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(54) **LYOCELL MATERIAL, FILTERS, SMOKING ARTICLES AND METHOD FOR PREPARING THEREOF**

(57) The present application relates to a lyocell material, a smoking article filter including the lyocell material, and a smoking article. The lyocell material and smoking

article filter, according to the present application, may replace conventional cellulose acetate material and smoking article filters including the same.

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Description**Technical Field**

- 5 **[0001]** The present application relates to a lyocell material, a filter including the same, a smoking article, and methods of preparing the same.

Background Art

- 10 **[0002]** Until now, cellulose acetate fiber has primarily been used as a cigarette filter material. Although cellulose acetate is known to be a biodegradable substance, smoking article filters made of cellulose acetate maintain their original shape for about one to two years after being buried in soil, and require considerable time to fully biodegrade. In light of the volume and toxicity of not only discarded tobacco products that are collected and landfilled but also tobacco products that are thrown away in the environment and left unattended, further improvement in the biodegradability of smoking article filters is necessary. Accordingly, lyocell, which is more environmentally friendly than cellulose acetate, has recently been selected as a material to replace cellulose acetate.

Disclosure of Invention**20 Technical Problem**

- [0003]** One objective of the present application is to provide a lyocell material capable of replacing cellulose acetate, which has been commercialized as a filter material for smoking articles.
- 25 **[0004]** Another objective of the present application is to provide a lyocell material for smoking article filters that is environmentally friendly in its manufacturing process and exhibits excellent biodegradability upon disposal.
- [0005]** Another objective of the present application is to provide a lyocell filter for smoking articles.
- [0006]** Another objective of the present application is to provide a smoking article (e.g., a cigarette) that includes a lyocell filter.

30 Solution to Problem

- [0007]** According to embodiments of the present application, there may be provided a lyocell material, a filter including the same, a smoking article, and the like.
- 35 **[0008]** In particular, a lyocell material including a crimped lyocell multifilament and having a whiteness of 55 to 85 is provided.
- [0009]** Further, a smoking article filter including a lyocell material having a whiteness of 55 to 85 is provided.
- [0010]** According to another embodiment of the present application, there may be provided a smoking article including the lyocell material or the filter.
- 40 **[0011]** According to another embodiment of the present application, there may be provided a method of preparing the lyocell material, a filter including the lyocell material, and a smoking article.
- [0012]** In the present specification, the term "smoking article" may refer to an article capable of generating an aerosol, such as a cigarette (cigar) or a cigar. In this regard, the smoking article may include an aerosol-generating material or an aerosol-forming substrate. Also, the smoking article may include a solid material based on a tobacco raw material, such as reconstituted tobacco, cut tobacco, or cast-leaf tobacco. In addition, the smoking article may include a volatile compound.
- 45 **[0013]** Unless otherwise defined herein, where the characteristics of a lyocell material, a smoking article filter, or relevant components or configurations are affected by temperature, the temperature at which such characteristics are identified or measured may be room temperature. Room temperature, in the absence of intentional cooling or heating, may be, for example, from 10 °C to 35 °C, particularly from 15 °C to 35 °C, from 20 °C to 30 °C, or about 25 °C.
- [0014]** Hereinbelow, the invention of the present application will be described in further detail.
- 50 **[0015]** In the present specification, the term "crimp" may refer to a configuration that includes a wave, curl, or undulation imparted-either inherently or through mechanical, thermal, and/or chemical processes-to a material such as a fiber, (mono)filament, multifilament, and/or yarn. Crimp may be characterized by periodic deviations from a straight axis along the length of the material, fiber, filament, multifilament, and/or yarn. One crimp in the material, fiber, filament, multifilament, and/or yarn may be defined as one repeating unit of the periodic deviation. The presence of crimp affects properties such as elasticity, bulk, resilience, and texture of both the material and textiles made from the material.
- 55 **[0016]** In the present specification, the term "degree of polymerization" (DPw; degree of polymerization) may refer to the number of monomer units and/or repeating units in a macromolecule, polymer, or oligomer molecule. The degree of polymerization may be expressed as M_n/M_0 , where M_n is the number-average molecular weight of the macromolecule,

polymer, or oligomer, and M_0 is the molecular weight of a single monomer or repeating unit.

[0017] In the present specification, the term "lyocell multifilament" may refer to a multifilament made of cellulose. In particular, the lyocell multifilament may be a (multi)filament and/or fiber derived or primarily derived from cellulose obtained from wood pulp, and in particular may be a semi-synthetic (multi)filament and/or fiber.

[0018] In the present specification, the term "lyocell tow" may refer to a tow that includes at least one lyocell multifilament or is composed of at least one lyocell multifilament.

[0019] In the present specification, the term "whiteness" refers to the white appearance of a surface, particularly a surface of lyocell material and/or fractured lyocell material (including the fracture surface). "Whiteness" may represent whiteness measured in accordance with CIE D65-10 and/or CIE whiteness and/or a CIE whiteness index. Whiteness may be measured by spectrophotometry. In particular, whiteness may be measured using a CCM device. Without limitation, an X-Rite ColorEye 7000A Spectrophotometer may be used as the CCM instrument.

[0020] In the present specification, "brightness" refers to the degree of light reflectance from a material and/or a material sheet on a scale of 0 to 100. In particular, the light may have a wavelength of 460 nm. In some embodiments, "brightness" refers to paper brightness. Brightness may be a value measured by spectrophotometry using a light source with a wavelength of 460 nm. In particular, brightness can be measured using CCM equipment. Without limitation, ColorEye 7000A Spectrophotometer (X-Rite) may be used as the CCM instrument.

[0021] In the present specification, the "fractured portion of the lyocell material, the lyocell material having been fractured" may refer to the overlapped portion obtained by cutting three samples of a lyocell material-each having a total fineness of 1,667 tex to 6,111 tex (15,000 denier to 55,000 denier)-in a direction perpendicular to the longitudinal direction of the lyocell material, then overlapping the cut pieces.

[0022] In the present specification, "opened lyocell material" refers to lyocell material and/or lyocell fiber and/or lyocell multifilament that has been separated, uncoiled, loosened, or unwrapped from its originally compressed and/or rolled state.

[0023] In the present specification, "ppm" may indicate a weight ratio.

[0024] In the present specification, the term "basis weight" refers to the mass per unit area of plug wrap(s) and/or wrapper(s). The basis weight of plug wrap and/or wrapper may be determined by measuring the mass and area of the plug wrap and/or wrapper, then dividing the mass of the plug wrap and/or wrapper by the area.

[0025] The present application relates to a lyocell material. The lyocell material may be used in a smoking article, and although not specifically limited thereto, the lyocell material may be used in a smoking article filter.

[0026] According to an aspect, a lyocell material including a crimped lyocell multifilament and having a whiteness of 55 to 85 is provided.

[0027] In some embodiments, the whiteness may be a value measured from a fractured portion of the lyocell material.

[0028] In some embodiments, the whiteness may be a value measured from an opened lyocell material.

[0029] In some embodiments, the whiteness may be a value measured from the lyocell material included in a smoking article filter.

[0030] In some embodiments, the brightness measured at a wavelength of 460 nm may be 75 or more.

[0031] In some embodiments, the brightness may be 90 or less.

[0032] In some embodiments, the brightness may be a value measured from a fractured portion of a fractured lyocell material.

[0033] In some embodiments, the brightness may be a value measured from an opened lyocell material.

[0034] In some embodiments, the brightness may be a value measured from the lyocell material included in a smoking article filter.

[0035] In some embodiments, the lyocell material may further include hydrogen peroxide, wherein the concentration of the hydrogen peroxide may be 1,000 ppm or less relative to the total weight of the lyocell material.

[0036] In some embodiments, the concentration of the hydrogen peroxide may be 50 ppm or more relative to the total weight of the lyocell material.

[0037] In some embodiments, the concentration of the hydrogen peroxide may be 250 ppm to 700 ppm relative to the total weight of the lyocell material.

[0038] In some embodiments, the concentration of the hydrogen peroxide may be measured by redox titration.

[0039] In some embodiments, the concentration of the hydrogen peroxide may be determined according to Equation 1 below.

[Equation 1]

$$\text{Concentration (\% of Hydrogen Peroxide)} = 0.0017 \times V \times F \times D / S \times 100$$

[0040] In Equation 1, V represents the amount (ml) of 0.1 N potassium permanganate solution used for titration, F represents the normality factor of 0.1 N potassium permanganate solution, D represents the dilution ratio (1) of hydrogen

peroxide-containing solution extracted from the sample, and S represents the weight (g) of the sample.

[0041] In some embodiments, the lyocell material may further include hydrogen peroxide and have a brightness of 75 or more as measured at a wavelength of 460 nm, wherein the concentration of the hydrogen peroxide may be 1,000 ppm or less relative to the total weight of the lyocell material.

[0042] In some embodiments, the number of crimps may be 3.94 crimps/cm to 19.69 crimps/cm (10 crimps/inch to 50 crimps/inch).

[0043] In some embodiments, the number of crimps may be 9.84 crimps/cm to 11.81 crimps/cm (25 crimps/inch to 30 crimps/inch).

[0044] In some embodiments, the lyocell multifilament may have a single filament fineness of 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier).

[0045] In some embodiments, the lyocell material may have a total fineness of 1,667 tex to 6,111 tex (15,000 denier to 55,000 denier).

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

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

[0048] In some embodiments, the lyocell material may be included in a smoking article filter.

[0049] According to an aspect, a smoking article filter including a lyocell material having a whiteness of 55 to 85 is provided. In some embodiments, the lyocell material is a lyocell material according to the present invention.

[0050] In some embodiments, in the smoking article filter, whiteness may be a value measured from a fractured portion of the lyocell material.

[0051] In some embodiments, in the smoking article filter, the lyocell material may have a brightness of 75 or more as measured at a wavelength of 460 nm.

[0052] In some embodiments, in the smoking article filter, brightness may be a value measured from a fractured portion of the lyocell material.

[0053] In some embodiments, in the smoking article filter, the lyocell material may further include hydrogen peroxide, wherein the concentration of the hydrogen peroxide may be 1,000 ppm or less relative to the total weight of the lyocell material.

[0054] In some embodiments, in the smoking article filter, the concentration of the hydrogen peroxide may be 50 ppm or more relative to the total weight of the lyocell material.

[0055] In some embodiments, in the smoking article filter, the concentration of the hydrogen peroxide may be from 250 ppm to 700 ppm relative to the total weight of the lyocell material.

[0056] According to another aspect, a smoking article including a filter for a smoking article according to the present invention is provided.

[0057] According to another aspect, a method of preparing a lyocell material is provided, the method including: spinning a lyocell dope; coagulating to obtain a lyocell multifilament; washing; bleaching; and imparting crimp, wherein during the bleaching, transport of the lyocell multifilament is performed by at least one upper roller and at least one lower roller.

[0058] The crimp-imparting may be referred to as crimping.

[0059] In some embodiments, in the method of preparing a lyocell material, the number of lower rollers may be two or more.

[0060] In some embodiments, in the method of preparing a lyocell material, the number of lower rollers may be eight or less.

[0061] In some embodiments, in the method of preparing a lyocell material, during the bleaching, the lyocell multifilament may be immersed in a bleaching solution at least twice.

[0062] In some embodiments, in the method of preparing a lyocell material, during the bleaching, the lyocell multifilament may be immersed in a bleaching solution eight times or less.

[0063] In some embodiments, in the method of preparing a lyocell material, the temperature of the bleaching solution may be from 30 °C to 110 °C.

[0064] In some embodiments, in the method of preparing a lyocell material, the immersion time per lower roller may be less than 0.54 seconds.

[0065] In some embodiments, the method of preparing a lyocell material may further include an emulsion treatment, wherein the emulsion treatment may be performed before the bleaching, after the bleaching, or simultaneously with the bleaching operation.

[0066] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed after the washing.

[0067] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed before the crimp-imparting.

[0068] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed in a treatment bath distinct from the bleaching. Particularly, the emulsion treatment may be performed in a treatment bath distinct from the treatment bath where the bleaching is performed.

[0069] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed in the same treatment bath as the bleaching operation.

[0070] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed in the same treatment bath as the bleaching, and the emulsion treatment may be performed simultaneously with the bleaching operation.

[0071] In some embodiments, the lyocell material has a whiteness of 55 to 85 and a brightness of 75 or more as measured at a wavelength of 460 nm. Further, the content of H_2O_2 present in the lyocell material (i.e., residual amount of H_2O_2) may be 50 ppm to 700 ppm based on the total weight of the lyocell material. As a result, consumer preference regarding color may be improved while off-flavors may not be generated from the lyocell material. Furthermore, by including the lyocell material, consumer satisfaction with the use experience of the smoking article filter may be enhanced.

[0072] To produce a lyocell material having a whiteness of 55 to 85 and a brightness of 75 or more as measured at a wavelength of 460 nm, the transport of the lyocell multifilament is carried out by at least one upper roller and at least one lower roller during the bleaching. The upper roller is arranged so as not to be immersed in the bleaching solution, and/or so as not to impregnate the lyocell multifilament with the bleaching solution, and/or so as not to be immersed in the bleaching solution, while the lower roller is arranged so as to be immersed in the bleaching solution. In particular, the number of lower rollers may be at least two and up to eight.

[0073] If the lyocell multifilament is transported only by the lower roller(s) within or through the bleaching solution and/or if the immersion time per lower roller is 0.54 seconds or more, the lyocell multifilament experiences excessive resistance from the bleaching solution during transport. Consequently, the lyocell multifilament is compressed in the transport direction and stretched in a direction perpendicular to the transport direction (i.e., the width direction). Because the lyocell multifilament is stretched in the width direction, it does not become uniformly crimped due to an increase in width and a decrease in density at the edges. In particular, after the crimp-imparting, edge breakage may be observed in the lyocell multifilament that has been stretched in the width direction, and the reliability of the crimp-imparting process may be compromised.

[Non-Circular Cross-Section]

[0074] One or more lyocell monofilaments included in the lyocell material of the present application may have a non-circular cross-section. As used herein, "non-circular" means that the outline of the cross-section is not circular, and "cross-section" may be a cross-section obtained by virtually or actually cutting the lyocell monofilament in a direction perpendicular to its length direction.

[0075] The outline of the non-circular cross-section may be in contact with both a hypothetical first circle and a hypothetical second circle. In addition, the hypothetical second circle may be depicted within the hypothetical first circle and/or located inside the hypothetical first circle. "Hypothetical first circle" may also be referred to as "hypothetical circumscribed circle" and/or "circumscribed circle", and the "hypothetical second circle" may also be referred to as "hypothetical inscribed circle" and/or "inscribed circle".

[0076] The hypothetical first circle may be the circle, drawn so as to include the entire cross-section of the monofilament, that has the smallest possible area among all such circles. The hypothetical second circle may be the circle, drawn within the cross-section of the monofilament, that has the largest possible area among all such circles.

[0077] In cases where a circumscribed circle can be drawn around the cross-section of the monofilament, the hypothetical first circle may be that circumscribed circle. In cases where an inscribed circle can be drawn within the cross-section of the monofilament, the hypothetical second circle may be that inscribed circle.

[0078] The non-circular cross-section may include multiple protrusions, and for example, may be a Y-shaped cross-section having three protrusions. It may be understood that such multiple protrusions are integrally formed around the hypothetical second circle as a central portion, with their tips coming into contact with the hypothetical first circle.

[0079] The degree of non-circularity of the monofilament may be defined according to Mathematical Formula 1 below.

<Mathematical Formula 1>

$$\text{Degree of Non-Circularity} = r_1 / r_2$$

[0080] In this formula, r_1 is the radius of the hypothetical first circle, and r_2 is the radius of the hypothetical second circle.

[0081] For example, the radius of the hypothetical first circle may be from 4 μm to 40 μm , the radius of the hypothetical second circle may be from 2 μm to 14 μm , and the degree of non-circularity may be from 1.01 to 10.

[0082] In addition, the space occupancy of the monofilament may be defined according to Mathematical Formula 2.

<Mathematical Formula 2>

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

5 **[0083]** In this formula, S1 is the area of the hypothetical first circle, and S2 is the cross-sectional area of the monofilament included in the lyocell fiber.

[0084] For example, the space occupancy of a monofilament having a non-circular cross-section may be from 120 % to 600 %.

10 **[Fineness]**

[0085] The lyocell material of the present application includes a lyocell multifilament, and this lyocell multifilament may have a fineness suitable for manufacturing a smoking article filter and ensuring its functionality.

15 **[0086]** In some embodiments, filaments constituting the lyocell multifilament may have a single-filament fineness of 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier). Here, the single-filament fineness of the filaments refers to the fineness of a single monofilament separated from the multifilament.

20 **[0087]** In particular, for example, the single-filament fineness of the filaments may be 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. Meanwhile, the lower limit of the single-filament fineness of the filaments 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. Meeting the aforementioned range may be more advantageous for ensuring stable physical properties of a smoking article filter (e.g., achieving appropriate hardness or draw resistance) and maintaining reliable processing performance.

25 **[0088]** In some embodiments, the lyocell multifilament may have a total fineness of 1,667 tex to 6,111 tex (15,000 denier 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, 3,278 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 of the total fineness 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, 1,667 tex (15,000 denier) or less, or 1,611 tex (14,500 denier) or less. In addition, the upper limit of the total fineness 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, 1,667 tex (15,000 denier) or less, or 1,611 tex (14,500 denier) or less.

(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. If the total fineness falls outside the aforementioned range, the process reliability for manufacturing a smoking article filter may deteriorate (e.g., making continuous processing impossible due to cutting). In addition, during the production of the smoking article filter, if the amount of tow inserted into the filter plug wrap becomes too little or too much, achieving adequate filter properties (e.g., hardness or draw resistance) may become difficult.

[0089] A method for measuring fineness is not particularly limited, but comprises the following procedure. First, a 2 m length of a lyocell material (for example, a lyocell tow) is obtained and placed in a temperature- and humidity-controlled room at 20 °C and 65 % relative humidity for 24 hours to stabilize. One end of the stabilized lyocell tow is fixed and a 2 kg weight is attached to the other end. The tow in an elongated state due to the weight is maintained for 5 seconds (to stabilize), subsequently cut to 90 cm to obtain a sample, and the weight of the sample is measured (total fineness). The fineness is converted into denier by multiplying the measured weight by 10,000. Dividing the total fineness by the number of monofilaments in the sample yields the single-filament fineness of the monofilaments in the sample.

[0090] The total fineness of the aforementioned lyocell multifilament may be determined by the single-filament fineness and the number of crimps. In the present application, both the single-filament fineness and the number of crimps may be controlled, thereby allowing the total fineness of the tow to be suitably maintained for manufacturing a smoking article filter and ensuring its functionality.

[Number of Crimps]

[0091] In some embodiments, the lyocell multifilament may have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch). For example, the lower limit of the number of crimps may be 5.91 crimps/cm (15 crimps/inch) or more, 7.87 crimps/cm (20 crimps/inch) or more, 9.84 crimps/cm (25 crimps/inch) or more, 11.81 crimps/cm (30 crimps/inch) or more, 13.78 crimps/cm (35 crimps/inch) or more, 15.75 crimps/cm (40 crimps/inch) or more, or 17.72 crimps/cm (45 crimps/inch) or more. The upper limit of the number of crimps may be, for example, 17.72 crimps/cm (45 crimps/inch) or less, 15.75 crimps/cm (40 crimps/inch) or less, 13.78 crimps/cm (35 crimps/inch) or less, 11.81 crimps/cm (30 crimps/inch) or less, or 9.84 crimps/cm (25 crimps/inch) or less. The number of crimps and its uniformity may be controlled through pressure and temperature conditions associated with the crimping process described below.

[0092] Although not particularly limited thereto, the number of crimps may be measured using single-fiber property evaluation equipment (for example, a Favimat). In particular, the produced lyocell material (preferably, a lyocell tow) sample may be left under conditions of 20 ± 2 °C and 65 ± 4 % relative humidity for 24 hours to stabilize. A test specimen may be taken in a way that preserves the crimp in the stabilized sample. The collected test specimen may be mounted on a dedicated jig with a gauge length of 10 mm to 30 mm. During measurement, the initial load may be 0.05 g/denier, and the crimp sensitivity may be 0.01 mm. The number of crimps may be measured under the conditions mentioned above, namely 20 ± 2 °C and 65 ± 4 % relative humidity.

[0093] Although not particularly limited thereto, a lyocell material produced to satisfy the aforementioned single-filament fineness, total fineness, and/or number of crimps may be used for a smoking article.

[Binder]

[0094] In a non-limiting example, the lyocell material may further include a binder. For example, the binder may be present on the surface of the lyocell multifilament or between the lyocell multifilaments (or monofilaments). By further increasing the hardness of the smoking article filter, the binder may prevent issues such as the filter getting stuck during filter manufacturing or smoking article (e.g., cigarette) production.

[0095] The type of binder that may be used is not particularly limited, and any known binder may be employed so long as it does not impair the objectives of the present application. For example, a binder that can offer sufficient compatibility with

the emulsion used in the present application, improve the hardness of the filter, and provide excellent bonding strength may be utilized.

[0096] In a non-limiting example, the binder may include a polyester-based binder, a cellulose-based binder, and/or a vinyl-based binder.

[0097] Although not particularly limited thereto, the polyester-based binder may be a polyester binder including one or more selected from the group consisting of alkylene, arylene, or heteroarylene groups having 5 to 12 carbon atoms.

[0098] As the cellulose-based binder, hydroxypropyl methylcellulose (HPMC), ethylcellulose (EC) and/or methylcellulose (MC), carboxymethylcellulose (CMC), or a combination thereof may be utilized without being limited thereto.

[0099] In some embodiments, the cellulose-based binder is selected from the group consisting of hydroxypropyl methylcellulose, ethylcellulose, methylcellulose, carboxymethylcellulose, and a combination thereof.

[0100] As the vinyl-based binder, polyvinylpyrrolidone (PVP), polyvinyl alcohol (PVA), ethylene-vinyl acetate (EVA), or a combination thereof may be utilized without being limited thereto.

[0101] In some embodiments, the vinyl-based binder is selected from the group consisting of polyvinylpyrrolidone, polyvinyl alcohol, ethylene-vinyl acetate, and a combination thereof.

[0102] A method of imparting and/or coating the binder onto a lyocell material is described below.

[Bleaching Solution]

[0103] The lyocell material includes a crimped lyocell multifilament and has a whiteness of 55 to 85. To achieve the aforementioned whiteness, the lyocell multifilament and/or the lyocell material may undergo bleaching with a bleaching solution.

[0104] The bleaching solution may include a bleaching component and/or a bleaching agent, along with a solvent, for bleaching the lyocell multifilament and/or the lyocell material. Preferably, the bleaching component and/or bleaching agent may be hydrogen peroxide (H_2O_2). In addition, the solvent may be any solvent that can dissolve hydrogen peroxide, and for example, purified water may be considered as the solvent. In the present specification, "purified water" may refer to water that has been mechanically filtered or treated to remove impurities therefrom. In some embodiments, purified water refers to water containing impurities at 1,000 ppm or less, preferably 100 ppm or less, and more preferably 10 ppm or less, relative to the total weight of the water. Such purified water may be distilled water. The hydrogen peroxide concentration may be from 2 wt% to 8 wt%, relative to the total weight of the bleaching solution. Preferably, the hydrogen peroxide concentration may be from 3 wt% to 8 wt%, from 4 wt% to 8 wt%, from 5 wt% to 8 wt%, from 3 wt% to 7 wt%, from 3 wt% to 6 wt%, from 3 wt% to 5 wt%, from 4 wt% to 7 wt%, from 5 wt% to 7 wt%, or from 4 wt% to 6 wt%, relative to the total weight of the bleaching solution.

[0105] By maintaining the hydrogen peroxide concentration within the aforementioned ranges, the whiteness of the lyocell multifilament may be improved, and the concentration of residual hydrogen peroxide may be suitably controlled.

[0106] Meanwhile, the bleaching solution may be maintained at a temperature of 30 °C to 110 °C. Preferably, the upper limit of the temperature of the bleaching solution may be 110 °C, 105 °C, 100 °C, 95 °C, 90 °C, 85 °C, 80 °C, 75 °C, 70 °C, 65 °C, 60 °C, 55 °C, 50 °C, 45 °C, or 40 °C, and the lower limit of the temperature of the bleaching solution may be 30 °C, 35 °C, 40 °C, 45 °C, 50 °C, 55 °C, 60 °C, 65 °C, 70 °C, 75 °C, 80 °C, 85 °C, 90 °C, 95 °C, or 100 °C.

[0107] By keeping the bleaching solution temperature within the aforementioned ranges, bleaching of the lyocell multifilament and/or lyocell material may be achieved while suppressing off-flavors caused by bleaching, for example, acidic odors. As a result, the whiteness and sensory properties of the lyocell multifilament may be uniformly improved.

[0108] Meanwhile, the bleaching solution may further include the emulsion described below. This allows the lyocell multifilament and/or lyocell material to undergo bleaching and emulsion treatment simultaneously.

[Emulsion]

[0109] The lyocell material may include a lyocell multifilament; and an emulsion coated on the lyocell multifilament. In addition, the emulsion includes (a) an esterification product of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol; and (b) an esterification product of sorbitan and a fatty acid having 16 or more carbon atoms. Such an emulsion may be applied to part or all of the mono- or multifilaments constituting the lyocell material. In addition, the emulsion may penetrate between the filaments.

[0110] An emulsion that contains at least the aforementioned components (a) and (b) may exhibit hydrophobicity. As a result, the lyocell material treated with this emulsion has excellent spreading characteristics.

[0111] In a specific example of the present application, the lyocell material may contain the emulsion in a predetermined amount. Here, the emulsion content may refer to OPU (wt%) described below. "OPU" denotes the 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, and particularly, may be 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. In addition, the upper limit of the amount of the emulsion 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.

[0112] A method for measuring the emulsion content (OPU) may, for example, employ an extrusion technique. For example, a sample (e.g., 2 g to 5 g, particularly about 2.5 g) is taken (the weight of this sample is referred to as the "sample weight") and placed into a syringe-shaped container. The material of the container is not particularly limited, but may be stainless steel (SUS), for example. Next, a solvent (e.g., methanol) is introduced into the container holding the sample (the amount of the solvent may be 10 ml or less, for example about 8 ml). When adding the solvent to the sample, a dropwise method may be used, and the drop rate is uniformly controlled. The solvent introduced in this way into the container then drops from one end of the syringe-shaped container onto a plate. This plate is pre-weighed (its pre-measured weight is referred to as "plate weight A") and is installed such that the solvent dropped onto the plate can evaporate at 120 °C to 130 °C (e.g., 125 °C). The aforementioned processes of introducing and dropping the solvent are repeated three times, and then, using the syringe-shaped container, a pressure (e.g., 98 N/cm² (10 kgf/cm²) or less, 49 N/cm² (5 kgf/cm²) or less, or about 20 to 39 N/cm² (2 to 4 kgf/cm²)) is applied to the sample once. Through this process, the solvent and emulsion present in the sample are sufficiently extruded. Pressure is applied until no more solvent is released from the sample. Thereafter, the plate is placed in a desiccator for 5 minutes to 10 minutes, and the weight of the plate holding the sample is measured ("plate weight B"). The emulsion content is then calculated according to the following equation:

Emulsion Content by Extrusion (OPU, % or wt%) = $\{(Plate\ Weight\ B - Plate\ Weight\ A) / (Sample\ Weight)\} \times 100$ <Equation>

[0113] In addition, the lyocell material serving as the basis for measuring the emulsion content may be, at least, an emulsion-treated lyocell multifilament. For example, the lyocell material may be a lyocell multifilament to which a first emulsion treatment (described below) has been applied, a lyocell multifilament to which both a first and a second emulsion treatment (described below) have been applied, or a lyocell multifilament to which the aforementioned emulsion treatment(s) as well as the binder (described below) have been applied. In addition, the lyocell multifilament treated with the emulsion and/or binder may be one that is crimped.

[0114] With respect to the emulsion of the present application, component (a) may be a compound that can function as a lubricant or oil, and a component harmless enough to the human body for use in food. Component (a) imparts lubricity to the fiber entering the crimper. Insufficient lubricity causes the lyocell to bunch up and fail to exit the crimper; excessively high lubricity leads to poor crimp formation. Taking these functions into consideration, the amount of component (a) may be controlled as described below.

[0115] There is no particular limitation on the type of fatty acid having 16 or more carbon atoms that forms component (a). A fatty acid having 16 or more carbon atoms that can yield an esterification product harmless enough to the human body for use in food, may be used.

[0116] For example, the fatty acid having 16 or more carbon atoms may be a saturated and/or unsaturated fatty acid.

[0117] Examples of the saturated fatty acid may include palmitic acid (hexadecanoic acid, CH₃(CH₂)₁₄COOH), margaric acid (heptadecanoic acid, CH₃(CH₂)₁₅COOH), stearic acid (octadecanoic acid, CH₃(CH₂)₁₆COOH), nonadecylic acid (nonadecanoic acid, CH₃(CH₂)₁₇COOH), or arachidic acid (eicosanoic acid, CH₃(CH₂)₁₈COOH). However, the types of saturated fatty acids that can be used are not limited to aforementioned examples.

[0118] Examples of the unsaturated fatty acid may include palmitoleic acid (CH₃(CH₂)₅CH=CH(CH₂)₇COOH), oleic acid (CH₃(CH₂)₇CH=CH(CH₂)₇COOH), linoleic acid (C₁₈H₃₂O₂), arachidonic acid (C₂₀H₃₂O₂), and the like. However, the types of unsaturated fatty acids that can be used are not limited to the aforementioned examples.

[0119] 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.

[0120] The upper limit on the number of carbon atoms in 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.

[0121] With respect to component (a), there is likewise no particular limitation on the type of aliphatic monohydric alcohol that forms the esterification product. An aliphatic monohydric alcohol that can yield an esterification product harmless enough to the human body for use in food.

[0122] For example, the aliphatic monohydric alcohol may be either a saturated or unsaturated aliphatic alcohol, which may take a linear or branched form.

[0123] In some embodiments, the aliphatic monohydric alcohol may have 1 to 40 carbon atoms. In particular, the aliphatic monohydric alcohol may have, for example, 4 or more, 8 or more, 12 or more, 16 or more, or 20 or more carbon

atoms.

[0124] Examples of such aliphatic monohydric alcohols may include methanol, ethanol, butanol, lauryl alcohol, isotridecanol, and stearyl alcohol, without being limited thereto.

[0125] In some embodiments, the aliphatic monohydric alcohol is selected from the group consisting of methanol, ethanol, butanol, lauryl alcohol, isotridecanol, and stearyl alcohol.

[0126] In some embodiments of the present application, an esterification product of isotridecanol and stearic acid (e.g., isotridecyl stearate) may be used as component (a). However, the type of component (a) is not limited thereto.

[0127] As will be described below, the amount of component (a) included in the emulsion may be controlled in view of the function of the emulsion or the function of component (a).

[0128] Component (b), namely an esterification product of sorbitan and a fatty acid having 16 or more carbon atoms, may be a compound that can function as an emulsifier, and a component harmless enough to the human body for use in food.

[0129] Because component (b) has both hydrophilic and hydrophobic properties due to sorbitan (a polyhydric alcohol), the dispersion of component (a), which imparts lubricity to the fibers, becomes facilitated in the water described below. Moreover, when used together, components (a) and (b) not only enhance the dispersibility of the emulsion as mentioned above, but also lower the melting point to ensure ease of handling and stability of the emulsion. The amount of component (b) may be controlled in consideration of the aforementioned functions, as described below.

[0130] There is no particular limitation placed on the type of fatty acid having 16 or more carbon atoms used to form component (b). A fatty acid having 16 or more carbon atoms that can yield an esterification product harmless enough to the human body for use in food, may be used.

[0131] For example, the fatty acid having 16 or more carbon atoms may be a saturated and/or unsaturated fatty acid.

[0132] Examples of the saturated fatty acid may include palmitic acid (hexadecanoic acid, $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$), margaric acid (heptadecanoic acid, $\text{CH}_3(\text{CH}_2)_{15}\text{COOH}$), stearic acid (octadecanoic acid, $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$), nonadecylic acid (nonadecanoic acid, $\text{CH}_3(\text{CH}_2)_{17}\text{COOH}$), or arachidic acid (eicosanoic acid, $\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$). However, the types of saturated fatty acids that can be used are not limited to the aforementioned examples.

[0133] Examples of the unsaturated fatty acid include palmitoleic acid ($\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), oleic acid ($\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), linoleic acid ($\text{C}_{18}\text{H}_{32}\text{O}_2$), arachidonic acid ($\text{C}_{20}\text{H}_{32}\text{O}_2$), and the like. However, the types of unsaturated fatty acids that can be used are not limited to the aforementioned examples.

[0134] 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.

[0135] The upper limit on the number of carbon atoms in 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.

[0136] In embodiments of the present application, component (b) may be an esterification product of sorbitan and oleic acid (e.g., sorbitan monooleate). However, the type of component (b) that may be used is not limited thereto.

[0137] The amount of component (b) may be adjusted in consideration of the functions of component (b) and the emulsion itself.

[0138] In some embodiments, the emulsion may include, per 100 parts by weight of component (a)-that is, an esterification product of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol-20 to 60 parts by weight of component (b), an esterification product of sorbitan and a fatty acid having 16 or more carbon atoms.

[0139] In particular, the emulsion of the present application may include, per 100 parts by weight of component (a), 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 of component (b). Further, the upper limit of the amount of component (b) per 100 parts by weight of 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. Meeting the aforementioned amount ranges may impart hydrophobicity to the surface of the emulsion-treated lyocell multifilament or lyocell tow.

[0140] In some embodiments, the emulsion may include 40 wt% to 80 wt% of component (a) (the esterification product of a fatty acid having 16 or more carbon atoms and an aliphatic monohydric alcohol) based on 100 wt% of the total weight of the emulsion. In particular, based on 100 wt% of the total weight of the emulsion, the amount of 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. Further, the upper limit of the amount of component (a) 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.

[0141] In some embodiments, the emulsion may contain component (a) in excess.

[0142] In some embodiments, the emulsion may include 15 wt% to 55 wt% of component (b), an esterification product of sorbitan and a fatty acid having 16 or more carbon atoms, based on 100 wt% of the total weight of the emulsion. In particular, based on 100 wt% of the total weight of the emulsion, the amount of 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. Further, the upper limit of the amount of component (b) 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.

[0143] In some embodiments, the emulsion may be included in a bleaching solution, wherein the bleaching solution may contain a bleaching component and/or bleaching agent, and a solvent.

[0144] Although not particularly limited, the emulsion may be included in an amount constituting the remainder of the bleaching solution based on 100 wt% of the bleaching solution, after accounting for the bleaching component and/or bleaching agent, and the solvent. The amount of the emulsion included in the bleaching solution (i.e., the total amount of remaining components excluding bleaching ingredients/bleaching agents and solvents) may be, for example, 90 wt% or less, 85 wt% or less, 80 wt% or less, 75 wt% or less, 70 wt% or less, 65 wt% or less, 60 wt% or less, 55 wt% or less, 50 wt% or less, 45 wt% or less, 40 wt% or less, 35 wt% or less, 30 wt% or less, 25 wt% or less, or 20 wt% or less. Further, the lower limit of the amount of the emulsion may be, for example, 0 wt% or more, 0.1 wt% or more, 0.5 wt% or more, 1 wt% or more, 5 wt% or more, 10 wt% or more, 15 wt% or more, 20 wt% or more, 25 wt% or more, 30 wt% or more, 35 wt% or more, 40 wt% or more, 45 wt% or more, 50 wt% or more, 55 wt% or more, 60 wt% or more, 65 wt% or more, 70 wt% or more, 75 wt% or more, 80 wt% or more, or 85 wt% or more.

[Method of Preparing Lyocell Material]

[0145] The present application relates to a method of preparing a lyocell material. Through this method, a lyocell material may be prepared, which may be used in a smoking article.

[0146] In particular, the method of preparing a lyocell material includes: spinning a lyocell dope; coagulating to obtain a lyocell multifilament; washing; bleaching; and imparting crimp. In addition, transport of the lyocell multifilament during the bleaching may be carried out by at least one upper roller and at least one lower roller. In particular, the washing refers to a process of washing (cleaning) the lyocell multifilament, the bleaching refers to a process of bleaching the lyocell multifilament, and the crimp-imparting refers to a process of imparting crimp to the lyocell multifilament. In some embodiments, the aforementioned processes are performed in the order mentioned.

[0147] Furthermore, the method of preparing a lyocell material may further include an emulsion treatment. For example, the emulsion treatment may be performed before the bleaching operation, after the bleaching operation, or at the same time as the bleaching operation. If the emulsion treatment is performed at the same time as the bleaching operation, the emulsion treatment may be understood to be included in the bleaching operation.

[0148] Additionally, the emulsion treatment may be performed after the washing or before the crimp-imparting.

[0149] Moreover, the method of preparing a lyocell material may further include a binder treatment; and other processes.

[0150] Furthermore, the emulsion treatment may be independently performed, for example, by spraying an emulsion of the aforementioned composition onto the lyocell multifilament or by immersing the lyocell multifilament in the emulsion. The emulsion treatment may be performed such that the emulsion content of the lyocell material (e.g., OPU (wt%)) satisfies a predetermined range as described above.

[0151] The crimp-imparting may be performed, for example, by applying steam and/or pressure to the lyocell multifilament.

[0152] The method of preparing a lyocell material according to an embodiment of the present application will be described in greater detail below. The method of the present application may be performed by including one or more processes described below.

<(a) Spinning Lyocell Dope>

[0153] This process involves spinning a lyocell spinning dope containing lyocell cellulose (or cellulose pulp) and N-methylmorpholine-N-oxide (NMMO).

[0154] Commercially available cellulose acetate filters have been identified as a primary source of microplastics. However, the amine oxide-based solvent used in the production of lyocell fibers can be recycled and is biodegradable upon disposal, so lyocell materials do not generate any pollutants in their manufacturing process. Moreover, because lyocell tow biodegrades within a relatively short time, lyocell is more environmentally friendly a material than cellulose acetate.

[0155] In some embodiments, the amount of cellulose in the spinning dope may be 5 wt% to 15 wt% based on 100 wt% of the total weight of the dope. If the amount of the cellulose is excessively low, realizing the characteristics of the lyocell fiber may become difficult; on the other hand, if the amount exceeds the aforementioned range, dissolution in solvent may become difficult. In view of the foregoing, the amount of the 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, relative to the total weight of the spinning dope, and the upper limit of the amount of the cellulose in the spinning dope 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, relative to the total weight of the spinning dope. The term "cellulose" as used herein may refer to "lyocell cellulose".

[0156] In some embodiments, the spinning dope may include an aqueous N-methylmorpholine-N-oxide (NMMO) solution. Taking into account the extent of cellulose dissolution, process temperature, etc., the aqueous solution may

include, for example, 80 parts by weight to 95 parts by weight of N-methylmorpholine-N-oxide, and 5 parts by weight to 20 parts by weight of water.

[0157] In some embodiments, the cellulose or cellulose pulp may contain from 85 wt% to 97 wt% of alpha-cellulose, based on 100 wt% of the total cellulose and/or cellulose pulp.

[0158] In some embodiments, the cellulose or cellulose pulp may contain from 1 wt% to 15 wt% of hemicellulose, based on 100 wt% of the total cellulose and/or cellulose pulp. By adjusting the amount of hemicellulose to the aforementioned range, stable physical properties (e.g., hardness or appropriate draw resistance) and processability of the lyocell material may be more readily achieved.

[0159] In certain embodiments of the present disclosure, the degree of polymerization (DPw) of the cellulose may be from 600 to 1,700. In some embodiments, the degree of polymerization refers to the number of repeating units and/or monomers of the cellulose, alpha-cellulose, and/or hemicellulose within the cellulose pulp.

[0160] In the spinning process, the shape of the spinneret used for discharging the spinning dope is not particularly limited. For example, a donut-shaped spinneret may be used.

[0161] The nozzle temperature of the spinneret, in particular the spinning temperature, may be suitably selected by those skilled in the art. Taking into account that variations in spinning temperature can affect the viscosity of the spinning dope and hinder discharge, the spinning temperature may be, for example, 100 °C to 120 °C or less, or 100 °C to 110 °C or less.

[0162] In some embodiments, the spinning of the spinning dope may be performed under spinning conditions controlled so that the single-filament fineness is 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier). For instance, one or more of the spinning conditions—such as the discharge rate of the spinning dope or the spinning speed—may be appropriately controlled so that the single-filament fineness of the filaments in the lyocell material satisfies a range of 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier). Here, "single-filament fineness" refers to the fineness of a single monofilament separated from the multifilament.

[0163] In particular, for example, the single-filament fineness of the filaments may be 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. Meanwhile, the lower limit of the single-filament fineness of the filaments 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. Meeting the aforementioned range may be more advantageous for ensuring stable draw resistance in the smoking article filter and securing process reliability.

[0164] The spinning dope discharged through the spinneret may undergo a coagulation process described below.

<(b) Coagulation and Obtaining Multifilament >

[0165] This process may involve coagulation of the extruded lyocell spinning dope to obtain a lyocell multifilament.

[0166] The coagulation may employ a method that brings the extruded dope into contact with air and/or a coagulation liquid.

[0167] In some embodiments, the coagulation may include: a first coagulation process in which cooled air is supplied to the extruded lyocell dope; and a second coagulation process in which the extruded dope having undergone the first coagulation is immersed in a coagulation liquid for coagulation.

[0168] According to such a coagulation method, the lyocell dope discharged from the spinneret may undergo a first coagulation in a space between the spinneret and a coagulation bath (air-gap section). For example, in this air-gap section, cooling air from an air-cooling device located inside the spinneret may be supplied from the inside to the outside of the spinneret. Additionally, the first coagulation may be carried out using a so-called air-quenching method or other known means in the art.

[0169] In some embodiments, the upper temperature limit of the cooling air used in the first coagulation may be, for example, 15 °C or below. In particular, the cooling air may be air having a temperature of 14 °C or less, 13 °C or less, 12 °C or less, 11 °C or less, or 10 °C or less. If the temperature exceeds the aforementioned range, coagulation of the spinning dope by air may be insufficient, and spinning-related processability may deteriorate.

[0170] The lower temperature limit of the cooling air may be determined in consideration of spinning processability and/or cross-sectional uniformity of the filaments. For example, if the temperature of the cooling air is less than 4 °C, the spinneret surface may cool, causing irregularities in the filament surface and deteriorating spinning processability. In light of the foregoing, the cooling air may be 5 °C or more, 6 °C or more, 7 °C or more, 8 °C or more, or 9 °C or more.

[0171] The degree to which the cooling air is supplied may be controlled in consideration of sufficient coagulation, spinning processability, and the effects on filament properties. For example, the cooling air may be supplied at an airflow rate of 70 Nm³/h to 400 Nm³/h to the extruded spinning dope. More specifically, the airflow rate may be 100 Nm³/h or more,

150 Nm³/h or more, 200 Nm³/h or more, or 250 Nm³/h or more, and the upper limit of the airflow rate may be, for example, 350 Nm³/h or less, 300 Nm³/h or less, 250 Nm³/h or less, 200 Nm³/h or less, or 150 Nm³/h or less.

[0172] After the first coagulation process, the cooled extruded dope may be supplied to a coagulation tank or bath containing a coagulation liquid (a second coagulation process). For suitable progress of the coagulation, the temperature of the coagulation liquid may, for example, be 30 °C or less, or 25 °C or less. In addition, the temperature of the coagulation liquid may be at least 10 °C, at least 15 °C, or at least 20 °C. By maintaining the temperature in the aforementioned range, the coagulation rate may be appropriately maintained.

[0173] The type of coagulation liquid for the second coagulation process is not particularly limited. For example, the coagulation liquid may be one including one or more from water and N-methylmorpholine-N-oxide (NMMO).

[0174] Without limitation, if the coagulation liquid is to contain water and NMMO, the water content of the coagulation liquid relative to the total weight of the coagulation liquid may be 60 wt% to 90 wt%, and the NMMO content relative to the total weight of the coagulation liquid may be 10 wt% to 40 wt%. Alternatively, the coagulation liquid may include 70 wt% to 80 wt% of water and 20 wt% to 30 wt% of NMMO, relative to the total weight of the coagulation liquid. The concentration of such a coagulation liquid may be controlled using a sensor, etc. so as to remain stable during the preparation process.

<(c) Washing>

[0175] If necessary, after the aforementioned process of coagulation and obtaining the multifilament, the lyocell multifilament may be washed. Through this washing, any residual NMMO and/or other impurities within the filament may be removed.

[0176] The method of performing the washing is not particularly limited. For example, the washing may be carried out by introducing the coagulated lyocell multifilament into a washing bath using a take-up roller. Alternatively, the washing may be performed by spraying a washing liquid onto the multifilament as they are conveyed to the next process by a take-up roller.

[0177] The components of the washing liquid are not particularly limited. For example, the washing liquid may include water, and may further include other known additives.

[0178] Additionally, in consideration of reuse after washing, the washing liquid may be regulated to a temperature of up to 100 °C.

<(d) Bleaching>

[0179] In some embodiments, the method of preparing a lyocell material includes bleaching. During the bleaching, the lyocell multifilament may be bleached with a bleaching solution, and pigments and impurities contained in the lyocell multifilament may be removed. Details regarding the bleaching solution are provided above.

[0180] Provided is the method of preparing a lyocell material in which during the bleaching, the lyocell multifilament is transported by at least one upper roller and at least one lower roller. The upper roller is arranged so as not to be immersed in the bleaching solution, and/or not to impregnate the lyocell multifilament with the bleaching solution, and/or not to be immersed in the bleaching solution, while the lower roller is arranged so as to be immersed in the bleaching solution, and/or to impregnate the lyocell multifilament with the bleaching solution, and/or to be immersed in the bleaching solution. In particular, the upper roller may be located at an upper portion of the treatment tank containing the bleaching solution, and when viewed from above, the upper roller may appear to be disposed within an outer circumferential surface of the treatment tank.

[0181] Since the upper roller is not immersed in the bleaching solution, the lyocell multifilament temporarily departs from the bleaching solution in the vicinity of the upper roller. Furthermore, since the lower roller is immersed in the bleaching solution, the lyocell multifilament is temporarily immersed in the bleaching solution in the vicinity of the lower roller.

[0182] Accordingly, by adjusting the number of upper rollers and lower rollers, both the immersion time of the lyocell multifilament in the bleaching solution and the degree to which the lyocell multifilament is compressed by the bleaching solution may be controlled.

[0183] In some embodiments, in the method of preparing a lyocell material, the number of lower rollers may be two or more. Preferably, the lower limit of the number of lower rollers may be two, three, four, five, six, or seven, and the upper limit of the number of lower rollers may be three, four, five, six, or eight.

[0184] In some embodiments, in the method of preparing a lyocell material, the number of upper rollers may be two or more. Preferably, the lower limit of the number of upper rollers may be two, three, four, five, six, or seven, and the upper limit of the number of upper rollers may be three, four, five, six, or eight.

[0185] In addition, the number of lower rollers may be the same as the number of upper rollers, or one fewer than the number of upper rollers, or one more than the number of upper rollers.

[0186] The upper rollers and lower rollers may also be alternately arranged. For example, the lyocell multifilament may be transported first by a first upper roller, then by a first lower roller, and subsequently by a second upper roller.

[0187] In some embodiments, in the method for preparing a lyocell material, the lyocell multifilament may be impregnated with the bleaching solution two to eight times during the bleaching. Preferably, the lyocell multifilament may be impregnated with the bleaching solution three times or more, four times or more, five times or more, six times or more, or seven times or more, and eight times or less, seven times or less, six times or less, five times or less, four times or less, or three times or less. The composition of the bleaching solution may be as described above.

[0188] In some embodiments, the immersion time for each lower roller may be less than 0.54 seconds. In some embodiments, the immersion time for each lower roller may be from 0.10 seconds to 0.53 seconds. If the immersion time per lower roller is 0.54 seconds or more, the lyocell multifilament may experience excessive resistance from the bleaching solution during transport. As a result, the lyocell multifilament is compressed in the transport direction and stretched in a direction perpendicular to the transport direction (i.e., the width direction). The lyocell multifilament, stretched in the width direction, fails to become uniformly crimped due to an increase in width and a decrease in density at the edges. In particular, after the crimp-imparting, edge breakage may be observed in the lyocell multifilament that has been stretched in the width direction, compromising the reliability of the crimp-imparting process.

[0189] In addition, the lower roller may have a depth from 100 mm to 850 mm. This depth refers to the distance from the surface of the bleaching solution to the center of the lower roller. By adjusting this depth, the immersion time of the lyocell multifilament per lower roller is controlled. For example, increasing the depth of the lower roller increases the immersion time of the lyocell multifilament.

[0190] Preferably, the lower limit of the depth may be 100 mm, 110 mm, 120 mm, 130 mm, 140 mm, or 150 mm, and the upper limit of the depth may be 850 mm, 800 mm, 750 mm, 700 mm, 650 mm, 600 mm, 550 mm, 500 mm, 450 mm, 400 mm, 350 mm, or 300 mm.

[0191] In addition, the diameter of the lower roller and the diameter of the upper roller may each independently be from 100 mm to 200 mm. In particular, the range of these diameters may be from 110 mm to 200 mm, 120 mm to 200 mm, 130 mm to 200 mm, 140 mm to 200 mm, 150 mm to 200 mm, 100 mm to 190 mm, 100 mm to 180 mm, 100 mm to 170 mm, 100 mm to 160 mm, or 100 mm to 150 mm.

[0192] In addition, the emulsion treatment may be carried out in the same treatment bath used for the bleaching operation. In this case, the treatment bath may contain both a bleaching solution and an emulsion, wherein the bleaching solution and the emulsion may be uniformly prepared as described above.

[0193] On the other hand, the emulsion treatment may be carried out in a treatment bath separate from the bleaching operation. In that case, one bath containing a bleaching solution and another bath containing an emulsion may each be prepared, wherein both the bleaching solution and the emulsion may be uniformly prepared in accordance with the description above.

[0194] In some embodiments, in the method of preparing a lyocell material, the emulsion treatment may be performed in the same treatment bath used for the bleaching operation, and the emulsion treatment may be carried out at the same time as the bleaching operation.

[0195] For example, a bleaching solution having a hydrogen peroxide concentration of 2 wt% to 8 wt% may be used during the bleaching operation. In some embodiments, the bleaching solution may contain hydrogen peroxide at a concentration of 2 wt% to 8 wt%, based on the total weight of the bleaching solution, the temperature of the bleaching solution may be from 40 °C to 100 °C. Within the bleaching solution, there may be a total of two to eight lower rollers, each having a diameter of about 150 mm. The lower rollers may be spaced at equal intervals. In addition, each lower roller may have a depth of 150 mm to 300 mm. Upper rollers may be arranged above the lower rollers. The number of upper rollers may be one fewer than the number of lower rollers. The upper rollers may be spaced at equal intervals. When viewed from the side, lower rollers, upper rollers, and lower rollers may be seen to be alternately disposed along the advancing direction of the lyocell multifilament.

[0196] As each lower and upper roller rotates, the transport of the lyocell multifilament proceeds in one direction. In particular, rotation of the lower rollers causes the lyocell multifilament to be transported into and immersed in the bleaching solution, while rotation of the upper rollers causes the lyocell multifilament to be transported out of the bleaching solution.

[0197] While the lyocell multifilament is immersed in the bleaching solution, the lyocell multifilament experiences resistance due to transport and the bleaching solution. In particular, when resistance by the bleaching solution is continuous, the lyocell multifilament is unnecessarily stretched in the width direction. As a result, the lyocell multifilament either fails to be fed into the crimping device, or even if fed into the crimping device, exhibits deterioration in the quality of the imparted crimp.

[0198] In other words, conventionally, improving the whiteness and brightness of the lyocell multifilament through bleaching leads to deterioration of the crimp characteristics of the lyocell multifilament. Hence, manufacturing a lyocell multifilament having good crimp characteristics while simultaneously satisfying predetermined whiteness and predetermined brightness was technically limited by conventional methods.

[0199] However, by arranging lower and upper rollers in an alternating fashion as described above-so that the lyocell multifilament is immersed in the bleaching solution only briefly and repeatedly-the continuous exposure time of the lyocell multifilament to the bleaching solution can be limited, for example, to less than 0.54 seconds per immersion, while still

subjecting the multifilament to sufficient bleaching conditions. As a result, the lyocell multifilament may have a whiteness of 55 to 85, a brightness of 75 or more, and an H₂O₂ content of 1,000 ppm or less based on the total weight of the lyocell material while maintaining its crimp characteristics (e.g., crimp count, crimp uniformity) without degradation.

5 <(e) Emulsion Treatment>

[0200] If necessary, an emulsion treatment may be performed on the lyocell multifilament. This process involves applying an emulsion containing the aforementioned components to the surface of the filament. By performing the emulsion treatment, friction exerted on the filament may be reduced, and crimp formation in the subsequent crimp-imparting described below may be facilitated. As described below, if the emulsion treatment is to be carried out two or more times, the process may be referred to as a first emulsion treatment, a second emulsion treatment, and so on, in chronological order.

[0201] Without particular limitation, the emulsion treatment may be carried out by immersing the lyocell multifilament in a bath filled with the emulsion so that the lyocell multifilament is fully submerged. Alternatively, the emulsion treatment may be carried out by spraying an emulsion solution onto the multifilament as they are conveyed to the next stage by a take-up roller.

[0202] After the emulsion treatment as described above, in order to make the amount of emulsion applied onto the lyocell multifilament uniform, a process may further be carried out in which a roll (or the like), positioned before and/or after the emulsion treatment, squeezes the emulsion off the surface of the lyocell multifilament.

[0203] In some embodiments, the emulsion treatment may be carried out such that the emulsion content (OPU: oil pick-up ratio (wt%)) is at least 1.0 wt% based on 100% by weight of the lyocell multifilament that has undergone at least a single treatment of emulsion. Here, the "lyocell multifilament that has undergone at least a single treatment of emulsion" may refer to, for example, a lyocell multifilament that has undergone a first emulsion treatment; a lyocell multifilament that has undergone both a first and a second emulsion treatment (see below); or a lyocell multifilament that has undergone such emulsion treatments in addition to a binder treatment described below. Further, the lyocell multifilament that has undergone the emulsion and/or binder treatment as described above may be one that has been crimped.

[0204] In particular, the emulsion content of the lyocell multifilament that has undergone at least the emulsion treatment 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 lyocell multifilament that has undergone at least the emulsion treatment. The upper limit of the emulsion content 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, based on 100 wt% of the lyocell multifilament that has undergone at least the emulsion treatment. In this context, the content may refer to the dry weight remaining after any solvent (e.g., water) or liquid component included in the emulsion has evaporated.

[0205] When the emulsion of the aforementioned composition is applied within this content range, the hydrophilic properties of the lyocell material may be improved.

[0206] In some cases, the emulsion may be dried following the above-described emulsion treatment.

[0207] In embodiments of the present application, one or more of the processes described above may be controlled so that the single-filament fineness of the filaments constituting the lyocell multifilament is 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier). Here, the single-filament fineness of the filaments refers to the fineness of a single monofilament separated from the multifilament.

[0208] In particular, for example, the single-filament fineness of the filaments may be 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 of the single-filament fineness of the filaments 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. Meeting the aforementioned range may be more advantageous for ensuring stable draw resistance in the smoking article filter and securing process reliability.

[0209] Although not particularly limited, the process that is controlled to achieve the above-described single-filament fineness range may be the aforementioned spinning process. Alternatively, to achieve the aforementioned single-filament fineness range, all of the above-described spinning, coagulation, washing, and emulsion treatment processes may be controlled.

<(f) Imparting of Crimp>

[0210] This crimp-imparting process may be a process of obtaining crimped multifilaments, preferably crimped tow, by applying pressure to the emulsion-treated lyocell multifilament through steam and/or a pressing roller. The crimp-imparting process may be referred to as a crimping process. In the present specification, "emulsion-treated" and "emulsified" may be used interchangeably.

[0211] Through crimping, the lyocell multifilament may be imparted with waves, and the fiber may acquire a bulky characteristic. Crimping can be performed using a known crimping device such as one that includes a stuffer box and/or a steam box. The crimping device that may be used is not particularly limited as long as it is capable of applying one or more of the pressures described below.

[0212] In some embodiments, the crimp-imparting may be carried out by first supplying steam to the lyocell multifilament to preheat and swell the lyocell multifilament, followed by pressing the lyocell multifilament with a pressing roller to form crimps in the lyocell multifilament. In this case, a steam box may be used for steam supply, and such a steam box may be positioned upstream of the crimping device.

[0213] In some embodiments, the crimp-imparting may be carried out in such a way that the pressing of the lyocell multifilament with a press roller and the supply of steam occur simultaneously.

[0214] In some embodiments, the crimp-imparting may first involve supplying steam to the lyocell multifilament to preheat and swell the lyocell multifilament, followed by a procedure in which the pressing of the lyocell multifilament with a press roller and the supply of steam occur simultaneously.

[0215] In some embodiments, the crimp-imparting may be performed by applying steam in the range of 0.98 N/cm² to 19.61 N/cm² (0.1 kgf/cm² to 2.0 kgf/cm²) to the lyocell multifilament before being fed into the crimping device (in particular, the press roller).

[0216] For example, steam of 1.96 N/cm² (0.2 kgf/cm²) or more, 2.94 N/cm² (0.3 kgf/cm²) or more, 3.92 N/cm² (0.4 kgf/cm²) or more, 4.90 N/cm² (0.5 kgf/cm²) or more, or 5.88 N/cm² (0.6 kgf/cm²) or more may be provided by a steam box. Additionally, steam of 14.71 N/cm² (1.5 kgf/cm²) or less, 13.73 N/cm² (1.4 kgf/cm²) or less, 12.75 N/cm² (1.3 kgf/cm²) or less, 11.77 N/cm² (1.2 kgf/cm²) or less, 10.79 N/cm² (1.1 kgf/cm²) or less, or 9.81 N/cm² (1.0 kgf/cm²) or less may be provided. If the amount or pressure of steam supplied is below the aforementioned range, crimp formation may not go smoothly. If the amount or pressure of steam supplied exceeds the aforementioned range, the filaments may become overly flexible in the crimping device, resulting in excessive crimp that prevents the filaments from passing through the crimping device.

[0217] In some embodiments, the crimp-imparting may be performed by pressing the lyocell multifilament with a pressing roller to form crimps in the lyocell multifilament. In addition, the steam supply may not be performed before the pressing, the steam supply may not be performed simultaneously with the pressing, and the steam supply may not be performed both before and simultaneously with the pressing.

[0218] In some embodiments, the crimp-imparting may not be carried out by applying a pressure in the range of 14.71 N/cm² to 39.23 N/cm² (1.5 kgf/cm² to 4.0 kgf/cm²) to the lyocell multifilament with a press roller within the crimping device.

[0219] For example, a pressure of 15.69 N/cm² (1.6 kgf/cm²) or more, 16.67 N/cm² (1.7 kgf/cm²) or more, 17.65 N/cm² (1.8 kgf/cm²) or more, 18.63 N/cm² (1.9 kgf/cm²) or more, 19.61 N/cm² (2.0 kgf/cm²) or more, 20.60 N/cm² (2.1 kgf/cm²) or more, 21.58 N/cm² (2.2 kgf/cm²) or more, 22.56 N/cm² (2.3 kgf/cm²) or more, 23.54 N/cm² (2.4 kgf/cm²) or more, or 24.52 N/cm² (2.5 kgf/cm²) or more may be applied to the lyocell multifilament via the press roller. Additionally, a pressure of 38.25 N/cm² (3.9 kgf/cm²) or less, 37.27 N/cm² (3.8 kgf/cm²) or less, 36.29 N/cm² (3.7 kgf/cm²) or less, 35.31 N/cm² (3.6 kgf/cm²) or less, 34.33 N/cm² (3.5 kgf/cm²) or less, 33.35 N/cm² (3.4 kgf/cm²) or less, 32.37 N/cm² (3.3 kgf/cm²) or less, 31.39 N/cm² (3.2 kgf/cm²) or less, 30.41 N/cm² (3.1 kgf/cm²) or less, 29.42 N/cm² (3.0 kgf/cm²) or less, 28.44 N/cm² (2.9 kgf/cm²) or less, 27.46 N/cm² (2.8 kgf/cm²) or less, 26.48 N/cm² (2.7 kgf/cm²) or less, 25.50 N/cm² (2.6 kgf/cm²) or less, or 24.52 N/cm² (2.5 kgf/cm²) or less may be applied to the lyocell multifilament via the press roller.

[0220] If the pressure by the press roller is below the aforementioned range, the intended number of crimps may not be fully achieved. If the roller pressure exceeds the aforementioned range, the pressing force may be too high, preventing the filaments from entering the crimping device smoothly or passing through the crimping device. Wrinkles may be formed on the lyocell multifilament by the press roller providing the aforementioned pressure.

[0221] In some embodiments, using an upper plate, a pressure of 0.98 N/cm² to 19.61 N/cm² (0.1 kgf/cm² to 2 kgf/cm²) may be applied to the lyocell multifilament. In addition, the upper plate may apply pressure to the lyocell multifilament while or after the lyocell multifilament passes through the press roller.

[0222] For example, the pressure applied by the upper plate may be 1.96 N/cm² (0.2 kgf/cm²) or more, 2.94 N/cm² (0.3 kgf/cm²) or more, 3.92 N/cm² (0.4 kgf/cm²) or more, or 4.90 N/cm² (0.5 kgf/cm²) or more. Additionally, a pressure of 14.71 N/cm² (1.5 kgf/cm²) or less, 13.73 N/cm² (1.4 kgf/cm²) or less, 12.75 N/cm² (1.3 kgf/cm²) or less, 11.77 N/cm² (1.2 kgf/cm²) or less, 10.79 N/cm² (1.1 kgf/cm²) or less, or 9.81 N/cm² (1.0 kgf/cm²) or less may be applied by the upper plate.

[0223] Furthermore, if the pressure of the upper plate—which moves up and down to achieve uniform crimp after the press roller—is below 0.98 N/cm² (0.1 kgf/cm²), the upper plate may not be fixed due to the internal pressure of the crimping

device. As a result, the tow may remain in the crimping device for a prolonged time, compromising continuous processing. On the other hand, if the pressure of the upper plate exceeds 19.61 N/cm^2 (2 kgf/cm^2), steam may not be discharged smoothly from the crimping device, causing irregular crimp shapes.

[0224] In some embodiments, the crimp-imparting may employ a doctor blade that applies a predetermined pressure to the lyocell multifilament. The doctor blade helps control the dwell time of the filaments loaded into the crimper device, thus contributing to adjusting the number of crimps. Such a doctor blade may be positioned, for example, in the travel path of the lyocell multifilament discharged from the pressing point after being pressed by the aforementioned roller.

[0225] In some embodiments, the crimp-imparting may be performed by applying a pressure of 0.98 N/cm^2 to 19.61 N/cm^2 (0.1 kgf/cm^2 to 2.0 kgf/cm^2) to the lyocell multifilament, which has passed through the roller of the crimping device, by means of a doctor blade.

[0226] 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.

[0227] In some embodiments, the crimp-imparting may be performed at a temperature ranging from 120°C to 250°C . If the temperature is excessively low, the shape-stability effect of the crimp may become poor; if the temperature is excessively high, the concentration of oil components in the crimper device may increase, making crimp formation difficult. Therefore, in view of factors such as the aforementioned steam pressure, the temperature may be suitably controlled at 130°C or more, 140°C or more, or 150°C or more, and at 200°C or lower, 180°C or lower, or 160°C or lower.

<(g) Binder Treatment>

[0228] In some embodiments, the method may further include a binder treatment process in which the emulsion-treated lyocell multifilament or the lyocell multifilament obtained from the crimp-imparting process is treated with a binder.

[0229] When manufacturing a smoking article filter using the lyocell material (for example, a lyocell tow), a binder may be additionally used. The binder may increase the hardness of the smoking article filter containing the lyocell material, thereby preventing problems such as filter jamming during filter manufacturing or cigarette manufacturing processes.

[0230] The method of coating binder onto the lyocell material is not particularly limited. For example, an emulsion treatment can be performed by immersing the lyocell multifilament in a bath filled with binder and/or binder solution so that the lyocell multifilament can be completely submerged in the binder. Alternatively, the binder coating on the lyocell multifilament can be performed by spraying and/or atomizing the binder and/or binder solution through a nozzle.

[0231] The types and components of applicable binders are as previously described in the foregoing description, and thus will not be repeated here.

[0232] In some embodiments, the binder and/or binder solution may further include a solvent in addition to the aforementioned components. The solvent may include, for example, water, ethanol, propylene glycol, and/or glycerin, without being limited thereto. If the binder and/or binder solution contains a solvent, the solvent content may be, for instance, about 20 wt% to 80 wt%, or about 40 wt% to 60 wt%, based on 100 wt% of the entire binder and/or binder solution.

[0233] The binder treatment may be carried out to the extent necessary to achieve the objectives of the above-described binder treatment. For example, the binder treatment may be performed so that the binder content is 20 wt% or less, for instance, from 8 wt% to 15 wt%, based on 100 wt% of the lyocell multifilament that has been treated with the emulsion and the binder. Here, the content may refer to the dry weight remaining after any solvent or liquid component in the binder has evaporated.

[0234] Once the binder is coated onto the lyocell multifilament, the binder may be dried. Although the drying temperature is not particularly limited, the drying may be carried out at room temperature (about 10°C to 35°C), for example.

<(h) Other Processes>

[0235] After the crimp-imparting process, an appropriate post-treatment may be further performed.

[0236] In some embodiments, a second emulsion treatment (h1) may be further carried out. Through this second emulsion treatment, the tow may be given greater flexibility. The second emulsion treatment may be performed in the same way or in a manner analogous to the (e) emulsion treatment described above.

[0237] In particular, the second emulsion treatment may be conducted by applying an emulsion to the lyocell tow that has undergone a process by a crimper. This may facilitate various processes involved in manufacturing a smoking article filter. For example, the second emulsion treatment may help the fiber and filter spread easily in air during a spreading process, and may also limit fiber breakage in a stretching process.

[0238] The second emulsion treatment, if carried out, may take place either before or after the binder treatment. Alternatively, the second emulsion treatment may be performed regardless of whether there is a binder treatment.

[0239] Even if the second emulsion treatment is performed as described above, the content (OPU content) of the

emulsion in the material may be controlled so as to remain within the range described above.

[0240] In some embodiments, a drying treatment (h2) may be further performed. This drying may be carried out, for example, at a temperature in the range of 100 °C to 130 °C. The drying method or procedure is not particularly limited, and any known technique may be employed. For example, hot air may be applied to the tow, or the tow may be passed through or left in a room with controlled temperature for a certain time.

[0241] From one aspect, the present disclosure provides a lyocell material obtained by the above-described method of preparing a lyocell material.

[Smoking Article]

[0242] Although not particularly limited, the lyocell material prepared by the aforementioned 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, the lyocell material may be included in a combustible cigarette. As another example, the lyocell material can be included in a heat-not-burn cigarette, and the heat-not-burn cigarette can be used with an aerosol-generating device (not shown).

[0244] For example, when used as a heat-not-burn smoking article, the smoking article may be inserted separately into the aerosol-generating device. Here, the aerosol-generating device may include a receiving recess to accommodate the aerosol-generating article, and may further include a heater for heating the aerosol-generating article to produce an aerosol, a controller for overall operation of the aerosol-generating device, a battery for providing power for the aerosol-generating device's operation, and a sensor to detect that the aerosol-generating article has been inserted into the aerosol-generating device.

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

[0246] The tobacco medium part may include a tobacco material, and the tobacco material may include nicotine. Additionally, the tobacco medium part may further include an excipient.

[0247] The excipient may include a binder, a filler, and other additives. For example, a tobacco medium contained in the tobacco medium part may be produced in the form of granules, including a tobacco material, an excipient, and the like.

[0248] For example, to maintain a consistent shape, strength, and mass of the tobacco medium part, a filler may additionally be included. For example, the lyocell material may be included in the tobacco medium part. 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 part, a filter plug wrap enclosing the filter part, a tipping wrapper joining the tobacco medium part and the filter, and the like.

[Smoking Article Filter]

[0250] The lyocell material may be used in a smoking article filter. In some embodiments, the lyocell material may have a whiteness of 55 to 85. Preferably, the lower limit of the whiteness may be 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, or 70, and the upper limit of the whiteness may be 85, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75, 74, 73, 72, or 71.

[0251] In some embodiments, the whiteness of the lyocell material can be any of the following ranges: from 55 to 85, 55 to 84, 55 to 83, 55 to 82, 55 to 81, 55 to 80, 55 to 79, 55 to 78, 55 to 77, 55 to 76, 55 to 75, 55 to 74, 55 to 73, 55 to 72, or 55 to 71; from 56 to 85, 56 to 84, 56 to 83, 56 to 82, 56 to 81, 56 to 80, 56 to 79, 56 to 78, 56 to 77, 56 to 76, 56 to 75, 56 to 74, 56 to 73, 56 to 72, or 56 to 71; from 57 to 85, 57 to 84, 57 to 83, 57 to 82, 57 to 81, 57 to 80, 57 to 79, 57 to 78, 57 to 77, 57 to 76, 57 to 75, 57 to 74, 57 to 73, 57 to 72, or 57 to 71; from 58 to 85, 58 to 84, 58 to 83, 58 to 82, 58 to 81, 58 to 80, 58 to 79, 58 to 78, 58 to 77, 58 to 76, 58 to 75, 58 to 74, 58 to 73, 58 to 72, or 58 to 71; from 59 to 85, 59 to 84, 59 to 83, 59 to 82, 59 to 81, 59 to 80, 59 to 79, 59 to 78, 59 to 77, 59 to 76, 59 to 75, 59 to 74, 59 to 73, 59 to 72, or 59 to 71; from 60 to 85, 60 to 84, 60 to 83, 60 to 82, 60 to 81, 60 to 80, 60 to 79, 60 to 78, 60 to 77, 60 to 76, 60 to 75, 60 to 74, 60 to 73, 60 to 72, or 60 to 71; from 61 to 85, 61 to 84, 61 to 83, 61 to 82, 61 to 81, 61 to 80, 61 to 79, 61 to 78, 61 to 77, 61 to 76, 61 to 75, 61 to 74, 61 to 73, 61 to 72, or 61 to 71; from 62 to 85, 62 to 84, 62 to 83, 62 to 82, 62 to 81, 62 to 80, 62 to 79, 62 to 78, 62 to 77, 62 to 76, 62 to 75, 62 to 74, 62 to 73, 62 to 72, or 62 to 71; from 63 to 85, 63 to 84, 63 to 83, 63 to 82, 63 to 81, 63 to 80, 63 to 79, 63 to 78, 63 to 77, 63 to 76, 63 to 75, 63 to 74, 63 to 73, 63 to 72, or 63 to 71; from 64 to 85, 64 to 84, 64 to 83, 64 to 82, 64 to 81, 64 to 80, 64 to 79, 64 to 78, 64 to 77, 64 to 76, 64 to 75, 64 to 74, 64 to 73, 64 to 72, or 64 to 71; from 65 to 85, 65 to 84, 65 to 83, 65 to 82, 65 to 81, 65 to 80, 65 to 79, 65 to 78, 65 to 77, 65 to 76, 65 to 75, 65 to 74, 65 to 73, 65 to 72, or 65 to 71; from 66 to 85, 66 to 84, 66 to 83, 66 to 82, 66 to 81, 66 to 80, 66 to 79, 66 to 78, 66 to 77, 66 to 76, 66 to 75, 66 to 74, 66 to 73, 66 to 72, or 66 to 71; from 67 to 85, 67 to 84, 67 to 83, 67 to 82, 67 to 81, 67 to 80, 67 to 79, 67 to 78, 67 to 77, 67 to 76, 67 to 75, 67 to 74, 67 to 73, 67 to 72, or 67 to 71; from 68 to 85, 68 to 84, 68 to 83, 68 to 82, 68 to 81, 68 to 80, 68 to 79, 68 to 78, 68 to 77, 68 to 76, 68 to 75, 68 to 74, 68 to 73, 68 to 72, or 68 to 71; from 69 to

85, 69 to 84, 69 to 83, 69 to 82, 69 to 81, 69 to 80, 69 to 79, 69 to 78, 69 to 77, 69 to 76, 69 to 75, 69 to 74, 69 to 73, 69 to 72, or 69 to 71; from 70 to 85, 70 to 84, 70 to 83, 70 to 82, 70 to 81, 70 to 80, 70 to 79, 70 to 78, 70 to 77, 70 to 76, 70 to 75, 70 to 74, 70 to 73, 70 to 72, or 70 to 71. By satisfying the aforementioned whiteness range, the off-flavor and sensory properties of a smoking article filter including the lyocell material may be uniformly improved.

[0252] Additionally, whiteness may be a value measured from a fractured portion of the lyocell material. Fracturing of the lyocell material can be performed by mechanical means. The fractured portion of the lyocell material may be observed from the lyocell material with bare eyes and/or optical tools after the facturing of the lyocell material. For example, fracturing of the lyocell material can be carried out by cutting three samples of the lyocell material, each having a total fineness of 1,667 tex to 6,111 tex (15,000 denier to 55,000 denier), in a direction perpendicular to the longitudinal direction of the lyocell material and then overlapping them. The whiteness may be a value measured from the overlapped portion of the fractured surfaces.

[0253] In addition, the whiteness may be a value measured from an opened lyocell material. Specifically, the whiteness may be a value measured from the lyocell material contained in the smoking article filter. In particular, the whiteness may be a value measured from a fractured portion of the lyocell material contained in the smoking article filter.

[0254] Additionally, the brightness of the lyocell material, measured at a wavelength of 460 nm, may be 75 or more, and may be 90 or less. Preferably, the lower limit of the brightness may be 75, 76, 77, 78, 79, 80, or 81, and the upper limit of the brightness may be 90, 89, 88, 87, 86, 85, 84, 83, 82, 81, 80, 79, 78, 77, or 76.

[0255] In some embodiments, the brightness may be any of the following ranges: from 75 to 90, 75 to 89, 75 to 88, 75 to 87, 75 to 86, 75 to 85, 75 to 84, 75 to 83, 75 to 82, 75 to 81, 75 to 80, 75 to 79, 75 to 78, 75 to 77, or 75 to 76; from 76 to 90, 76 to 89, 76 to 88, 76 to 87, 76 to 86, 76 to 85, 76 to 84, 76 to 83, 76 to 82, 76 to 81, 76 to 80, 76 to 79, 76 to 78, or 76 to 77; from 77 to 90, 77 to 89, 77 to 88, 77 to 87, 77 to 86, 77 to 85, 77 to 84, 77 to 83, 77 to 82, 77 to 81, 77 to 80, 77 to 79, or 77 to 78; from 78 to 90, 78 to 89, 78 to 88, 78 to 87, 78 to 86, 78 to 85, 78 to 84, 78 to 83, 78 to 82, 78 to 81, 78 to 80, or 78 to 79; from 79 to 90, 79 to 89, 79 to 88, 79 to 87, 79 to 86, 79 to 85, 79 to 84, 79 to 83, 79 to 82, 79 to 81, or 79 to 80; from 80 to 90, 80 to 89, 80 to 88, 80 to 87, 80 to 86, 80 to 85, 80 to 84, 80 to 83, 80 to 82, or 80 to 81; from 81 to 90, 81 to 89, 81 to 88, 81 to 87, 81 to 86, 81 to 85, 81 to 84, or 81 to 83, or 81 to 82.

[0256] By satisfying the aforementioned brightness range, the off-flavor and sensory properties of a smoking article filter containing the lyocell material may be uniformly improved.

[0257] The brightness may also be a value measured from a fractured portion of the lyocell material. Details regarding the fractured portion are provided above.

[0258] Additionally, the brightness may be a value measured from opened lyocell material. In particular, the brightness may be a value measured from the lyocell material included in a smoking article filter. More particularly, the brightness may be a value measured from a fractured portion of the lyocell material included in a smoking article filter.

[0259] Meanwhile, the whiteness and brightness of the lyocell material may each be measured, independently of one another, using a CCM instrument. Without being particularly limited thereto, an X-Rite ColorEye 7000A Spectrophotometer may be used as the CCM instrument.

[0260] Further, the brightness may be measured with respect to a light source having a wavelength of 460 nm. The whiteness may be a value measured in accordance with CIE D65-10. The whiteness and the brightness may each independently be an average value.

[0261] Preferably, of the lyocell material according to some embodiments, the brightness may be at least 75 and the whiteness may be from 55 to 80; or the brightness may be at least 75 and the whiteness may be from 55 to 75; or the brightness may be at least 75 and the whiteness may be from 55 to 70; or the brightness may be at least 76 and the whiteness may be from 55 to 80; or the brightness may be at least 76 and the whiteness may be from 55 to 75; or the brightness may be at least 76 and the whiteness may be from 55 to 70; or the brightness may be at least 77 and the whiteness may be from 55 to 80; or the brightness may be at least 77 and the whiteness may be from 55 to 75; or the brightness may be at least 77 and the whiteness may be from 55 to 70; or the brightness may be at least 78 and the whiteness may be from 55 to 80; or the brightness may be at least 78 and the whiteness may be from 55 to 75; or the brightness may be at least 78 and the whiteness may be from 55 to 70; or the brightness may be at least 79 and the whiteness may be from 55 to 80; or the brightness may be at least 79 and the whiteness may be from 55 to 75; or the brightness may be at least 79 and the whiteness may be from 55 to 70; or the brightness may be at least 80 and the whiteness may be from 55 to 80; or the brightness may be at least 80 and the whiteness may be from 55 to 75; or the brightness may be at least 80 and the whiteness may be from 55 to 70.

[0262] When the lyocell material is processed to simultaneously enhance its brightness and whiteness, chemical and/or physical modifications may occur in the lyocell multifilament(s) and/or monofilament(s) contained in the lyocell material. In contrast, by satisfying both the brightness range and the whiteness range described above, it becomes possible to achieve a harmonious balance of minimizing chemical and/or physical modifications to the lyocell multifilament(s) and/or monofilament(s) included in the lyocell material while improving the use experience of the lyocell material.

[0263] Additionally, the lyocell material may further include hydrogen peroxide, wherein the concentration (i.e., the residual amount) of hydrogen peroxide may be 1,000 ppm or less and may be 50 ppm or more, relative to the total weight of

the lyocell material. The upper limit of the concentration may be 1,000 ppm, 950 ppm, 900 ppm, 850 ppm, 800 ppm, 750 ppm, 700 ppm, 650 ppm, 600 ppm, 550 ppm, 500 ppm, or 450 ppm, relative to the total weight of the lyocell material, and the lower limit of the concentration may be 50 ppm, 100 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm, or 350 ppm, relative to the total weight of the lyocell material. By satisfying the foregoing range for the hydrogen peroxide concentration in the lyocell material, the off-flavor and sensory properties of a smoking article filter that includes the lyocell material can be uniformly improved.

[0264] Meanwhile, the hydrogen peroxide concentration may be a value measured by redox titration. In particular, the hydrogen peroxide concentration may be measured according to Equation 1 below:

[Equation 1]

$$\text{Concentration (\% of Hydrogen Peroxide)} = 0.0017 \times V \times F \times D / S \times 100$$

[0265] In Equation 1, V represents the amount (ml) of 0.1 N potassium permanganate solution used for titration, F represents the normality factor of 0.1 N potassium permanganate solution, D represents the dilution ratio, which is 1, of hydrogen peroxide-containing solution extracted from the sample, and S represents the weight (g) of the sample.

[0266] Additionally, in some embodiments, the whiteness of the lyocell material may be from 55 to 85, the brightness of the lyocell material measured at a wavelength of 460 nm may be 75 or more, and the concentration of hydrogen peroxide contained in the lyocell material may be 1,000 ppm or less, relative to the total weight of the lyocell material.

[0267] In addition, the lyocell material may be a lyocell tow. In some embodiments, the lyocell tow may include a crimped lyocell multifilament.

[0268] For example, the present application relates to a smoking article filter. The smoking article filter may include a lyocell material, and this lyocell material may be the lyocell material as described above. In addition, the smoking article filter may include a lyocell tow, and this lyocell tow may be the lyocell tow as described above.

[0269] In addition, the lyocell material includes the emulsion in an amount of at least 0.1 wt% based on 100 wt% of the entire lyocell material. Other descriptions regarding the emulsion's components and content in embodiments of the present application are the same as those described above.

[0270] In some embodiments, the single-filament fineness of the filaments constituting the lyocell multifilament may be from 1.67 dtex to 8.89 dtex (1.5 denier to 8.0 denier). The specific numerical values are the same as those described above.

[0271] In some embodiments, the crimped lyocell multifilament may be a lyocell material having a total fineness of 1,667 tex to 6,111 tex (15,000 denier to 55,000 denier), and preferably may be a lyocell tow. The specific numerical values are the same as those described above.

[0272] In some embodiments, the crimped lyocell multifilament may have from 3.94 crimps per centimeter to 19.69 crimps per centimeter (10 crimps per inch to 50 crimps per inch). The specific numerical values are the same as those described above.

[0273] In some embodiments, the smoking article filter may further include a binder on the surface of the crimped lyocell multifilament or between the crimped lyocell multifilaments. The binder increases the hardness of the smoking article filter produced from the tow, preventing issues such as the filter getting jammed during the filter manufacturing process or the cigarette manufacturing process. Descriptions regarding the type, components, and content of the binder that can be used are the same as those described above.

[0274] In some embodiments, the smoking article filter may further include a plug wrap (which may be referred to as wrapping paper, filter paper, or filter plug wrap). For example, the plug wrap may be a porous or non-porous paper that wraps around the aforementioned lyocell tow and maintains the filter shape (e.g., cylinder or tube).

[0275] In some embodiments, the smoking article filter may have a predetermined shape and size.

[0276] For example, the filter may have a rod shape. For example, the smoking article filter may have a shape similar to a cylinder.

[0277] In addition, the filter may have a length of 10 mm to 50 mm, for example. For example, the length of the filter may have its 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 may have its 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.

[0278] In a specific example of the present disclosure, the filter having the aforementioned length may have a circular cross section, and the circumference of the circular cross section may be 10 mm to 40 mm. For example, the circumference of the filter may have its 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 may have its upper limit of 35 mm or less, 30 mm or less, 25 mm or less, 20 mm or less, or 15 mm or less.

[0279] In some embodiments, the smoking article filter may include lyocell tow and filter plug wrap. Descriptions of the lyocell tow and the filter plug wrap are the same as set forth above and are therefore omitted.

[0280] The plug wrap may enclose the aforementioned lyocell tow and may be porous or nonporous paper that

maintains the filter shape (e.g., cylindrical).

[0281] In some embodiments, when porous plug wrap is used, the plug wrap may have a porosity of 10 CU to 50,000 CU (Coresta Units). Coresta Unit may be defined as the volumetric flow rate ($\text{cm}^3 \cdot \text{min}^{-1}$) of air passing through a 1 cm^2 substrate sample (i.e., porous wrapping paper) under a 1 kPa pressure difference. Specifically, the porosity of the plug wrap may have a lower limit of, 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 45,000 CU or more, and may have an upper limit of, 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 a specific example of the present disclosure, the wrapping paper may have a porosity ranging from 22,000 CU to 26,000 CU, or from 23,000 CU to 25,000 CU.

[0282] In some embodiments, the basis weight of the wrapping paper may be 15 g/cm^2 to 60 g/cm^2 . Specifically, the lower limit of the basis weight of the plug wrap 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 of the basis weight of the wrapping paper 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 a specific example of the present disclosure, the plug wrap 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.

[0283] Although not particularly limited, the rod-shaped filter may have a weight of 50 mg or more. Specifically, 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 may have 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.

[0284] Descriptions of other filters for smoking articles or materials contained therein are the same as set forth above and are therefore omitted.

[Method of Manufacturing Smoking Article Filter]

[0285] For example, the present disclosure relates to a method of manufacturing a smoking article filter. This method is a method of manufacturing the above-described lyocell-based smoking article filter, and may be a method that includes the above-described method of preparing the lyocell material.

[0286] With respect to the method for manufacturing the smoking article filter, since the processes other than the actual filter-forming process are identical to those described above for the lyocell material, their description is omitted. Furthermore, any other descriptions that overlap with the above content are also omitted.

[0287] The process of manufacturing the filter can be suitably performed by those skilled in the art according to known methods.

[0288] For instance, the filter may be manufactured by forming a rod shape from plug wrap filled with the lyocell material. Alternatively, a filter may be manufactured by cutting to an appropriate length a filter paper filled with the lyocell material in the form of a rod. Details of the plug wrap are provided above.

[0289] Although not particularly limited, additional processes such as opening or plasticizer treatment may be performed on the lyocell material prior to filling the lyocell material into the filter paper. Opening the lyocell material may increase the surface area of the lyocell material. For example, opening of the lyocell material may be achieved by applying an external force in the longitudinal, width, and/or thickness directions of the lyocell material.

[0290] Preferably, the lyocell material used in the manufacture of the smoking article filter may be a lyocell tow.

[0291] Although not particularly limited, a known cellulose acetate multifilament may additionally be included in the smoking article filter, provided that it does not hinder the objectives of the present invention. The cellulose acetate multifilament may be mixed with the lyocell multifilament. The cellulose acetate multifilament may be included in a segment distinct from the segment containing the lyocell multifilament.

Advantageous Effects of the Invention

[0292] According to the present application, provided are a lyocell material for smoking article filters that can replace commercially available cellulose acetate (CA), and a smoking article filter including the lyocell material. In particular, according to some embodiments, the lyocell material satisfies a predetermined whiteness, a predetermined brightness, and/or a predetermined hydrogen peroxide content. As a result, a smoking article filter including the lyocell material may provide limited off-flavor, enhanced sensory properties, and improved user experience.

Best Mode for Carrying out Invention

[0293] The operation and effects of the invention will be described in detail through specific embodiments set forth

below. However, these embodiments are presented by way of example only and shall not be construed to limit the scope of the invention in any manner.

[0294] A lyocell material was prepared according to the process described in Manufacturing Example below. Unless otherwise specified, the conditions used were within the scope of the foregoing description.

[Manufacturing Example]

[0295] A spinning dope for producing tow with a concentration of 11 wt% was prepared by mixing a cellulose pulp (having a degree of polymerization (DPw) of 820 and an alpha-cellulose content of 93.9 %) into an NMMO/H₂O solvent containing 0.01 wt% propyl gallate. Then, while maintaining the spinning temperature at 110 °C at the spinning nozzle, the discharge amount and spinning speed were appropriately controlled, and the spinning dope was spun.

[0296] The filamentary spinning dope discharged from the spinning nozzle passed through an air-gap section and was supplied to a coagulation bath containing a coagulation liquid at about 15 °C, wherein this coagulation liquid had a composition of 75 wt% water and 25 wt% NMMO, based on 100 wt% of the total coagulation liquid. Here, in the air-gap section, cooling air at a temperature of 8 °C and an airflow rate of 120 Nm³/h primarily coagulated the spinning dope. In addition, the concentration of the coagulation liquid was continuously monitored using a sensor and a refractometer.

[0297] The coagulated lyocell filaments were then washed. In particular, the filaments were introduced onto a take-up roller, and residual NMMO in the filaments was removed by a washing solution sprayed in the washing device. Next, the washed filaments were immersed in a treatment bath containing a bleaching solution and an emulsion. At the top of the treatment bath, an upper roller was installed, and a lower roller was positioned so as to be immersed in the bleaching solution. The washed filaments were transported by the upper roller and the lower roller.

[0298] At the bath outlet, the filaments were treated under a pressure of 29.42 N/cm² (3 kgf/cm²) by a nip roll, and then introduced into a crimp machine to impart crimps. In particular, a pressure of 24.52 N/cm² (2.5 kgf/cm²) was applied by the press roller, and a pressure of 4.90 N/cm² (0.5 kgf/cm²) was applied by the doctor blade, to produce a tow.

[0299] A second emulsion treatment was performed on the produced tow for antistatic and flexibility purposes, and immediately thereafter, the tow was passed through a continuous dryer set to 120 °C, yielding the dried tow product.

[0300] The produced tow has a single-filament fineness of 2.78 dtex to 4.44 dtex (2.5 denier to 4.0 denier), a total fineness of 3,333 tex to 5,000 tex (30,000 denier to 45,000 denier), and a crimp count of 5.91 crimps/cm to 15.75 crimps/cm (15 crimps/inch to 40 crimps/inch).

[EXAMPLES]

Examples 1 to 7

[0301] A lyocell material was produced according to Manufacturing Example, wherein the conditions of the bleaching process were as shown in Table 1 below. The lyocell materials of Examples 1 to 7 were confirmed to have widths ranging from 30 mm to 34 mm. Furthermore, it was confirmed that crimp was imparted uniformly, and no edge breakage was observed in the crimp-imparting process.

Comparative Example 1

[0302] Except that the bleaching process was omitted, a lyocell material was produced according to Manufacturing Example. The lyocell material of Comparative Example 1 was confirmed to have a width of 24 mm. However, it was found that uniform crimp formation was limited in the crimp-imparting process.

Comparative Examples 2 to 4

[0303] A lyocell material was produced according to Manufacturing Example, and the conditions of the bleaching process were as shown in Table 1 below. Each of the lyocell materials of Comparative Examples 2 to 4 was confirmed to have a width of about 30 mm, wherein crimp was imparted relatively uniformly.

[Table 1]

		Conditions of the bleaching process				
		Depth of lower roller (mm)	Immersion time per lower roller (s)	Number of lower rollers	Total immersion time (s)	Temperature of bleaching solution (°C)
Example	1	150	0.14	2	0.28	60
	2	300	0.27	2	0.54	60
	3	150	0.14	4	0.54	60
	4	300	0.27	4	1.08	60
	5	150	0.14	4	0.54	100
	6	150	0.14	4	0.54	40
	7	150	0.14	8	1.08	60
Comparative Example	1	0	0.00	0	0.00	-
	2	150	0.14	1	0.14	60
	3	150	0.14	4	0.54	20
	4	150	0.14	4	0.54	120

[Evaluation Example]**<Experiment 1: Evaluation of the Characteristics of Lyocell Material>**

[0304] Smoking article filters, each including the lyocell material prepared in Examples 1 to 7, Comparative Example 1, and Comparative Examples 3 to 5, and the lyocell material from Comparative Example 2 were prepared.

[0305] To evaluate the whiteness and brightness of the lyocell material, each smoking article filter was cut, and the lyocell material was fractured. The cross-section at the fractured portion was measured using a CCM device (ColorEye 7000A Spectrophotometer from X-Rite). Brightness was measured with respect to a light source at a wavelength of 460 nm, and whiteness was measured according to CIE D65-10. Each measurement was repeated three times. The average values of the measured whiteness and brightness for each lyocell material are shown in Table 2 below.

[0306] Additionally, to evaluate the residual amount of hydrogen peroxide present in the lyocell material, each smoking article filter was left under constant temperature and humidity conditions for 24 hours. Thereafter, relative to the weight of the lyocell material within the filter, the lyocell material was immersed in ultrapure water at 10 wt% concentration, and the lyocell material was subjected to ultrasonic treatment for 30 minutes. Next, instead of adding 10 ml of the ultrapure water, 10 ml of distilled water and 2 ml of 6 N H₂SO₄ were added to the lyocell material to prepare a sample for titration.

[0307] The residual amount of hydrogen peroxide present in the sample was titrated using 0.1 N KMnO₄ and a Metrohm 665 Dosimat titrator. The residual amount of hydrogen peroxide was measured in accordance with Equation 1 below. The measured results are shown in Table 2.

[Equation 1]

$$\text{Concentration (\%)} \text{ of Hydrogen Peroxide} = 0.0017 \times V \times F \times D / S \times 100$$

[0308] In Equation 1, V represents the amount (ml) of 0.1 N potassium permanganate solution used for titration, F represents the normality factor of 0.1 N potassium permanganate solution, D represents the dilution ratio (1) of hydrogen peroxide-containing solution extracted from the sample, and S represents the weight (g) of the sample.

[Table 2]

		Characteristics of the lyocell material		
		Brightness (@460nm)	Whiteness	Residual amount of H ₂ O ₂
Example	1	79.2	59.3	81
	2	83.7	72.5	298
	3	83.9	73.4	315
	4	84.2	74.2	495
	5	86.1	80.5	545
	6	80.2	67.5	184
	7	86.6	82.1	678
Comparative Example	1	71.4	49.8	0
	2	72.2	51.2	45
	3	72.7	52.7	42
	4	89.2	90.3	1589

[0309] Referring to Table 2, the lyocell materials of Comparative Examples 1 to 3 were found to exhibit insufficient brightness and whiteness, and the lyocell material of Comparative Example 4 was found to contain an excessive residual amount of H₂O₂.

<Experiment 2: Sensory Evaluation of Smoking Article Filters>

[0310] Smoking articles were respectively prepared by using smoking article filters that each include the lyocell material produced in Examples 1 to 7 and Comparative Examples 1 to 4. A consumer evaluation was conducted for each smoking article. Sensory evaluation was performed through a home usage test with 100 randomly selected consumers.

[0311] The sensory evaluation was carried out on two items, off-flavor and satisfaction, using a seven-point scale. Participants were instructed to assess overall satisfaction in the satisfaction item. A smoking article (commercial product) including cellulose acetate tow was prepared as a control group, and the relative values (mean, %) of each Example and Comparative Example were calculated based on the control group. The evaluation results are shown in Table 3 below.

[Table 3]

		Sensory Evaluation of Smoking Article Filter (%)	
		Off-flavor	Satisfaction
Example	1	99.4	91.2
	2	97.1	96.3
	3	99.4	96.7
	4	99.1	96.3
	5	99.2	96.1
	6	99.3	92.1
	7	99.4	92.9
Comparative Example	1	101.2	51.2
	2	98.6	77.3
	3	99.4	68.7
	4	65.7	62.0

[0312] Referring to Table 3, Examples 1 to 7 were reported to provide improved off-flavor compared to the control group, whereas Comparative Example 1 was reported to provide worse off-flavor compared to the control group. Furthermore,

Examples 1 to 7 were all reported to provide satisfaction levels comparable to the control group. In contrast, Comparative Example 1 and Comparative Examples 2 to 4 were all reported to provide significantly lower satisfaction levels than the control group.

Claims

1. A lyocell material, comprising a crimped lyocell multifilament and having a whiteness of 55 to 85.
2. The lyocell material of claim 1, wherein the whiteness is a value measured from a fractured portion of the lyocell material.
3. The lyocell material of claim 1, wherein the lyocell material has a brightness of at least 75 as measured at a wavelength of 460 nm, and optionally the brightness is a value measured from a fractured portion of the lyocell material.
4. The lyocell material of claim 1, further comprising hydrogen peroxide, wherein a concentration of the hydrogen peroxide is 1,000 ppm or less, and optionally, the concentration of the hydrogen peroxide is 250 ppm to 700 ppm.
5. The lyocell material of claim 1, further comprising hydrogen peroxide, wherein the lyocell material has a brightness of at least 75 as measured at a wavelength of 460 nm, the hydrogen peroxide is present at a concentration of 1,000 ppm or less, and/or the crimped lyocell multifilament has 10 crimps/inch to 50 crimps/inch.
6. The lyocell material of claim 1, wherein the lyocell multifilament has a single-filament fineness of 1.5 denier to 8.0 denier, and/or a total fineness of 15,000 denier to 55,000 denier.
7. The lyocell material of claim 1, wherein the lyocell material is a lyocell tow.
8. The lyocell material of claim 1, wherein the lyocell material is for use in a smoking article filter.
9. A smoking article filter, comprising a lyocell material having a whiteness of 55 to 85.
10. The smoking article filter of claim 9, wherein the lyocell material has a brightness of at least 75 as measured at a wavelength of 460 nm.
11. The smoking article filter of claim 9, wherein the lyocell material further comprises hydrogen peroxide, wherein a concentration of the hydrogen peroxide is 1,000 ppm or less, and/or the concentration of the hydrogen peroxide is 250 ppm to 700 ppm.
12. A smoking article, comprising the smoking article filter of any one of claims 9 to 11.
13. A method of preparing a lyocell material, the method comprising:
 - spinning a lyocell dope;
 - coagulating to obtain a lyocell multifilament;
 - washing;
 - bleaching; and
 - imparting crimp,
 - wherein during the bleaching, transport of the lyocell multifilament is performed by at least one upper roller and at least one lower roller.
14. The method of claim 13, wherein during the bleaching, the lyocell multifilament is immersed in a bleaching solution at least twice.

- 15.** The method of claim 13,
wherein an immersion time per lower roller is less than 0.54 seconds.

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EUROPEAN SEARCH REPORT

Application Number

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