, the moisture content may be a value measured according to Equation 2:

Equation 2

$$\text{Moisture Content (\%)} = \frac{W-D}{D} * 100$$

wherein, in Equation 2, W represents a weight of a sample measured before drying, and D represents a weight of a sample measured after drying.

[0043] In some embodiments, the moisture content may be a value measured from a lyocell filament prior to crimping. Crimps are imparted in crimping of a method of manufacturing a lyocell material described below.

[0044] In some embodiments, the moisture content may be a value measured from a washed lyocell multifilament. The washed lyocell multifilament may refer to a lyocell multifilament that has undergone washing of a method of manufacturing a lyocell material described below.

[0045] In some embodiments, the moisture content may be a value measured from an emulsified lyocell multifilament. The emulsified lyocell multifilament may refer to a lyocell multifilament that has undergone treatment with an emulsion of a method of manufacturing a lyocell material described below.

[0046] In some embodiments, the lyocell material may be a lyocell tow.

[0047] In some embodiments, the lyocell material may be used for a filter for a smoking article.

[0048] In some embodiments, a filter for a smoking article, including any one of the lyocell materials, is provided.

[0049] In some embodiments, for a filter for a smoking article, a maximum weight per filter of the lyocell material may be 100 mg/filter to 1,000 mg/filter. In particular, the maximum weight per filter of the lyocell material may be 200 mg/filter to 1,000 mg/filter, 300 mg/filter to 1,000 mg/filter, 400 mg/filter to 1,000 mg/filter, 500 mg/filter to 1,000 mg/filter, 600 mg/filter to 1,000 mg/filter, 700 mg/filter to 1,000 mg/filter, or 800 mg/filter to 1,000 mg/filter.

[0050] In some embodiments, for a filter for a smoking article, a maximum suction resistance per filter may be 100 mmWG/filter to 900 mmWG/filter. In particular, the maximum suction resistance per filter of the lyocell material may be 100 mmWG/filter to 900 mmWG/filter, 150 mmWG/filter to 900 mmWG/filter, 200 mmWG/filter to 900 mmWG/filter, 250 mmWG/filter to 900 mmWG/filter, 300 mmWG/filter to 900 mmWG/filter, 350 mmWG/filter to 900 mmWG/filter, or 400 mmWG/filter to 900 mmWG/filter.

[0051] A minimum weight of the lyocell material included in a filter for a smoking article may be determined by the following method. For example, the minimum weight of the lyocell material may be a weight when all of Condition 1, Condition 2, and Condition A are satisfied:

[Condition 1] The manufacturing process of a filter for a smoking article may be performed continuously;
[Condition 2] The circumference of a filter for a smoking article is maintained at 24.2 mm; and
[Condition A] One end of the filter wrapping paper of a filter for a smoking article is empty to a depth of 0.5 mm.

[0052] The maximum weight of the lyocell material included in a filter for a smoking article may be determined by the following method. For example, the maximum weight of the lyocell material may be a weight when all of Condition 1, Condition 2, and Condition B are satisfied:

[Condition 1] The manufacturing process of a filter for a smoking article may be performed continuously;
[Condition 2] The circumference of a filter for a smoking article is maintained at 24.2 mm; and
[Condition B] The filter for a smoking article does not burst.

[0053] In some embodiments, a smoking article is provided including any one of the filters for a smoking article.

[0054] In some embodiments, a method of manufacturing a lyocell material is provided, including: spinning a lyocell dope; coagulating the spinned lyocell dope and obtaining a lyocell multifilament; washing the lyocell multifilament; treating the lyocell multifilament with an emulsion; and crimping the lyocell multifilament. In some embodiments, the steps are performed in the order mentioned.

[0055] Additionally, in some embodiments, in the method of manufacturing a lyocell material, a moisture content of the lyocell multifilament is controlled to 200 % to 350 % prior to the crimping.

[0056] In some embodiments, in the method of manufacturing a lyocell material, the moisture content of the lyocell multifilament may be controlled during the washing, after the washing, or during and after the washing.

[0057] In some embodiments, in the method of manufacturing a lyocell material, the moisture content of the lyocell multifilament may be controlled in the washing.

[0058] In some embodiments, in the method of manufacturing a lyocell material, the obtaining of the lyocell multifilament further includes drawing the lyocell multifilament by a first roller, the washing further includes drawing the lyocell multifilament by a second roller, and the moisture content of the lyocell multifilament may be controlled by a ratio of the rotational speed of the second roller to that of the first roller. In some embodiments, the rotational speed of the first roller may be different from the rotational speed of the second roller. In some embodiments, the rotational speed of the second roller may be greater than the rotational speed of the first roller.

[0059] In some embodiments, in the method of manufacturing a lyocell material, the drawing of the lyocell multifilament in the washing may be performed by one or more rollers, and when the drawing of the lyocell multifilament in the washing is performed by two or more rollers, the second roller may be the last roller.

[0060] In some embodiments, in the method of manufacturing a lyocell material, the ratio of the rotational speed of the second roller to that of the first roller may be 1.00 to 1.15.

[0061] In some embodiments, in the method of manufacturing a lyocell material, the moisture content of the lyocell multifilament may be controlled after the washing.

[0062] In some embodiments, in the method of manufacturing a lyocell material, the moisture content of the lyocell multifilament may be controlled after the treatment with an emulsion.

[0063] In some embodiments, in the method of manufacturing a lyocell material, the moisture content of the lyocell multifilament may be controlled with pressurization conditions.

[0064] In some embodiments, the method of manufacturing the lyocell material further includes pressurizing the lyocell multifilament, and the pressurizing of the lyocell multifilament may be included between the washing and the crimping.

[0065] In some embodiments, the method of manufacturing the lyocell material further includes pressurizing the lyocell multifilament, and the pressurizing of the lyocell multifilament may be included between the treatment with an emulsion and the crimping.

[0066] In some embodiments, in the method of manufacturing a lyocell material, the shape stability of crimps of the lyocell material measured after the crimping may be 20 % to 60 %.

[0067] In some embodiments, the lyocell material has the shape stability of crimps of 20 % to 60 %. Accordingly, the processability of the lyocell material is improved. In particular, in the manufacturing of a filter for a smoking article, including the lyocell material, the performance of the filter and the manufacturing efficiency of the filter may be increased by using a lyocell material having a certain shape stability of crimps.

[0068] In particular, a filter for a smoking article, including the lyocell material as described above, may have an increased maximum amount of the lyocell material per filter, and may have an increased maximum suction resistance of the filter for a smoking article. As a result, the filtering performance of a filter for a smoking article, including a lyocell material, may be improved, and the amount of the lyocell material required to achieve a certain filtering performance may be reduced.

[0069] In addition, the lyocell material having a certain shape stability of crimps may provide improved post-processability. As a result, the efficiency of a process of manufacturing a filter for a smoking article by using the lyocell material may be increased. Specifically, the time required for manufacturing the filter for a smoking article may be reduced. More specifically, the number of the filter for a smoking article manufactured per unit time may be significantly increased.

[0070] Meanwhile, in some embodiments, in the manufacturing of a lyocell material, the moisture content of a lyocell multifilament may be controlled prior to the crimping of the lyocell multifilament. Accordingly, crimps may be imparted to the lyocell multifilament with controlled moisture content, and changes in elongation and tenacity of the lyocell material according to the crimping may be controlled. As a result, the shape stability of crimps of the crimped lyocell material may be within a certain range.

[Non-circular cross-section]

[0071] One or more of lyocell monofilaments included in the lyocell material of the disclosure may have a non-circular cross-section. "Non-circular" means that the shape of the outline of a cross-section is not circular, and the "cross-section" may be a cross-section obtained by cutting the lyocell monofilament virtually or actually perpendicular to the longitudinal direction of the filament.

[0072] The outline of the non-circular cross-section may touch an imaginary first circle and an imaginary second circle. In addition, the imaginary second circle may be depicted within the imaginary first circle and/or the imaginary second circle may be within the imaginary first circle. The "imaginary first circle" may also be referred to as an "imaginary circumcircle" and/or a "circumcircle," and/or the "imaginary second circle" may also be referred to as an "imaginary incircle" and/or an "incircle."

[0073] The imaginary first circle may be a circle with the smallest area value among the circles drawn to completely encompass one cross-section of a monofilament. The imaginary second circle may be a circle with the largest area value among the circles drawn within the cross-section of a monofilament.

[0074] When a circumcircle including the cross-section of a monofilament may be drawn, the imaginary first circle may be the circumcircle. When an incircle may be drawn within the cross-section of a monofilament, the imaginary second circle may be the incircle.

[0075] The non-circular cross-section may have a shape including multiple protrusions, for example, a Y-shaped cross-section including three protrusions. It may be understood that the multiple protrusions are formed as one with the imaginary second circle as the center and that their ends touch the imaginary first circle. The terms mentioned herein have the same meanings as described above.

[0076] The degree of non-circularity of a monofilament may be defined by Mathematical Formula 1:

Mathematical Formula 1

$$\text{Degree of non-circularity} = r1/r2$$

[0077] wherein, r1 is a radius of the imaginary first circle, and r2 is a radius of the imaginary second circle.

[0078] For example, the radius of the imaginary first circle may be 4 to 40 μm, the radius of the imaginary second circle may be 2 to 14 μm, and the degree of non-circularity may be 1.01 to 10.

[0079] In addition, a space occupancy of a monofilament may be defined by Mathematical Formula 2:

Mathematical Formula 2

$$\text{Space occupancy} = (S1/S2) \times 100(\%)$$

wherein, S1 is an area of the imaginary first circle, and S2 is a cross-sectional area of a monofilament included in a lyocell fiber.

[0080] For example, the space occupancy of a monofilament having a non-circular cross-section may be 120 to 600 %.

[Fineness]

[0081] A lyocell multifilament may have a fineness suitable for manufacturing a filter for a smoking article and ensuring its function.

[0082] In one example, the single fineness of filament forming the lyocell multifilament may be 1.67 to 8.89 dtex (1.5 to 8.0 denier). In this regard, the single fineness of filament refers to a fineness of one monofilament separated from the multifilament.

[0083] In particular, the upper limit of the single fineness of filament may be, for example, 8.33 dtex (7.5 denier) or less, 7.78 dtex (7.0 denier) or less, 7.22 dtex (6.5 denier) or less, 6.67 dtex (6.0 denier) or less, 6.11 dtex (5.5 denier) or less, 5.56 dtex (5.0 denier) or less, 5.00 dtex (4.5 denier) or less, 3.89 dtex (3.5 denier) or less, 3.33 dtex (3.0 denier) or less, 2.78 dtex (2.5 denier) or less, or 2.22 dtex (2.0 denier) or less. In addition, the lower limit thereof may be, for example, 2.22 dtex (2.0 denier) or more, 2.78 dtex (2.5 denier) or more, 3.33 dtex (3.0 denier) or more, 3.89 dtex (3.5 denier) or more, 4.44 dtex (4.0 denier) or more, 5.00 dtex (4.5 denier) or more, 5.56 dtex (5.0 denier) or more, 6.11 dtex (5.5 denier) or more, 6.67 dtex (6.0 denier) or more, 7.22 dtex (6.5 denier) or more, or 7.78 dtex (7.0 denier) or more. Satisfying the ranges above may be more advantageous in securing stable physical properties (for example, implementation of hardness or suction resistance) and processability of a filter for a smoking article.

[0084] In one example, a total fineness of the lyocell multifilament may be 1,667 to 6,111 tex (15,000 to 55,000 denier).

For example, the lower limit of the total fineness may be, for example, 1,778 tex (16,000 denier) or more, 1,833 tex (16,500 denier) or more, 1,889 tex (17,000 denier) or more, 1,944 tex (17,500 denier) or more, 2,000 tex (18,000 denier) or more, 2,056 tex (18,500 denier) or more, 2,111 tex (19,000 denier) or more, 2,167 tex (19,500 denier) or more, 2,222 tex (20,000 denier) or more, 2,278 tex (20,500 denier) or more, 2,333 tex (21,000 denier) or more, 2,389 tex(21,500 denier) or more, 2,444 tex (22,000 denier) or more, 2,500 tex (22,500 denier) or more, 2,556 tex (23,000 denier) or more, 2,611 tex (23,500 denier) or more, 2,667 tex (24,000 denier) or more, 2,722 tex (24,500 denier) or more, 2,778 tex (25,000 denier) or more, 2,833 tex (25,500 denier) or more, 2,889 tex (26,000 denier) or more, 2,944 tex (26,500 denier) or more, 3,000 tex (27,000 denier) or more, 3,056 tex (27,500 denier) or more, 3,111 tex (28,000 denier) or more, 3,167 tex (28,500 denier) or more, 3,222 tex (29,000 denier) or more, 3,287 tex (29,500 denier) or more, 3,333 tex (30,000 denier) or more, 3,389 tex (30,500 denier) or more, 3,444 tex (31,000 denier) or more, 3,500 tex (31,500 denier) or more, 3,556 tex (32,000 denier) or more, 3,611 tex (32,500 denier) or more, 3,667 tex (33,000 denier) or more, 3,722 tex (33,500 denier) or more, 3,778 tex (34,000 denier) or more, 3,833 tex (34,500 denier) or more, 3,889 tex (35,000 denier) or more, 3,944 tex (35,500 denier) or more, 4,000 tex (36,000 denier) or more, 4,056 tex (36,500 denier) or more, 4,111 tex (37,000 denier) or more, 4,167 tex (37,500 denier) or more, 4,222 tex (38,000 denier) or more, 4,278 tex (38,500 denier) or more, 4,333 tex (39,000 denier) or more, 4,389 tex (39,500 denier) or more, 4,444 tex (40,000 denier) or more, 4,500 tex (40,500 denier) or more, 4,556 tex (41,000 denier) or more, 4,611 tex (41,500 denier) or more, 4,667 tex (42,000 denier) or more, 4,722 tex (42,500 denier) or more, 4,778 tex (43,000 denier) or more, 4,833 tex (43,500 denier) or more, 4,889 tex (44,000 denier) or more, 4,944 tex (44,500 denier) or more, 5,000 tex (45,000 denier) or more, 5,056 tex (45,500 denier) or more, 5,111 tex (46,000 denier) or more, 5,167 tex (46,500 denier) or more, 5,222 tex (47,000 denier) or more, 5,278 tex (47,500 denier) or more, 5,333 tex (48,000 denier) or more, 5,389 tex (48,500 denier) or more, 5,444 tex (49,000 denier) or more, 5,500 tex (49,500 denier) or more, 5,556 tex (50,000 denier) or more, 5,611 tex (50,500 denier) or more, 5,667 tex (51,000 denier) or more, 5,722 tex (51,500 denier) or more, 5,778 tex (52,000 denier) or more, 5,833 tex (52,500 denier) or more, 5,889 tex (53,000 denier) or more, 5,944 tex (53,500 denier) or more, 6,000 tex (54,000 denier) or more, or 6,056 tex (54,500 denier) or more. In addition, the upper limit thereof may be, for example, 6,056 tex (54,500 denier) or less, 6,000 tex (54,000 denier) or less, 5,944 tex (53,500 denier) or less, 5,889 tex (53,000 denier) or less, 5,833 tex (52,500 denier) or less, 5,778 tex (52,000 denier) or less, 5,722 tex (51,500 denier) or less, 5,667 tex (51,000 denier) or less, 5,611 tex (50,500 denier) or less, 5,556 tex (50,000 denier) or less, 5,500 tex (49,500 denier) or less, 5,444 tex (49,000 denier) or less, 5,389 tex (48,500 denier) or less, 5,333 tex (48,000 denier) or less, 5,278 tex (47,500 denier) or less, 5,222 tex (47,000 denier) or less, 5,167 tex (46,500 denier) or less, 5,111 tex (46,000 denier) or less, 5,056 tex (45,500 denier) or less, 5,000 tex (45,000 denier) or less, 4,944 tex (44,500 denier) or less, 4,889 tex (44,000 denier) or less, 4,833 tex (43,500 denier) or less, 4,778 tex (43,000 denier) or less, 4,722 tex (42,500 denier) or less, 4,667 tex (42,000 denier) or less, 4,611 tex (41,500 denier) or less, 4,556 tex (41,000 denier) or less, 4,500 tex (40,500 denier) or less, 4,444 tex (40,000 denier) or less, 4,389 tex (39,500 denier) or less, 4,333 tex (39,000 denier) or less, 4,278 tex (38,500 denier) or less, 4,222 tex (38,000 denier) or less, 4,167 tex (37,500 denier) or less, 4,111 tex (37,000 denier) or less, 4,056 tex (36,500 denier) or less, 4,000 tex (36,000 denier) or less, 3,944 tex (35,500 denier) or less, 3,889 tex (35,000 denier) or less, 3,833 tex (34,500 denier) or less, 3,778 tex (34,000 denier) or less, 3,722 tex (33,500 denier) or less, 3,667 tex (33,000 denier) or less, 3,611 tex (32,500 denier) or less, 3,556 tex (32,000 denier) or less, 3,500 tex (31,500 denier) or less, 3,444 tex (31,000 denier) or less, 3,389 tex (30,500 denier) or less, 3,333 tex (30,000 denier) or less, 3,278 tex (29,500 denier) or less, 3,222 tex (29,000 denier) or less, 3,167 tex (28,500 denier) or less, 3,111 tex (28,000 denier) or less, 3,056 tex (27,500 denier) or less, 3,000 tex (27,000 denier) or less, 2,944 tex (26,500 denier) or less, 2,889 tex (26,000 denier) or less, 2,833 tex (25,500 denier) or less, 2,778 tex (25,000 denier) or less, 2,722 tex (24,500 denier) or less, 2,667 tex (24,000 denier) or less, 2,611 tex (23,500 denier) or less, 2,556 tex (23,000 denier) or less, 2,500 tex (22,500 denier) or less, 2,444 tex (22,000 denier) or less, 2,389 tex (21,500 denier) or less, 2,333 tex (21,000 denier) or less, 2,278 tex (20,500 denier) or less, 2,222 tex (20,000 denier) or less, 2,167 tex (19,500 denier) or less, 2,111 tex (19,000 denier) or less, 2,056 tex (18,500 denier) or less, 2,000 tex (18,000 denier) or less, 1,944 tex (17,500 denier) or less, 1,889 tex (17,000 denier) or less, 1,833 tex (16,500 denier) or less, 1,778 tex (16,000 denier) or less, or 1,722 tex (15,500 denier) or less. When the total fineness is outside the ranges above, the processability of manufacturing a filter for a smoking article may not be good (continuous process is not possible due to yarn cutting), and when an amount of tow filled in the filter wrapping paper during the manufacturing of a filter for a smoking article is too small or too large, it may be difficult to secure sufficient physical properties (for example, hardness or suction resistance) of a filter.

[0085] There are no particular restrictions on the method of measuring fineness, but for example, a sample having a length of 2 m of a lyocell material to be measured, for example, lyocell tow, is taken, and left and stabilized in a room kept at a constant temperature and humidity of 20 °C and 65 % for 24 hours. One end of the stabilized lyocell tow is secured and a 2 kg weight is attached to the other end. After the tow is maintained (stabilized) in an extended state due to a load for 5 seconds, it is cut to have a length of 90 cm to obtain a sample, and a weight of the sample is measured (total fineness). The fineness is converted to a measure of denier, which is a measured weight $\times$ 10,000, according to a denier conversion method. The fineness of monofilament in the sample is calculated by dividing the total fineness by the number of monofilament strands in the sample.

[0086] The total fineness of the lyocell multifilament may be determined by the fineness of mono filament and the number of crimps. In the disclosure, the single fineness and the number of crimps may be controlled, and the total fineness of a lyocell material suitable for manufacturing a filter for a smoking article and securing its function may be secured.

[Number of crimps]

[0087] In one example, a lyocell multifilament may have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch).

[0088] For example, the number of crimps may be 5.91 ea/cm (15 ea/inch) or more, 7.87 ea/cm (20 ea/inch) or more, 9.84 ea/cm (25 ea/inch) or more, 11.81 ea/cm (30 ea/inch) or more, 13.78 ea/cm (35 ea/inch) or more, 15.75 ea/cm (40 ea/inch) or more, or 17.72 ea/cm (45 ea/inch) or more, and the upper limit thereof may be, for example, 17.72 ea/cm (45 ea/inch) or less, 15.75 ea/cm (40 ea/inch) or less, 13.78 ea/cm (35 ea/inch) or less, 11.81 ea/cm (30 ea/inch) or less, or 9.84 ea/cm (25 ea/inch) or less. The number of crimps and their uniformity may be controlled through pressure and temperature conditions in crimping described below.

[0089] Although not particularly limited, the number of crimps may be measured by using, for example, a device for evaluating physical properties of a monofilament (for example, Favimat). In particular, a sample of the manufactured lyocell material (preferably, lyocell tow) may be left and stabilized under conditions of a temperature of 20±2 °C and a humidity of 65± 4 % for 24 hours . A sample may be taken from the stabilized sample without damaging the crimps. The taken sample may be secured on a dedicated jig with a length (gauge length) of 10 to 30 mm. The initial load at measurement may be 0.44 cN/tex (0.05 g/de) and the crimp sensitivity may be 0.01 mm. The number of crimps may be measured under the conditions described above (i.e., a temperature of 20±2 °C and a humidity of 65±4 %).

[0090] Although not particularly limited, a lyocell material manufactured to meet the single fineness, the total fineness, and/or the number of crimps described above may be used in a smoking article.

[Physical properties of lyocell material]

[0091] The shape stability of crimps of a lyocell material may be 20 % to 60 %. In particular, the lower limit of the shape stability of crimps of a lyocell material may be 20 %, 25 %, 30 %, 35 %, 40 %, 45 %, 50 %, or 55 %, and the upper limit of the shape stability of crimps of a lyocell material may be 60 %, 55 %, 50 %, 45 %, 40 %, 35 %, or 25 %.

[0092] In some embodiments, the shape stability of crimps of a lyocell material may be 20 % to 60 %, 20 % to 55 %, 20 % to 50 %, 20 % to 45 %, 20 % to 40 %, 20 % to 35 %, 20 % to 30 %, 20 % to 25 %, 25 % to 60 %, 25 % to 55 %, 25 % to 50 %, 25 % to 45 %, 25 % to 40 %, 25 % to 35 %, 25 % to 30 %, 30 % to 60 %, 30 % to 55 %, 30 % to 50 %, 30 % to 45 %, 30 % to 40 %, 30 % to 35 %, 35 % to 60 %, 35 % to 55 %, 35 % to 50 %, 35 % to 45 %, 35 % to 40 %, 40 % to 60 %, 40 % to 55 %, 40 % to 50 %, 40 % to 45 %, 45 % to 60 %, 45 % to 55 %, 45 % to 50 %, 50 % to 60 %, 50 % to 55 %, or 55 % to 60 %. In addition, when the shape stability of crimps of a lyocell material is 20 % to 50 %, 25 % to 50 %, 30 % to 50 %, 35 % to 50 %, 40 % to 50 %, or 45 % to 50 %, the uniformity of crimps may be further improved.

[0093] In addition, the shape stability of crimps of a lyocell material may be calculated by Equation 1:

Equation 1

$$\text{Shape Stability of Crimps (\%)} = (L_0 - L_b)/(L_0 - L) * 100$$

wherein, in Equation 1, L represents a length of a monofilament measured under a condition of initial load (0.01 cN/tex), L_0 represents a length of a monofilament measured under a condition of 5 cN/tex load, and L_b represents a length of a monofilament measured under a condition of restoration (0.01 cN/tex) after the 5 cN/tex load is removed.

[0094] Additionally, the shape stability of crimps of a lyocell material may be an average of values measured for a plurality of monofilaments. For example, the shape stability of crimps may be an average of values measured for 20 monofilaments, an average of values measured for 50 monofilaments, or an average of values measured for 100 monofilaments.

[0095] Additionally, measurement of the shape stability of crimps may be performed according to ASTM D 3822 (ASTM D3822/D3822M-14 (2020)). For example, the time for which a monofilament is loaded may be 5 seconds, and the time for which the monofilament restores may be 5 seconds.

[0096] When the lyocell material has a shape stability of crimps of 20 % to 60 %, the processability of the lyocell material is improved. In particular, in the manufacturing of a filter for a smoking article, including the lyocell material, the performance of the filter and the manufacturing efficiency of the filter may be increased by using a lyocell material having a certain shape stability of crimps.

[0097] In the lyocell material having a certain shape stability of crimps, the tenacity of one or more monofilaments included in a lyocell multifilament may be 2.65 cN/tex to 7.06 cN/tex (0.3 g/de to 0.8 g/de).

[0098] In some embodiments, an average tenacity of monofilaments included in the lyocell multifilament may be 2.65

cN/tex to 7.06 cN/tex (0.3 g/de to 0.8 g/de).

[0099] In some embodiments, an elongation of one or more monofilaments included in a lyocell multifilament may be 5 % to 10 %.

[0100] In some embodiments, the average elongation of monofilaments included in the lyocell multifilament may be 5 % to 10 %.

[0101] Additionally, the elongation and tenacity of a monofilament may be measured by using a tensile tester. The object of which elongation and tenacity are measured by a tensile tester may be monofilaments taken from a lyocell material.

[0102] For example, the elongation and tenacity of monofilaments taken from a lyocell material may be measured by using a low-speed tensile machine from INSTRON, Co. The measurement conditions of the elongation and tenacity may be kept constant. For example, the elongation and tenacity of a monofilament may be measured separately or simultaneously by stretching the monofilament at a specific rate. The specific rate may be 60 mm/min. In addition, the measurement temperature, measurement pressure, and/or measurement humidity of the elongation and tenacity may be maintained uniformly.

[0103] Additionally, stabilization of the monofilament may be preceded before the shape stability of crimps, elongation, and tenacity are measured. Stabilization may be performed by leaving the monofilament under conditions of constant temperature (20±2 °C) and constant humidity (65±4 %RH) in accordance with KS K ISO 139.

[0104] When a lyocell material having a certain shape stability of crimps has a certain tenacity and a certain elongation or has a certain average tenacity and a certain average elongation, the post-processability of the lyocell material may be further improved. As a result, the efficiency of a process of manufacturing a filter for a smoking article by using the lyocell material may be increased. In particular, the time required for manufacturing a filter for a smoking article may be reduced. In particular, the number of filters for a smoking article manufactured per unit time may be significantly increased.

[Moisture content of lyocell multifilament]

[0105] For example, a moisture content of a lyocell multifilament may be 200 % to 350 %. When the moisture content of a lyocell multifilament is less than 200 %, the shape stability of crimps of the lyocell multifilament may exceed the range of 20 % to 60 %.

[0106] In some embodiments, the moisture content of a lyocell multifilament may be 200 % to 350 %, 200 % to 330 %, 200 % to 310 %, 200 % to 290 %, 200 % to 270 %, 200 % to 250 %, 200 % to 230 %, 200 % to 210 %, 220 % to 350 %, 220 % to 330 %, 220 % to 310 %, 220 % to 290 %, 220 % to 270 %, 220 % to 250 %, 220 % to 230 %, 240 % to 350 %, 240 % to 330 %, 240 % to 310 %, 240 % to 290 %, 240% to 270 %, 240% to 250 %, 260 % to 350 %, 260 % to 330 %, 260 % to 310 %, 260 % to 290 %, 260 % to 270 %, 280 % to 350 %, 280 % to 330 %, 280 % to 310 %, 280 % to 290 %, 300 % to 350 %, 300 % to 330 %, 300 % to 310 %, 320 % to 350 %, 320 % to 330 %, or 340 % to 350%.

[0107] When a filter for a smoking article is manufactured, a constant tension is applied to a crimped lyocell multifilament so that the crimped lyocell multifilament opens in the length direction and the width direction. Meanwhile, excessive shape stability of crimps leads to an increase in the tension, and the increase in the tension may result in a decrease in openability. Due to the decrease in openability, a maximum amount per filter of a lyocell material introduced into a filter wrapping paper may decrease, a maximum suction resistance of a filter for a smoking article may also decrease, and the manufacturing processability of a filter for a smoking article may also deteriorate.

[0108] Conversely, when the moisture content of a lyocell multifilament exceeds 350 %, the shape stability of crimps of the lyocell multifilament may fall below the range of 20 % to 60 %.

[0109] As a result, when a filter for a lyocell smoking article is manufactured, the crimps imparted may not maintain their shapes during the process of applying a constantt tension to the lyocell multifilament so that the crimped lyocell multifilament opens in the length direction and the width direction.

[0110] Additionally, excessive moisture may result in insufficient crimping of the lyocell multifilament. Due to failure to maintain the shapes of crimps or an insufficient number of crimps, the maximum amount per filter of a lyocell material may be reduced, the maximum suction resistance of a filter for a smoking article may also be reduced, and the manufacturing processability of a filter for a smoking article may also deteriorate.

[0111] The moisture content of the lyocell multifilament may be a value measured according to Equation 2:

Equation 2

$$\text{Moisture Content (\%)} = \frac{W-D}{D} * 100$$

wherein, in Equation 2, W represents a weight of a sample measured before drying, and D represents a weight of a sample measured after drying.

[0112] The moisture content may be a value measured from a lyocell filament before crimps are imparted (before

crimping). In addition, the moisture content may be a value measured from a lyocell filament immediately before crimps are imparted. For example, when washing is performed immediately prior to crimping, the moisture content may be a value measured from a lyocell multifilament after the washing is completed.

[0113] In addition, the moisture content may be a value measured from an emulsified lyocell multifilament. For example, when a method of manufacturing a lyocell multifilament includes treatment with an emulsion, the moisture content may be a value measured from the emulsified lyocell multifilament. In addition, when the method of manufacturing a lyocell multifilament includes treatment with an emulsion twice or more, the moisture content may be a value measured in the last treatment with an emulsion performed before crimping is performed.

[0114] Therefore, the moisture content of a lyocell multifilament may be controlled during the washing, after the washing, or during and after the washing. The moisture content may be controlled during the treatment with an emulsion, after the treatment with an emulsion, or during and after the treatment with an emulsion.

[0115] In some embodiments, the method of manufacturing the lyocell material further includes pressurizing the lyocell multifilament, and the pressurizing of the lyocell multifilament may be included between the washing and the crimping. Although not particularly limited, the pressurization of the lyocell multifilament may be performed at 29.42 N/cm^2 to 34.33 N/cm^2 (3.0 kgf/cm^2 to 3.5 kgf/cm^2).

[0116] By performing the pressurizing of the lyocell multifilament, the moisture content of the lyocell multifilament may be controlled as described above.

[Binder]

[0117] In one non-limiting example, the lyocell material may further include a binder. The binder may be present, for example, on the surface of the lyocell multifilament, or between the lyocell multifilaments (or monofilaments). The binder may increase the hardness of a filter for a smoking article, thereby preventing problems such as filter jamming during the manufacturing process of the filter or the manufacturing process of the smoking article (for example, cigarette).

[0118] The type of available binder is not particularly limited, and any known binder may be used as long as it does not hinder the purpose of the disclosure. For example, a binder that provides sufficient compatibility with the emulsion used in the disclosure, may improve the hardness of the filter, and may provide excellent bonding strength may be used.

[0119] In one non-limiting example, the binder may include a polyester-based binder, a cellulose-based binder, and/or a vinyl-based binder.

[0120] Although not particularly limited, as the polyester-based binder, a polyester binder including one or more selected from the group consisting of alkylene, arylene, and heteroarylene, having 5 to 12 carbon atoms, may be used.

[0121] Examples of available cellulose-based binder may include, but are not limited to, hydroxypropyl methyl cellulose (HPMC), ethyl cellulose (EC), and/or methyl cellulose (MC), carboxymethyl cellulose (CMC).

[0122] In some embodiments, the cellulose-based binder is selected from the group consisting of hydroxypropyl methyl cellulose, ethyl cellulose, methyl cellulose, carboxymethyl cellulose, and any combination thereof.

[0123] Examples of available vinyl-based binder may include, but are not limited to, polyvinylpyrrolidone (PVP), polyvinyl alcohol (PVA), and/or ethylene vinyl acetate (EVAc).

[0124] In some embodiments, the vinyl-based binder is selected from the group consisting of polyvinylpyrrolidone, polyvinyl alcohol, ethylene vinyl acetate, and any combination thereof.

[0125] A method of applying (coating) the binder onto a lyocell material is described below.

[Emulsion]

[0126] The lyocell material may include: lyocell multifilaments; and an emulsion coated onto the lyocell multifilaments. In addition, the emulsion includes: (a) an ester of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol; and (b) an ester of sorbitan and a fatty acid having 16 or more carbon atoms. Such an emulsion may be applied onto a portion or all of the mono- or multifilaments forming the lyocell material. In addition, the emulsion may penetrate between the filaments.

[0127] An emulsion including at least the components (a) and (b) may have hydrophobicity. As a result, a lyocell material treated with the emulsion has excellent spreading properties.

[0128] In some embodiments, the lyocell material may include a certain amount of the emulsion. In this regard, the amount of the emulsion may mean OPU (wt%) described below. The "OPU" may refer to "oil pick up ratio." For example, the lyocell material may include an emulsion in an amount of 0.1 wt% or more, based on 100 wt% of the total lyocell material. In particular, the amount of the emulsion may be 0.5 wt% or more, 1.0 wt% or more, 1.5 wt% or more, 2.0 wt% or more, 2.5 wt% or more, 3.0 wt% or more, particularly 3.5 wt% or more, 4.0 wt% or more, 4.2 wt% or more, 4.5 wt% or more, 5.0 wt% or more, 5.5 wt% or more, 6.0 wt% or more, 6.5 wt% or more, 7.0 wt% or more, 7.5 wt% or more, 8.0 wt% or more, 8.5 wt% or more, 9.0 wt% or more, or 9.5 wt% or more, based on 100 wt% of the total lyocell material. In addition, the upper limit thereof may be, for example, 20.0 wt% or less, 18.0 wt% or less, 17.0 wt% or less, 16.0 wt% or less, 15.0 wt% or less, 14.5 wt% or

less, 14.0 wt% or less, 13.5 wt% or less, 13.0 wt% or less, 12.5 wt% or less, 12.0 wt% or less, 11.5 wt% or less, 11.0 wt% or less, 10.5 wt% or less, 10 wt% or less, 9.5 wt% or less, 9.0 wt% or less, 8.5 wt% or less, 8.0 wt% or less, 7.8 wt% or less, or 7.6 wt% or less.

[0129] As a method of measuring an amount (OPU) of the emulsion, an extrusion method may be used, for example. For example, a sample (for example, 2 to 5 g, specifically about 2.5 g) is taken (a weight of the taken sample is called a sample weight) and the sample is injected into a syringe-shaped container. The material of the container is not particularly limited, but may be SUS (Steel Use Stainless). Next, a solvent (for example, methanol) is injected into the container containing the sample (the amount of the solvent injected may be 10 ml or less (for example, about 8 ml)). When injecting a solvent into a sample, a dropping method may be used, wherein a dropping rate may be controlled uniformly. Additionally, the solvent injected into the container as described above is allowed to drop from one end of the syringe-shaped container onto a plate. In this regard, the plate is pre-weighed (the weighed weight is referred to as a plate weight A), and the plate is installed so that the solvent dropped onto the plate may fly away (i.e., evaporate) at a temperature of 120 to 130 °C (for example, 125 °C). The solvent injection and the solvent dropping as described above are performed three times, and the sample is pressed once by applying pressure (for example, 98 N/cm^2 (10 kgf/cm^2) or less, 49 N/cm^2 (5 kgf/cm^2) or less, or 18 to 39 N/cm^2 (2 to 4 kgf/cm^2)) to the sample using a syringe-shaped container. This allows the solvent and emulsion present in the sample to be sufficiently extruded. The sample is squeezed under pressure until no solvent comes out. Afterwards, the plate is stored in a desiccator for 5 minutes to 10 minutes, and a weight of the plate containing the sample (a plate weight B) is measured. Then, an amount of the emulsion is calculated according to the following Equation:

$$\text{Amount of emulsion by extrusion (OPU, \% or wt\%)} = \{(\text{Plate weight B} - \text{Plate weight A})/(\text{Sample weight})\} \times 100 \quad \text{Equation}$$

[0130] In addition, the lyocell material that serves as the standard for the amount of the emulsion may be at least an emulsified lyocell multifilament. For example, the lyocell material may be a lyocell multifilament to which primary treatment with an emulsion (as described below) has been applied, a lyocell multifilament to which primary treatment with an emulsion and a secondary treatment with an emulsion (as described below) have been applied, or a lyocell multifilament to which binder treatment as described below has been applied along with the treatment with an emulsion as described above. In addition, the lyocell multifilament to which treatment with an emulsion and/or binder treatment has been applied may be crimped.

[0131] With respect to the emulsion of the disclosure, the component (a) may be a compound that may function as a type of lubricant or oil, and may be a component harmless to the human body enough to be used in foods. The component (a) imparts lubrication to the fibers introduced into a crimper. When the lubrication is not sufficient, the lyocell will clump together and not be able to pass through the crimper, and when the lubrication is too high, there is a problem of the crimp not being formed properly. An amount of the component (a) may be controlled as described below, taking these functions into consideration.

[0132] With respect to the component (a), the types of fatty acids having 16 or more carbon atoms forming the esters are not particularly limited. Fatty acids having 16 or more carbon atoms may be used as long as they provide esters harmless to the human body enough to be used in foods.

[0133] For example, fatty acids having 16 or more carbon atoms may be saturated fatty acids and/or unsaturated fatty acids.

[0134] Examples of saturated fatty acids may include palmitic acid (hexadecanoic acid, $CH_3(CH_2)_{14}COOH$), margaric acid (heptadecanoic acid, $CH_3(CH_2)_{15}COOH$), stearic acid (octadecanoic acid, $CH_3(CH_2)_{16}COOH$), nonadecylic acid (nonadecanoic acid, $CH_3(CH_2)_{17}COOH$), or arachidic acid (eicosanoic acid, $CH_3(CH_2)_{18}COOH$). However, the types of available saturated fatty acids are not limited thereto.

[0135] Examples of unsaturated fatty acids may include palmitoleic acid ($CH_3(CH_2)_5CH=CH(CH_2)_7COOH$), oleic acid ($CH_3(CH_2)_7CH=CH(CH_2)_7COOH$), linoleic acid ($C_{13}H_{32}O_2$), or arachidonic acid ($C_{20}H_{32}O_2$). However, the types of available unsaturated fatty acids are not limited thereto.

[0136] In some embodiments, the fatty acid is selected from the group consisting of palmitic acid, margaric acid, stearic acid, nonadecylic acid, arachidic acid, palmitoleic acid, oleic acid, linoleic acid, and arachidonic acid.

[0137] The upper limit of the carbon number of the fatty acid having 16 or more carbon atoms is not particularly limited, but may be, for example, 40 or less, 36 or less, 32 or less, 28 or less, 24 or less, or 20 or less.

[0138] The type of aliphatic monohydric alcohol forming the component (a) is also not particularly limited. Aliphatic monohydric alcohols capable of providing esters harmless to the human body enough to be used in foods may be used.

[0139] For example, the aliphatic monohydric alcohol may be a saturated fatty alcohol or an unsaturated fatty alcohol, having a linear or branched form.

[0140] In some embodiments, the aliphatic monohydric alcohol may have 1 to 40 carbon atoms. In particular, the carbon number of the aliphatic monohydric alcohol may be, for example, 4 or more, 8 or more, 12 or more, 16 or more, or 20 or

more.

[0141] Examples of the aliphatic monohydric alcohol may include, but are not limited to, methanol, ethanol, butanol, lauryl alcohol, isotridecanol, or stearyl alcohol.

[0142] In some embodiments, the aliphatic monohydric alcohol is selected from the group consisting of methanol, ethanol, butanol, lauryl alcohol, isotridecanol, and stearyl alcohol.

[0143] In some embodiments, an ester of isotridecanol and stearic acid (for example, isotridecyl stearate) may be used as the component (a). However, the types of the component (a) that may be used are not limited thereto.

[0144] As described below, the amout of the component (a) included in the emulsion may be controlled in consideration of the function of the emulsion or the function of the component (a).

[0145] The component (b), i.e., an ester of sorbitan and a fatty acid having 16 or more carbon atoms, is a compound that may function as a type of emulsifier, and may be a component harmless to the human body enough to be used in foods.

[0146] This component (b) has both hydrophobicity and hydrophilicity due to the polyhydric alcohol (i.e., sorbitan), which enables the component (a) imparting lubrication to fibers to be well dispersed in water as described below. In addition, the components (a) and (b) used together not only increase the dispersibility of the emulsion as described above, but also lower the melting point thereof, thereby ensuring the ease of use and handling and stability of the emulsion. The amount of the component (b) may be controlled as described below, taking these functions into consideration.

[0147] The types of fatty acids having 16 or more carbon atoms forming the component (b) are not particularly limited. Fatty acids having 16 or more carbon atoms may be used as long as they provide esters harmless to the human body enough to be used in foods.

[0148] For example, fatty acids having 16 or more carbon atoms may be saturated fatty acids and/or unsaturated fatty acids.

[0149] Examples of saturated fatty acids may include palmitic acid (hexadecanoic acid, $CH_3(CH_2)_{14}COOH$), margaric acid (heptadecanoic acid, $CH_3(CH_2)_{15}COOH$), stearic acid (octadecanoic acid, $CH_3(CH_2)_{16}COOH$), nonadecylic acid (nonadecanoic acid, $CH_3(CH_2)_{17}COOH$), or arachidic acid (eicosanoic acid, $CH_3(CH_2)_{18}COOH$). However, the types of available saturated fatty acids are not limited thereto.

[0150] Examples of unsaturated fatty acids may include palmitoleic acid ($CH_3(CH_2)_5CH=CH(CH_2)_7COOH$), oleic acid ($CH_3(CH_2)_7CH=CH(CH_2)_7COOH$), linoleic acid ($C_{13}H_{32}O_2$), or arachidonic acid ($C_{20}H_{32}O_2$). However, the types of available unsaturated fatty acids are not limited thereto.

[0151] In some embodiments, the fatty acid is selected from the group consisting of palmitic acid, margaric acid, stearic acid, nonadecylic acid, arachidic acid, palmitoleic acid, oleic acid, linoleic acid, and arachidonic acid.

[0152] The upper limit of the carbon number of the fatty acid having 16 or more carbon atoms is not particularly limited, but may be, for example, 40 or less, 36 or less, 32 or less, 28 or less, 24 or less, or 20 or less.

[0153] In some embodiments, an ester of sorbitan and oleic acid (for example, sorbitan monooleate) may be used as the component (b). However, the types of the component (b) that may be used are not limited thereto.

[0154] The amount of the component (b) may be controlled in consideration of the function of the component (b) and the function of the emulsion as described above.

[0155] In one example, the emulsion may include 20 to 60 parts by weight of (b) the ester of sorbitan and a fatty acid having 16 or more carbon atoms, with respect to 100 parts by weight of (a) the ester of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol.

[0156] In particular, the emulsion of the disclosure may include the component (b) in an amount of 25 parts by weight or more, 30 parts by weight or more, 35 parts by weight or more, 40 parts by weight or more, 45 parts by weight or more, or 50 parts by weight or more, with respect to 100 parts by weight of the component (a). In addition, the upper limit of the amount of the component (b) with respect to 100 parts by weight of the component (a) may be, for example, 55 parts by weight or less, 50 parts by weight or less, 45 parts by weight or less, 40 parts by weight or less, 35 parts by weight or less, 30 parts by weight or less, or 25 parts by weight or less. When the amount is within the ranges above, the surface of the emulsified lyocell multifilament or lyocell tow may have hydrophobicity.

[0157] In one example, the emulsion may include 40 to 80 wt% of (a) an ester of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol, based on 100 wt% of the total emulsion. In particular, the amout of the component (a) may be 45 wt% or more, 50 wt% or more, 55 wt% or more, 60 wt% or more, 65 wt% or more, 70 wt% or more, or 75 wt% or more, based on 100 wt% of the total emulsion. In addition, the upper limit of the amount thereof may be, for example, 75 wt% or less, 70 wt% or less, 65 wt% or less, 60 wt% or less, 55 wt% or less, 50 wt% or less, or 45 wt% or less.

[0158] In one example, the emulsion may include an excess amount of component (a).

[0159] In one example, the emulsion may include 15 to 55 wt% of (b) an ester of sorbitan and a fatty acid having 16 or more carbon atoms, based on 100 wt% of the total emulsion. In particular, based on 100 wt% of the total emulsion, the amount of the component (b) may be 20 wt% or more, 25 wt% or more, 30 wt% or more, 35 wt% or more, 40 wt% or more, 45 wt% or more, or 50 wt% or more. In addition, the upper limit of the amount thereof may be, for example, 50 wt% or less, 45 wt% or less, 40 wt% or less, 35 wt% or less, 30 wt% or less, or 25 wt% or less.

[0160] In one example, the emulsion may further include water. A small amount of water may assist treatment with an

emulsion.

[0161] The amount of water is not particularly limited, but water may be included in an amount remaining after excluding the total amount of the component (a) and the component (b) from 100 wt% of the total emulsion. The amount of water in the emulsion (i.e., the remaining amount excluding the total amount of the remaining components excluding water) may be, for example, 10 wt% or less, 9 wt% or less, 8 wt% or less, 7 wt% or less, 6 wt% or less, 5 wt% or less, 4 wt% or less, 3 wt% or less, 2 wt% or less, or 1 wt% or less. In addition, the lower limit thereof may be, for example, 0 wt% or more, 0.1 wt% or more, 0.5 wt% or more, or 1 wt% or more.

[Method of manufacturing lyocell material]

[0162] The disclosure relates to a method of manufacturing a lyocell material. By this method, a lyocell material may be manufactured and used in a smoking article.

[0163] In particular, the method of manufacturing the lyocell material may include: spinning a lyocell dope; coagulating the spinned lyocell dope and obtaining a multifilament; washing the multifilament; treaing the multifilament with an emulsion; and crimping the multifilament. In addition, the method of manufacturing the lyocell material may further include binder treatment; and other steps. In some embodiments, the steps are performed in the order mentioned.

[0164] The treatment with an emulsion may be performed before the crimping, after the crimping, or before and after the crimping.

[0165] The treatment with an emulsion may be performed independently, for example, by spraying the emulsion having the composition as described above onto the lyocell multifilament or immersing the lyocell multifilament into the emulsion. As described above, the treatment with an emulsion may be performed so that the amount of the emulsion (for example, OPU (wt%)) in the lyocell material is within a certain range.

[0166] The crimping may be performed, for example, by applying steam and/or pressure to the lyocell multifilament.

[0167] A method of manufacturing a lyocell material according to some embodiments, including treatment with an emulsion and crimping, is described in more detail below. The method of the disclosure may be performed by including one or more of the steps described below.

<(a) Spinning lyocell dope>

[0168] This step is spinning a lyocell spinning dope including lyocell cellulose (or cellulose pulp) and N-methylmorpholine-N-oxide (NMMO).

[0169] Commercialized cellulose acetate filters are identified as a major cause of microplastics. However, as an amine oxide-based solvent used in manufacturing a lyocell fiber is recyclable and biodegradable when disposed, a lyocell material does not produce any pollutants during its manufacturing process. Furthermore, since a lyocell tow biodegrades and may be removed within a relatively short period of time, a lyocell is a more environmentally friendly material than cellulose acetate.

[0170] In one example, the amount of cellulose in the spinning dope may be 5 to 15 wt%, based on 100 wt% of the total dope. When the amount of cellulose is too low, it is difficult to implement the characteristics of a lyocell fiber, and when the amount pf cellulose exceeds the range above, it is difficult to make cellulose dissolved in the solvent. In consideration of this, the amount of cellulose in the spinning dope may be 6 wt% or more, 7 wt% or more, 8 wt% or more, 9 wt% or more, or 10 wt% or more, based on 100 wt% of the total dope, and the upper limit thereof may be, for example, 14 wt% or less, 13 wt% or less, 12 wt% or less, 11 wt% or less, 10 wt% or less, or 9 wt% or less, based on 100 wt% of the total dope. The term "cellulose" may refer to "lyocell cellulose."

[0171] In one example, the spinning dope may include an aqueous solution of N-methylmorpholine-N-oxide (NMMO). The aqueous solution may include, for example, 80 to 95 wt% of N-methylmorpholine-N-oxide and 5 to 20 wt% of water, taking into consideration the degree of dissolution of cellulose and the process temperature.

[0172] In one example, the cellulose or cellulose pulp may have an amount of 85 to 97 wt% of an alpha-cellulose, with respect to 100 wt% of the total cellulose and/or cellulose pulp.

[0173] In one example, the cellulose or cellulose pulp may have an amount of 1 wt% to 15 wt% of a hemicellulose, with respect to 100 wt% of the total cellulose and/or cellulose pulp. By controlling the amount of a hemicellulose within the range above, stable physical properties (for example, implementation of hardness or suction resistance) and processability of a lyocell material may be more easily secured.

[0174] In addition, in some embodiments, a degree of polymerization (DPw) of the cellulose may be 600 to 1700. In some embodiments, the degree of polymerization refers to the number of repeating units and/or monomers of the cellulose and/or alpha-cellulose and/or hemicellulose in the cellulose pulp.

[0175] In the spinning, the shape of a spinneret for discharging the spinning dope is not particularly limited. For example, a donut-shaped spinneret may be used.

[0176] The nozzle temperature of the spinneret, particularly the spinning temperature, may be appropriately selected by

a person skilled in the art. Considering that the viscosity of the spinning dope may vary depending on the spinning temperature, which may result in poor discharge, the spinning temperature may be, for example, 100 °C to 120 °C, or 100 °C to 110 °C.

[0177] In one example, the spinning of the spinning dope may be performed under controlled spinning conditions so that the single fineness of filament may be 1.67 to 8.89 dtex (1.5 denier to 8.0 denier). For example, one or more spinning conditions among the discharge amount and spinning speed of the spinning dope may be appropriately controlled so that the single fineness of filament included in the lyocell material is 1.67 to 8.89 dtex (1.5 to 8.0 denier). In this regard, the single fineness of filament refers to the fineness of one monofilament separated from a multifilament.

[0178] In particular, the single fineness of filament may be, in particular, 8.33 dtex (7.5 denier) or less, 7.78 dtex (7.0 denier) or less, 7.22 dtex (6.5 denier) or less, 6.67 dtex (6.0 denier) or less, 6.11 dtex (5.5 denier) or less, 5.56 dtex (5.0 denier) or less, 5.00 dtex (4.5 denier) or less, 3.89 dtex (3.5 denier) or less, 3.33 dtex (3.0 denier) or less, 2.78 dtex (2.5 denier) or less, or 2.22 dtex (2.0 denier) or less. In addition, the lower limit thereof may be, in particular, 2.22 dtex (2.0 denier) or more, 2.78 dtex (2.5 denier) or more, 3.33 dtex (3.0 denier) or more, 3.89 dtex (3.5 denier) or more, 4.44 dtex (4.0 denier) or more, 5.00 dtex (4.5 denier) or more, 5.56 dtex (5.0 denier) or more, 6.11 dtex (5.5 denier) or more, 6.67 dtex (6.0 denier) or more, 7.22 dtex (6.5 denier) or more, or 7.78 dtex (7.0 denier) or more. Satisfying the ranges above may be more advantageous in implementing stable suction resistance and securing processability of a filter for a smoking article.

[0179] The spinning dope discharged through the spinneret may undergo coagulation described below.

<(b) Coagulation and obtaining multifilament>

[0180] At this step, the spinned lyocell spinning dope is coagulated, and a lyocell multifilament may be obtained.

[0181] The coagulation may be performed in a manner in which the spinning dope comes into contact with air and/or a coagulating liquid.

[0182] In one example, the coagulation may include: primary coagulation of supplying cooling air to the spinned lyocell dope; and secondary coagulation of introducing the primarily coagulated spinning dope into a coagulating liquid to result in coagulation thereof.

[0183] According to the coagulation method, the lyocell dope discharged from the spinneret may be primarily coagulated in the space (air gap section) between the spinneret and a coagulation tank. In such an air gap section, cooling air may be supplied from the air cooling section located inside the spinneret to the outside from the inside of the spinneret. In addition, primary coagulation may be achieved by so-called air quenching method or means known in the relevant field.

[0184] In one example, the upper limit of the temperature of the cooling air used in the primary coagulation may be, for example, 15 °C or lower. In particular, the cooling air may be air having a temperature of 14 °C or lower, 13 °C or lower, 12 °C or lower, 11 °C or lower, or 10 °C or lower. Above the temperature, the spinning dope may not be sufficiently coagulated by air, and the spinning-related processability may not be good.

[0185] The lower limit of the temperature of the cooling air may be determined by considering the spinning processability and/or the cross-sectional uniformity of a filament. For example, when the temperature of the cooling air is below 4 °C, the surface of the spinneret is cooled, the surface of the filament becomes uneven, and the spinning processability is also deteriorated. In consideration of this, the cooling air may be 5 °C or higher, 6 °C or higher, 7 °C or higher, 8 °C or higher, or 9 °C or higher.

[0186] The degree to which the cooling air is supplied may be controlled taking into account sufficient coagulation, spinning processability, and the influence on the physical properties of a filament. For example, the cooling air may be supplied to the spinning dope discharged at an air flow rate of 70 to 400 Nm^3/h per spinneret. In particular, the air flow rate may be 100 Nm^3/h or more, 150 Nm^3/h or more, 200 Nm^3/h or more, or 250 Nm^3/h or more, and the upper limit of the air flow rate may be, for example, 350 Nm^3/h or less, 300 Nm^3/h or less, 250 Nm^3/h or less, 200 Nm^3/h or less, or 150 Nm^3/h or less.

[0187] After the primary coagulation as described above, the cooled spinning dope may be supplied to a coagulation tank or bath containing a coagulating liquid (secondary coagulation). For proper coagulation to proceed, the temperature of the coagulating liquid may be, for example, 30 °C or lower, or 25 °C or lower. In addition, the temperature of the coagulating liquid may be 10 °C or higher, 15 °C or higher, or 20 °C or higher. When the temperature is maintained, the coagulation rate may be appropriately maintained.

[0188] The type of the coagulating liquid for the secondary coagulation as described above is not particularly limited. For example, the coagulating liquid may include one or more of water and N-methylmorpholine-N-oxide (NMMO).

[0189] Although not particularly limited, when the coagulating liquid includes water and NMMO, an amount of water in the coagulating liquid may be 60 to 90 wt% and an amount of NMMO in the coagulating liquid may be 10 to 40 wt%, based on 100 wt% of the total coagulating liquid. Alternatively, the coagulating liquid may include 70 to 80 wt% of water and 20 to 30 wt% of NMMO, based on 100 wt% of the total coagulating liquid. The concentration of this coagulating liquid may be controlled to be maintained during the manufacturing process by using sensors and the like.

<(c) Washing>

[0190] If necessary, washing of the lyocell multifilament may be performed after the coagulation and obtaining of the multifilament as described above. This washing may remove remaining NMMO and/or other impurities in the filament.

[0191] There are no particular restrictions on the washing method. For example, washing may be performed by introducing the coagulated lyocell multifilament into a washing tank by using a traction roller. Alternatively, the washing may be performed by spraying a washing liquid during the movement to the next stage by a traction roller.

[0192] There are no particular restrictions on the components of the washing liquid. For example, the washing liquid may include water and may further include known additives.

[0193] In addition, considering reuse after washing and the like, the washing liquid may be controlled to and used at a temperature of 100°C or lower.

[0194] For example, when the obtaining of a lyocell multifilament further includes drawing the lyocell multifilament by a first roller, and the washing further includes drawing the lyocell multifilament by a second roller, the moisture content of the lyocell multifilament may be controlled by a ratio of the rotational speed of the second roller to that of the first roller. In some embodiments, the rotational speed of the first roller may be different from the rotational speed of the second roller. In some embodiments, the rotational speed of the second roller may be greater than the rotational speed of the first roller. In addition, the drawing of the lyocell multifilament in the washing may be performed by one or more rollers, and when the drawing of the lyocell multifilament in the washing is performed by two or more rollers, the second roller may be the last roller.

[0195] By controlling the ratio of the rotational speed of the second roller to that of the first roller, the tenacity and elongation of the lyocell multifilament may be controlled. In particular, the ratio of the rotational speed of the second roller to that of the first roller may be 1.00 to 1.15. When the ratio of the rotational speed of the second roller to that of the first roller is less than 1.00, the performance of crimping the lyocell multifilament may deteriorate due to a decrease in a modulus value caused by an increase in the tenacity of the monofilament. Conversely, when the ratio of the rotational speed of the second roller to that of the first roller exceeds 1.15, the tenacity of the monofilament may be reduced, and the shape stability of crimps of the lyocell multifilament may be reduced.

[0196] In some embodiments, the method of manufacturing the lyocell material further includes pressurizing the lyocell multifilament, and the pressurizing of the lyocell multifilament may be included between the washing and the crimping. Although not particularly limited, the pressurization of the lyocell multifilament may be performed at 29.42 N/cm^2 to 34.33 N/cm^2 (3.0 kgf/cm^2 to 3.5 kgf/cm^2).

[0197] By performing the pressurizing of the lyocell multifilament, the moisture content of the lyocell multifilament may be controlled as described above.

<(d) Treatment with emulsion>

[0198] If necessary, emulsifying the lyocell multifilament may be performed. This step is applying an emulsion having the components as described above onto the surface of the filament. Through the treatment with an emulsion, friction applied to the filament is reduced and crimps may be formed well in the crimping described below. When the treatment with an emulsion is performed twice or more as described below, the treatment with an emulsion may be called primary treatment with an emulsion or secondary treatment with an emulsion depending on the order.

[0199] Although not particularly limited, the treatment with an emulsion may be performed by immersing the lyocell multifilament into a bath filled with the emulsion so that the lyocell multifilament is completely immersed into the emulsion. Alternatively, the treatment with an emulsion may be performed by spraying an emulsion liquid during movement to the next stage by a traction roller.

[0200] To ensure that an amount of emulsion applied onto the lyocell multifilament after the treatment with an emulsion as described above is constant, an additional process may be performed, in which a roll positioned before and/or after the treatment with an emulsion squeezes out the emulsion from the surface of the lyocell multifilament.

[0201] In one example, the treatment with an emulsion may be performed such that the amount of the emulsion (OPU: oil pick up ratio (wt%)) is 1.0 wt% or more based on 100 weight % of the at least lyocell multifilament treated with the emulsion. In this regard, for the at least emulsified lyocell multifilament, for example, the lyocell material may be a lyocell multifilament to which primary treatment with an emulsion has been applied, a lyocell multifilament to which primary treatment with an emulsion and secondary treatment with an emulsion (see the descriptions below) have been applied, or a lyocell multifilament to which binder treatment as described below has been applied along with the treatment with an emulsion as described above. In addition, the lyocell multifilament to which treatment with an emulsion and/or binder treatment has been applied as described above may be crimped.

[0202] In particular, the amount of the emulsion in the at least emulsified lyocell multifilament may be 0.5 wt% or more, 1.0 wt% or more, 1.5 wt%, or more 2.0 wt% or more, 2.5 wt% or more, 3.0 wt% or more, particularly 3.5 wt% or more, 4.0 wt% or more, 4.2 wt% or more, 4.5 wt% or more, 5.0 wt% or more, 5.5 wt% or more, 6.0 wt% or more, 6.5 wt% or more, 7.0

wt% or more, 7.5 wt% or more, 8.0 wt% or more, 8.5 wt% or more, 9.0 wt% or more, or 9.5 wt% or more, based on 100 wt% of the total of the at least emulsified lyocell multifilament. In addition, the upper limit thereof may be, in particular, 20.0 wt% or less, 18.0 wt% or less, 17.0 wt% or less, 16.0 wt% or less, 15.0 wt% or less, 14.5 wt% or less, 14.0 wt% or less, 13.5 wt% or less, 13.0 wt% or less, 12.5 wt% or less, 12.0 wt% or less, 11.5 wt% or less, 11.0 wt% or less, 10.5 wt% or less, 10 wt% or less, 9.5 wt% or less, 9.0 wt% or less, 8.5 wt% or less, 8.0 wt% or less, 7.8 wt% or less, or 7.6 wt% or less, based on 100 wt% of the at least emulsified lyocell multifilament. In this regard, the amount may refer to a dry weight after the solvent (for example, water) or liquid component that may be included in the emulsion has been evaporated.

[0203] When the emulsion having the composition as described above is processed within the amount ranges above, the hydrophilic properties of the lyocell material may be supplemented.

[0204] In some cases, drying of the emulsion may be performed after the treatment with an emulsion as described above.

[0205] In some embodiments, one or more of the steps described above may be controlled so that the single fineness of filament forming the lyocell multifilament may be from 1.67 to 8.89 dtex (1.5 to 8.0 denier). The single fineness of filament refers to a fineness of one monofilament separated from a multifilament.

[0206] In particular, the single fineness of filament may be, for example, 8.33 dtex (7.5 denier) or less, 7.78 dtex (7.0 denier) or less, 7.22 dtex (6.5 denier) or less, 6.67 dtex (6.0 denier) or less, 6.11 dtex (5.5 denier) or less, 5.56 dtex (5.0 denier) or less, 5.00 dtex (4.5 denier) or less, 3.89 dtex (3.5 denier) or less, 3.33 dtex (3.0 denier) or less, 2.78 dtex (2.5 denier) or less, or 2.22 dtex (2.0 denier) or less. In addition, the lower limit thereof may be, for example, 2.22 dtex (2.0 denier) or more, 2.78 dtex (2.5 denier) or more, 3.33 dtex (3.0 denier) or more, 3.89 dtex (3.5 denier) or more, 4.44 dtex (4.0 denier) or more, 5.00 dtex (4.5 denier) or more, 5.56 dtex (5.0 denier) or more, 6.11 dtex (5.5 denier) or more, 6.67 dtex (6.0 denier) or more, 7.22 dtex (6.5 denier) or more, or 7.78 dtex (7.0 denier) or more. Satisfying the ranges above may be more advantageous in implementing stable suction resistance and securing processability of a filter for a smoking article.

[0207] Although not particularly limited, the step controlled to secure the ranges of the single fineness as described above may be the spinning. Alternatively, the spinning, the coagulation, the washing, and the treatment with an emulsion as described above may all be controlled to secure the ranges of the single fineness as described above.

[0208] In addition, in some embodiments, in the manufacturing of a lyocell material, the moisture content of the lyocell multifilament may be controlled prior to the crimping of the lyocell multifilament. Accordingly, crimps may be imparted to the lyocell multifilament with controlled moisture content, and changes in elongation and tenacity of the lyocell material according to the crimping may be controlled. As a result, the shape stability of crimps of the crimped lyocell material may be within a certain range.

[0209] In some embodiments, the method of manufacturing the lyocell material further includes pressurizing the lyocell multifilament, and the pressurizing of the lyocell multifilament may be included between the treatment with an emulsion and the crimping. Although not particularly limited, the pressurization of the lyocell multifilament may be performed at 29.42 N/cm^2 to 34.33 N/cm^2 (3.0 kgf/cm^2 to 3.5 kgf/cm^2).

[0210] By performing the pressurizing of the lyocell multifilament, the moisture content of the lyocell multifilament may be controlled as described above.

<(e) Crimping>

[0211] The imparting of crimps is applying steam and/or pressure via a press roller to the emulsified lyocell multifilament to obtain a crimped multifilament, preferably a crimped tow. The imparting of crimps may be referred to as crimping. As used herein, the terms "treated with an emulsion" and "emulsified" may be used interchangeably.

[0212] Crimping imparts waves to the lyocell multifilament, giving the fibers bulky characteristics. Crimping may be performed by using a known crimping device, such as one including a stuffer box and/or a steam box, and the usable crimping device is not particularly limited as long as it is a device capable of applying one or more of the pressures described below.

[0213] In one example, the crimping may be performed on the lyocell multifilament of which moisture content has been controlled through washing or treatment with an emulsion.

[0214] In one example, the crimping may be performed in such a way that the pressurization of the lyocell multifilament by a press roller and the steam application are performed simultaneously.

[0215] In one example, the crimping may be performed by applying steam of 0.98 to 19.61 N/cm^2 (0.1 to 2.0 kgf/cm^2) to the lyocell multifilament prior to introduction into a crimping device (particularly, a press roller).

[0216] In one example, the crimping may be performed by pressurizing the lyocell multifilament with a press roller to form wrinkles in the lyocell multifilament.

[0217] In one example, the crimping may be performed by applying a pressure of 14.71 to 39.23 N/cm^2 (1.5 to 4.0 kgf/cm^2) to the lyocell multifilament introduced into the crimping device by using a press roller.

[0218] For example, a pressure of 15.69 N/cm^2 (1.6 kgf/cm^2) or more, 16.67 N/cm^2 (1.7 kgf/cm^2) or more, 17.65 N/cm^2 (1.8 kgf/cm^2) or more, 18.63 N/cm^2 (1.9 kgf/cm^2) or more, 19.61 N/cm^2 (2.0 kgf/cm^2) or more, 20.60 N/cm^2 (2.1 kgf/cm^2) or

more, 21.58 N/cm^2 (2.2 kgf/cm^2) or more, 22.56 N/cm^2 (2.3 kgf/cm^2) or more, 23.54 N/cm^2 (2.4 kgf/cm^2) or more, or 24.52 N/cm^2 (2.5 kgf/cm^2) or more may be applied to the lyocell multifilament by the press roller. In addition, a pressure of 38.25 N/cm^2 (3.9 kgf/cm^2) or less, 37.27 N/cm^2 (3.8 kgf/cm^2) or less, 36.29 N/cm^2 (3.7 kgf/cm^2) or less, 35.31 N/cm^2 (3.6 kgf/cm^2) or less, 34.33 N/cm^2 (3.5 kgf/cm^2) or less, 33.35 N/cm^2 (3.4 kgf/cm^2) or less, 32.37 N/cm^2 (3.3 kgf/cm^2) or less, 31.39 N/cm^2 (3.2 kgf/cm^2) or less, 30.41 N/cm^2 (3.1 kgf/cm^2) or less, 29.42 N/cm^2 (3.0 kgf/cm^2) or less, 28.44 N/cm^2 (2.9 kgf/cm^2) or less, 27.46 N/cm^2 (2.8 kgf/cm^2) or less, 26.48 N/cm^2 (2.7 kgf/cm^2) or less, 25.50 N/cm^2 (2.6 kgf/cm^2) or less, or 24.52 N/cm^2 (2.5 kgf/cm^2) or less may be applied by the press roller.

[0219] When the pressure of the press roller is below the ranges above, the desired number of crimps may not be formed sufficiently. In addition, when the pressure of the roller exceeds the ranges above, the pressing force may be too strong and the filament may not be smoothly introduced into the crimping device or may not pass through the crimping device. Wrinkles may be formed in the lyocell multifilament by a press roller providing the pressure in the ranges above.

[0220] In one example, a pressure of 0.98 to 19.61 N/cm^2 (0.1 to 2 kgf/cm^2) may be applied to the lyocell multifilament by using an upper plate. In addition, the upper plate may apply pressure to the lyocell multifilament as the lyocell multifilament passes through or is passing through the press roller.

[0221] For example, the pressure applied by the upper plate may be 1.96 N/cm^2 (0.2 kgf/cm^2) or more, 2.94 N/cm^2 (0.3 kgf/cm^2) or more, 3.92 N/cm^2 (0.4 kgf/cm^2) or more, or 4.90 N/cm^2 (0.5 kgf/cm^2) or more. In addition, a pressure of 14.71 N/cm^2 (1.5 kgf/cm^2) or less, 13.73 N/cm^2 (1.4 kgf/cm^2) or less, 12.75 N/cm^2 (1.3 kgf/cm^2) or less, 11.77 N/cm^2 (1.2 kgf/cm^2) or less, 10.79 N/cm^2 (1.1 kgf/cm^2) or less, or 9.81 N/cm^2 (1.0 kgf/cm^2) or less may be applied by the upper plate.

[0222] Furthermore, when the pressure of the upper plate, which moves up and down to provide uniform crimping after passing through the press roller, is less than 0.98 N/cm^2 (0.1 kgf/ cm^2), the upper plate may not be fixed due to the pressure inside the crimp device, causing the tow to remain in the crimp device for a long time, thereby preventing the continuity of the process from being maintained. When the pressure of the upper plate exceeds 19.61 N/cm^2 (2 kgf/cm^2), the steam may not be discharged smoothly inside the crimp device, causing the shape of crimps to become irregular.

[0223] In one example, the crimping may involve the application of a doctor blade that applies a certain pressure to the lyocell multifilament. The doctor blade controls the residence time of the filament introduced into the crimper, which is a crimp machine, thereby contributing to the control of the number of crimps. Such a doctor blade may be positioned, for example, in the path of the lyocell multifilament as it is pressed by the roller described above and then discharged at a pressurization point of the roller.

[0224] In one example, the crimping may be performed by applying a pressure of 0.98 to 19.61 N/cm^2 (0.1 to 2.0 kgf/cm^2) to the lyocell multifilament passing through the roller of the crimping device by using a doctor blade.

[0225] For example, the pressure applied by the doctor blade may be 1.96 N/cm^2 (0.2 kgf/cm^2) or more, 2.94 N/cm^2 (0.3 kgf/cm^2) or more, 3.92 N/cm^2 (0.4 kgf/cm^2) or more, or 4.90 N/cm^2 (0.5 kgf/cm^2) or more. In addition, a pressure of 14.71 N/cm^2 (1.5 kgf/cm^2) or less, 13.73 N/cm^2 (1.4 kgf/cm^2) or less, 12.75 N/cm^2 (1.3 kgf/cm^2) or less, 11.77 N/cm^2 (1.2 kgf/cm^2) or less, 10.79 N/cm^2 (1.1 kgf/cm^2) or less, or 9.81 N/cm^2 (1.0 kgf/cm^2) or less may be applied by the doctor blade.

[0226] In one example, the crimping may be performed at a temperature in the range of 120 to 250 °C. When the temperature is too low, the shape stabilization effect of crimps may not be good, and when the temperature is too high, the concentration of the oil component in the crimp device may increase, making crimp formation difficult. Therefore, considering the steam pressure described above and the like, the temperature may be appropriately controlled in the range of 130 °C or higher, 140 °C or higher, or 150 °C or higher, and in the range of 200 °C or lower, 180 °C or lower, or 160 °C or lower.

<(f) Binder treatment>

[0227] In one example, the method may further include performing binder treatment on the emulsified lyocell multifilament or the lyocell multifilament obtained by the crimping.

[0228] When a filter for a smoking article is manufactured by using a lyocell material (for example, a lyocell tow), a binder may be additionally used. The binder may increase the hardness of the filter for a smoking article, including the lyocell material, thereby preventing problems such as filter jamming during the filter manufacturing process or cigarette manufacturing process.

[0229] There are no particular restrictions on the method of coating the lyocell material with the binder. For example, the treatment with an emulsion may be performed by immersing the lyocell multifilament into a bath filled with a binder (or a binder solution) so that the lyocell multifilament is completely immersed into the binder. Alternatively, the coating of the lyocell multifilament with the binder may be achieved by injecting (or spraying) the binder (or binder solution) through a nozzle.

[0230] The types and components of available binders are as described above, so they are omitted.

[0231] In one example, the binder (or binder solution) may further include a solvent in addition to the components described above. Solvents may include, but are not limited to, water, ethanol, propylene glycol, and/or glycerin. When the binder (or binder solution) includes a solvent, the solvent may be included in an amount of, for example, about 20 to 80 wt%,

or 40 to 60 wt%, based on 100 wt% of the total binder (or binder solution).

[0232] The binder treatment may be performed at a level that may achieve the purpose of the binder treatment described above. For example, the binder treatment may be performed so that the amount of the binder is in the range of 20 wt% or less, for example, 8 to 15 wt%, based on 100 wt% of the emulsified and binder-treated lyocell multifilament. In this regard, the amount may refer to a dry weight after the solvent or liquid component that may be included in the binder has been evaporated.

[0233] After the lyocell multifilament is coated with the binder, drying of the binder may proceed. The drying temperature is not particularly limited, but drying may be performed at room temperature (about 10 to 35 °C), for example.

<(g) Other steps>

[0234] After crimping, appropriate post-processing may be additionally performed.

[0235] In one example, secondary treatment with an emulsion (g1) may be additionally performed. The secondary treatment with an emulsion may impart more flexibility to a tow. The secondary treatment with an emulsion may be performed in the same manner as or in accordance with the (d) treatment with an emulsion described above.

[0236] In particular, the secondary treatment with an emulsion may be performed by applying an emulsion onto a lyocell tow that has undergone a process using a crimper. This may be advantageously utilized in various processes performed during the manufacturing of a filter for a smoking article. For example, the secondary treatment with an emulsion may help ensure that fibers and filters are air-repellent during a spreading process, while also limiting fiber breakage during a drawing process.

[0237] The secondary treatment with an emulsion as described above may be performed before or after the binder treatment. Alternatively, the secondary treatment with an emulsion may be performed with or without binder treatment.

[0238] Even in cases where the secondary treatment with an emulsion as described above is performed, the secondary treatment with an emulsion process may be performed so that the amount of the emulsion or OPU amount in the material is within the ranges as described above.

[0239] In one example, a drying processing (g2) may be performed additionally. The drying may be performed, for example, at a temperature in the range of 100 to 130 °C. The drying processing manner or method is not particularly limited, and known technologies may be used. For example, this may be done by applying hot air to the tow or passing the tow through or leaving it in a temperature-controlled room for a certain period of time.

[0240] The lyocell material according to the disclosure may be obtained by the method of manufacturing the lyocell material as described above.

[0241] The lyocell material according to the disclosure may be a material obtainable by the method of manufacturing the lyocell material as described above.

[Smoking article]

[0242] Although not particularly limited, the lyocell material manufactured by the method may be included in a smoking article. The smoking article may be an aerosol-generating article. The aerosol-generating article may include an aerosol-generating material or an aerosol-forming substrate.

[0243] For example, a lyocell material may be included in a combustible cigarette. As another example, the lyocell material may be included in a heated cigarette, and the heated cigarette may be used in conjunction with an aerosol-generating device.

[0244] For example, when used as a heated smoking article, the smoking article may be inserted separately into the aerosol-generating device. Here, the aerosol-generating device includes a receiving groove capable of receiving an aerosol-generating article, and in addition, may include a heater for heating the aerosol-generating article to generate an aerosol, a control unit for generally controlling the operation of the aerosol-generating device, a battery for providing power used for operating the aerosol-generating device, and a detector for recognizing that the aerosol-generating article has been inserted into the aerosol-generating device.

[0245] The smoking article may include a tobacco medium portion, a filter for the smoking article, and a wrapper, wherein the filter for the smoking article may be located at one end, for example at the rear end or the front end, of the tobacco medium portion. The tobacco medium portion and the filter for the smoking article may each include a single segment, or may each independently include a plurality of segments.

[0246] The tobacco medium portion includes a tobacco substance, and the tobacco substance include nicotine. In addition, the tobacco medium portion may additionally include one or more excipients.

[0247] Excipients may include binders, fillers, and other additives. For example, the tobacco medium included in the tobacco medium portion may be manufactured in the form of granules including a tobacco substances and an excipient.

[0248] For example, a filler may be additionally included to maintain constant shape, strength, and mass of the tobacco medium portion. For example, a lyocell material may be included in the tobacco medium portion. In addition, the lyocell

material may be used as a filler.

[0249] The wrapper may be subdivided into a cigarette paper wrapping the tobacco medium portion, a filter wrapping paper wrapping the filter, and a tipping wrapper combining the tobacco medium portion and the filter.

[Filter for smoking article]

[0250] A lyocell material may be used in a filter for a smoking article. The lyocell material may be a lyocell tow. In one example, the lyocell tow includes a crimped lyocell multifilament.

[0251] For example, the disclosure relates to a filter for a smoking article. The filter for a smoking article include a lyocell material, and the lyocell material may be the same as described above. In addition, the filter for a smoking article may include a lyocell tow, and the lyocell tow may be the same as described above.

[0252] Additionally, the lyocell material include the emulsion in an amount of 0.1 wt% or more with respect to 100 wt% of the total lyocell material. In addition, the descriptions of the components of the emulsion and amounts thereof according to some embodiments are the same as described above.

[0253] In some embodiments, the single fineness of filament forming the lyocell multifilament may be 1.67 to 8.89 dtex (1.5 to 8.0 denier). The specific figures are the same as those described above.

[0254] In some embodiments, the crimped lyocell multifilament may be a lyocell material having a total fineness of 1,667 to 6,111 tex (15,000 to 55,000 denier), and preferably, the lyocell material may be a lyocell tow. The specific figures are the same as those described above.

[0255] In one example, the crimped lyocell multifilament may have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch). The specific figures are the same as those described above.

[0256] In one example, the filter for a smoking article may further include a binder on the surface of the crimped lyocell multifilaments or between the crimped lyocell multifilaments. The binder may increase the hardness of the filter for a smoking article made of tows, thereby preventing problems such as filter jamming during the manufacturing process of the filter or the manufacturing process of a cigarette. The descriptions of the types, components, and amounts of available binders are the same as described above.

[0257] In one example, the filter for a smoking article may further include a wrapping paper (which may be referred to as a roll paper, a filter paper, or a filter wrapping paper). For example, the wrapping paper may wrap the lyocell tow described above and may be porous or non-porous paper that may maintain the shape (for example, a column or cylinder) of the filter.

[0258] In some embodiments, the filter for a smoking article may have a certain shape and size.

[0259] For example, the filter may have a rod shape. In particular, the filter for a smoking article may have a cylindrical shape.

[0260] In addition, the filter may have a length of, for example, 10 to 50 mm. Specifically, the length of the filter may have a lower limit of 15 mm or more, 20 mm or more, 25 mm or more, 30 mm or more, 35 mm or more, 40 mm or more, or 45 mm or more, and an upper limit of 45 mm or less, 40 mm or less, 35 mm or less, 30 mm or less, 25 mm or less, 20 mm or less, or 15 mm or less.

[0261] In some embodiments, the filter having a length in the ranges above may have a circular cross-section, and the circumference of the circular cross-section may be 10 to 40 mm. For example, the circumference of the filter may have a lower limit of 15 mm or more, 20 mm or more, 25 mm or more, 30 mm or more, or 35 mm or more, and an upper limit of 35 mm or less, 30 mm or less, 25 mm or less, 20 mm or less, or 15 mm or less.

[0262] In one example, the filter for a smoking article may include a lyocell tow and a filter wrapping paper. The descriptions of the lyocell tow and the filter wrapping paper are the same as described above, so they are omitted.

[0263] The wrapping paper may wrap the lyocell tow described above and may be porous or non-porous paper that may maintain the shape (for example, a column or cylinder) of the filter.

[0264] In one example, when a porous wrapping paper is used, the wrapping paper may have a porosity of 10 to 50,000 CU (Coresta Unit). Coresta Unit may be defined as a volume flow rate (cm^3min^{-1}) of air passing through a substrate sample (i.e. porous wrapping paper) of 1 cm^2 at a pressure difference of 1 kPa. In particular, the lower limit of the porosity of the wrapping paper may be, for example, 1,000 CU or more, 5,000 CU or more, 10,000 CU or more, 15,000 CU or more, 20,000 CU or more, 25,000 CU or more, 30,000 CU or more, 35,000 CU or more, 40,000 CU or more, or 45000 CU or more, and the upper limit thereof may be, for example, 45,000 CU or less, 40,000 CU or less, 35,000 CU or less, 30,000 CU or less, 25,000 CU or less, or 20,000 CU or less. In some embodiments, the wrapping paper may have a porosity in the range of 22,000 to 26,000 CU, or 23,000 to 25,000 CU.

[0265] In one example, a basis weight of the wrapping paper may be 15 to 60 g/cm^2. In particular, the lower limit of the basis weight of the wrapping paper may be, for example, 20 g/cm^2 or more, 25 g/cm^2 or more, 30 g/cm^2 or more, 35 g/cm^2 or more, 40 g/cm^2 or more, 45 g/cm^2 or more, 50 g/cm^2 or more, or 55 g/cm^2 or more, and the upper limit thereof may be, for example, 55 g/cm^2 or less, 50 g/cm^2 or less, 45 g/cm^2 or less, 40 g/cm^2 or less, 35 g/cm^2 or less, 30 g/cm^2 or less, 25 g/cm^2 or less, or 20 g/cm^2 or less. In some embodiments, the wrapping paper may have a basis weight of 16 g/cm^2 or more, 17 g/cm^2 or more, 18 g/cm^2 or more, 19 g/cm^2 or more, 20 g/cm^2 or more, or 21 g/cm^2 or more, and 25 g/cm^2 or less, 24 g/cm^2

or less, 23 g/cm^2 or less, 22 g/cm^2 or less, or 21 g/cm^2 or less.

[0266] Although not particularly limited, the weight of a rod-shaped filter may be 50 mg or more. In particular, the weight of the filter may have, for example, a lower limit of 100 mg or more, 150 mg or more, or 200 mg or more, and an upper limit of 500 mg or less, 450 mg or less, 400 mg or less, 350 mg or less, 300 mg or less, 250 mg or less, or 200 mg or less.

[0267] The descriptions of other filters for smoking articles and materials included therein are the same as described above, so they are omitted.

[Method of manufacturing filter for smoking article]

[0268] For example, the disclosure relates to a method of manufacturing a filter for a smoking article. The method is a method of manufacturing the filter for a lyocell smoking article as described above, and may include the method of manufacturing the lyocell material described above.

[0269] With regard to the method of manufacturing the filter for a smoking article, the remaining processes except for the manufacturing of the filter are the same as those described for the lyocell material described above, and therefore, their descriptions are omitted. In addition, any explanation that overlaps with what has been described above is also omitted.

[0270] The manufacturing of the filter may be appropriately performed by a person skilled in the art according to a known method. For example, the filter may be manufactured by forming a wrapping paper filled with a lyocell material into a rod shape. Alternatively, the filter may be manufactured by cutting a filter paper filled with a lyocell material, having a rod shape, into segments, each having an appropriate length. The description of the wrapping paper is as described above.

[0271] Although not particularly limited, before filling the filter paper with the lyocell material, treatment with a plasticizer or opening may be additionally performed on the lyocell material. The surface area of the lyocell material may be increased by the opening of the lyocell material. For example, the opening of the lyocell material may be achieved by applying an external force in the length direction, width direction, and/or thickness direction.

[0272] Preferably, the lyocell material used in manufacturing a filter for a smoking articles may be a lyocell tow.

[0273] Although not particularly limited, the filter for a smoking article may additionally include a known cellulose acetate multifilament as long as it does not hinder the purpose of the disclosure. The cellulose acetate multifilament may be mixed with a lyocell multifilament. The cellulose acetate multifilament may be included in a segment distinct from the segment including the lyocell multifilament.

Advantageous Effects of the Invention

[0274] According to the disclosure, provided are a lyocell material for a filter for a smoking article that may replace commercialized cellulose acetate (CA), and a filter for a smoking article, including the same. In particular, by using a lyocell material having a certain shape stability of crimps, the performance of the filter for a smoking article and the time and cost required for manufacturing the filter for a smoking article may be reduced.

Best Mode for Carrying out Invention

[0275] The actions and effects of the disclosure will be described more specifically through specific examples of the disclosure below. However, this is presented as an example of the disclosure and the scope of the disclosure is not limited thereto in any way.

[0276] A lyocell material was manufactured through the same process as described in Manufacture Example below. Any conditions not specifically mentioned were made within the scope of the description given above.

[Manufacture Example]

[0277] Cellulose pulp having an amount of 93.9% of an alpha-cellulose with a degree of polymerization (DPw) of 820 was mixed with an NMMO/H_2O solvent having an amount of 0.01 wt% of propyl gallate to thereby manufacture a concentration of 11 wt% of a spinning dope for manufacturing a tow. Then, the spinning dope was spun at an appropriately controlled discharge amount and spinning rate while maintaining the spinning temperature at 110 °C at a spinning nozzle.

[0278] The spinning dope in a filament phase discharged from the spinning nozzle was supplied to a coagulating liquid (the coagulating liquid having a concentration of 75 wt% water and 25 wt% NMMO, based on 100 wt% of the total coagulating liquid and having a temperature of about 15 °C) in a coagulating tank through an air gap section. At this time, the spinning dope was primarily coagulated in the air gap section by cooling air at a temperature of 8 °C and an air flow rate of 120 N m^3/h. Thereafter, the primarily coagulated spinning dope was immersed into the coagulating liquid to undergo secondary coagulation, thereby obtaining a lyocell multifilament. The lyocell multifilament in the coagulating liquid were transported by a traction roller. Additionally, the concentration of the coagulating liquid was continuously monitored by using a sensor and a refractometer.

[0279] Then, the coagulated lyocell multifilament was washed. In particular, the filament was introduced into the traction roller, and NMMO remaining in the filament was removed by using a washing liquid sprayed from a washing device. Then, the washed filament was immersed inside a bath designed to have a prescribed concentration of emulsion.

[0280] A pressure of 29.42 N/cm^2 (3.0 kgf/cm^2) was applied on the filament by using a nip roll installed in a bath discharge section to control the moisture content of the lyocell multifilament. Thereafter, the filament was introduced into a crimp machine for crimping. In particular, the pressure of a press roller was set to 24.52 N/cm^2 (2.5 kgf/cm^2), and the pressure of a doctor blade was set to 4.90 N/cm^2 (0.5 kgf/cm^2) to manufacture a tow.

[0281] To prevent static electricity and provide flexibility to the manufactured tow, secondary treatment of emulsion was performed, and immediately after the treatment of emulsion, the emulsificated tow was passed through a continuous drying device set at 120 °C to obtain a dried tow product.

[0282] The single fineness of the manufactured tows was 2.22 to 3.89 dtex (2.0 to 3.5 denier), the total fineness thereof was 3,333 to 5,000 tex (30,000 to 45,000 denier), and the number of crimps was 9.84 to 11.81 ea/cm (25 to 30 ea/inch).

Example 1

[0283] A lyocell tow was manufactured according to Manufacture Example, but the ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.05.

Example 2

[0284] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 34.32 N/cm^2 (3.5 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.05.

Example 3

[0285] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 34.32 N/cm^2 (3.5 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.10.

Example 4

[0286] A lyocell tow was manufactured according to Manufacture Example, but the ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.10.

Example 5

[0287] A lyocell tow was manufactured according to Manufacture Example, but the ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.15.

Example 6

[0288] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 34.32 N/cm^2 (3.5 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.15.

Comparative Example 1

[0289] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 68.65 N/cm^2 (7.0 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.00.

Comparative Example 2

[0290] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 9.81 N/cm^2 (1.0 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.10.

Comparative Example 3

[0291] A lyocell tow was manufactured according to Manufacture Example, but the pressure of the nip roll was 49.03 N/cm^2 (5.0 kgf/cm^2). The ratio of the rotational speed of the last traction roller in the washing to that of the traction roller in the coagulating liquid was 1.15.

<Experiment 1>

[0292] The moisture content of each of the lyocell materials of Examples 1 to 6 and Comparative Examples 1 to 3 was measured. For each lyocell material, the moisture content was measured before crimping, and the moisture content was measured according to Equation 2:

Equation 2

$$\text{Moisture Content (\%)} = \frac{W-D}{D} * 100$$

wherein, in Equation 2, W represents a weight of a sample measured before drying, and D represents a weight of a sample measured after drying.

[0293] The ratio of rotational speeds, pressure of the nip roll, and moisture content of Examples 1 to 6 and Comparative Examples 1 to 3 are as shown in Table 1 below.

[Table 1]

		Ratio of rotational speeds	Pressure of nip roll (N/cm^2(kgf/cm^2))	Moisture content (%)
Example	1	1.05	29.42 (3.0)	284
	2	1.05	34.32 (3.5)	215
	3	1.10	34.32 (3.5)	245
	4	1.10	29.42 (3.0)	297
	5	1.15	29.42 (3.0)	312
	6	1.15	34.32 (3.5)	236
Comparative example	1	1.00	68.65 (7.0)	118
	2	1.10	9.81 (1.0)	415
	3	1.15	49.03 (5.0)	142

[0294] Referring to Table 1, it was confirmed that the moisture content of each of the lyocell materials of Examples 1 to 6 was within the range of 200 % to 350 %, and the moisture content of each of the lyocell materials of Comparative Examples 1 to 3 was less than 200 % or more than 350 %.

<Experiment 2>

[0295] For each of the lyocell materials of Examples 1 to 6 and Comparative Examples 1 to 3, the elongation, tenacity, and shape stability of crimps were measured.

[0296] The elongation and tenacity were measured by using a low-speed tensile machine from INSTRON, Co. The tensile rate of a monofilament during measurement was 60 mm/min.

[0297] The shape stability was measured by using FAVIMAT+ according to Equation 1. The initial load during measurement was 0.44 cN/tex (0.05 g/de) and the crimp sensitivity was 0.01 mm. The load applied to the monofilament was 5 cN/tex, and the load application time and storation time were 5 seconds each.

Equation 1

$$\text{Shape Stability of Crimps (\%)} = (L_0 - L_b)/(L_0 - L) * 100$$

wherein, in Equation 1, L represents a length of the monofilament measured under the condition of initial load (0.01 cN/tex),

L_0 represents a length of the monofilament measured under the condition of 5 cN/tex load, and L_b represents a length of the monofilament measured under the condition of restoration (0.01 cN/tex) after the 5 cN/tex load is removed.

[0298] The tenacity, elongation, and shape stability of crimps of Examples 1 to 6 and Comparative Examples 1 to 3 are as shown in Table 2 below.

[Table 2]

		Elongation (%)	Tenacity (cN/tex(g/de))	Shape stability of crimps (%)
Example	1	8.11	6.00 (0.68)	41.9
	2	7.97	6.36 (0.72)	36.6
	3	6.20	6.27 (0.71)	52.6
	4	6.25	5.83 (0.66)	48.6
	5	5.80	4.15 (0.47)	32.4
	6	5.88	3.71 (0.42)	28.6
Comparative example	1	6.12	8.65 (0.98)	68.9
	2	6.35	1.94 (0.22)	13.9
	3	5.72	7.68 (0.87)	70.0

[0299] Referring to Table 2, it was confirmed that the shape stability of crimps of each of the lyocell materials of Examples 1 to 6 was within the range of 20 % to 60 %, and the moisture content of each of the lyocell materials of Comparative Examples 1 to 3 was less than 20 % or more than 60 %.

<Experiment 3>

[0300] Filters for smoking articles were manufactured by using the lyocell materials of Examples 1 to 6 and Comparative Examples 1 to 3. The filters for smoking articles were manufactured in the shape of a rod.

[0301] For each filter for a smoking article, including the lyocell material, the maximum weight and maximum suction resistance of the lyocell material were measured. Weight refers to a weight of the lyocell material used in the manufacture of one filter for a smoking article. Suction resistance refers to the difference in pressure measured at both ends of the filter for a smoking article when 17.5 ml/sec of air was passed through the filter for a smoking article at room temperature conditions of 22±2 °C.

[0302] Additionally, the number of filters for smoking articles manufactured per minute (production volume per minute) by using the lyocell materials of Examples 1 to 6 and Comparative Examples 1 to 3 was calculated.

[0303] For each of the filters for smoking articles manufactured by using the lyocell materials of Examples 1 to 6 and Comparative Examples 1 to 3, the maximum weight, maximum suction resistance, and production per minute of each filter for smoking articles are as shown in Table 3 below.

[Table 3]

		Maximum weight (g/filter)	Maximum suction resistance (mmWG/filter)	Production per minute (filters/min)
Example	1	928	786	3,000
	2	921	756	3,000
	3	863	683	3,000
	4	875	712	3,000
	5	826	698	3,000
	6	832	652	3,000
Comparative example	1	753	552	500
	2	651	523	500
	3	732	562	500

[0304] Referring to Table 3, it was confirmed that the filters for smoking articles, including the lyocell materials of Examples 1 to 6, provide increased maximum weight and maximum suction resistance compared to the filters for smoking articles, including the lyocell materials of Comparative Examples 1 to 3. In addition, it was confirmed that the filters for smoking articles, including the lyocell materials of Examples 1 to 6 may be manufactured at a higher rate than the filters for smoking articles, including the lyocell materials of Comparative Examples 1 to 3.

Claims

1. A lyocell material comprising lyocell multifilaments imparted with crimps,
wherein a shape stability of the crimps is 20 % to 60 %.

2. The lyocell material of claim 1,

wherein a tenacity of one or more monofilaments comprised in the lyocell multifilament is 0.3 g/de to 0.8 g/de, and/or
the number of the crimps is 10 ea/inch to 50 ea/inch, and/or
a single fineness of the lyocell multifilament is 1.5 to 8.0 denier.

3. The lyocell material of claim 1,
wherein the lyocell material has a total fineness of 15,000 to 55,000 denier.

4. The lyocell material of claim 1,

wherein the shape stability of the crimps is calculated by Equation 1:

Equation 1

$$\text{Shape Stability of Crimps (\%)} = (L_0 - L_b)/(L_0 - L) * 100$$

wherein, in Equation 1, L represents a length of a monofilament measured under a condition of initial load (0.01 cN/tex), L_0 represents a length of a monofilament measured under a condition of 5 cN/tex load, and L_b represents a length of a monofilament measured under a condition of restoration (0.01 cN/tex) after the 5 cN/tex load is removed.

5. The lyocell material of claim 1,

wherein the shape stability of the crimps is 25 % to 55 %, and/or
a moisture content of the lyocell multifilaments is 200 % to 350 %.

6. The lyocell material of claim 5,

wherein the moisture content is a value measured according to Equation 2:

Equation 2

$$\text{Moisture Content (\%)} = \frac{W-D}{D} * 100$$

wherein, in Equation 2, W represents a weight of a sample measured before drying, and D represents a weight of a sample measured after drying.

7. The lyocell material of claim 5,

wherein the moisture content is a value measured from the lyocell multifilaments before the crimps are imparted, and/or
the lyocell material is a lyocell tow, and/or
the lyocell material is a filter for a smoking article.

8. A filter for a smoking article, comprising the lyocell material according to any one of claims 1 to 7.

9. The filter of claim 8,
wherein a maximum weight per filter of the lyocell material is 100 mg/filter to 1,000 mg/filter.

10. The filter of claim 9,
wherein a maximum suction resistance per filter is 100 mmWG/filter to 900 mmWG/filter.

11. A smoking article comprising the filter for a smoking article according to claim 8.

12. A method of manufacturing a lyocell material, comprising: spinning a lyocell dope; coagulating the spinned lyocell dope and obtaining a lyocell multifilament; washing the lyocell multifilament; treating the lyocell multifilament with an emulsion; and imparting crimps to the lyocell multifilament,
wherein a moisture content of the lyocell multifilament is controlled during the washing, after the washing, or during and after the washing.

13. The method of claim 12,
wherein the moisture content of the lyocell multifilament is controlled to 200 % to 350 % before the imparting of the crimps.

14. The method of claim 12,
wherein the moisture content of the lyocell multifilament is controlled by pressurization conditions.

15. The method of claim 12,
wherein a shape stability of crimps of the lyocell material measured after the imparting of the crimps is 20 % to 60 %.

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EUROPEAN SEARCH REPORT

Application Number
EP 24 22 3483

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	KR 102 296 584 B1 (KOLON INC [KR]; KT & G CORP [KR]) 1 September 2021 (2021-09-01) * examples, table, claims; paragraph [0038] - paragraph [0091] * -----	1,2, 4-12,15 3,13,14	INV. A24D3/06 A24D3/02 A24D3/04 A24D3/10
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29 April 2025	Villányi Kelemen, K

CATEGORY OF CITED DOCUMENTS

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