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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 filter for a smoking article, including the lyocell material, and a smoking article. The lyocell material and

the filter for a smoking article, according to the present application, may replace cellulose acetate materials and filters in the art.

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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 a method of preparing the lyocell material.

Background Art

- 10 **[0002]** Until now, cellulose acetate fibers have been mainly used as tobacco filter materials. Cellulose acetate is known to be a biodegradable material, but filters for a smoking article made of cellulose acetate remain in their original form for 1 to 2 years even after being buried in soil, and a considerable amount of time is required until the filters are completely biodegraded. Considering the amount and toxicity of tobacco products that are discarded and left in the living environment as well as tobacco products that are recovered as waste and landfilled after being used for smoking, there is a need to
- 15 further improve the biodegradability of filters for a smoking article. Accordingly, lyocells, which are more environmentally friendly, are recently being chosen as materials for replacing cellulose acetate.

Disclosure of Invention

20 Technical Problem

[0003] An object of the present application is to provide a lyocell material capable of replacing cellulose acetate commercialized for a filter for a smoking article.

- 25 **[0004]** Another object of the present application is to provide a lyocell material for a filter for a smoking article, of which a preparation process is environmentally friendly and which has excellent biodegradability when discarded.

[0005] Another object of the present application is to provide a lyocell filter for a smoking article.

[0006] Another object of the present application is to provide a smoking article (for example, a tobacco) including a lyocell filter.

30 Solution to Problem

[0007] According to an example of the present application, there may be provided a lyocell material, a filter including the same, a smoking article, and the like.

- 35 **[0008]** Specifically, there may be provided a lyocell material including a first lyocell multifilament, and a second lyocell multifilament, wherein the first lyocell multifilament includes a first monofilament having a first single fineness, and the second lyocell multifilament includes a second monofilament having a second single fineness, wherein the first single fineness is different from the second single fineness.

- 40 **[0009]** In addition, there may be provided a filter for a smoking article, which includes a lyocell material including a first lyocell multifilament, and a second lyocell multifilament, wherein the first lyocell multifilament includes a first monofilament having a first single fineness, and the second lyocell multifilament includes a second monofilament having a second single fineness, wherein the first single fineness is different from the second single fineness.

[0010] According to another specific example of the present application, there may be provided a smoking article including the lyocell material or the filter.

- 45 **[0011]** According to another specific example of the present application, there may be provided a method of preparing the lyocell material.

[0012] As used herein, the term "smoking article" may refer to an article such as a tobacco (cigarette) or a cigar capable of generating aerosol. In this regard, the smoking article may include an aerosol-generating material or an aerosol-forming substrate. In addition, the smoking article may include a solid material based on a tobacco raw material such as a tobacco leaf, a cut tobacco, or a reconstituted tobacco. In addition, the smoking material may include a volatile compound.

- 50 **[0013]** Unless specifically defined otherwise in the specification, when the properties of lyocell materials, filters for a smoking article, and components or compositions related thereto are affected by a temperature, the temperature at which the properties are confirmed or measured may be room temperature. In this case, the room temperature may be a temperature which is not particularly lowered or raised and may be, for example, in a range of about 10 °C to about 35 °C, specifically in a range of about 15 °C to about 35 °C or about 20 °C to about 30 °C, or about 25 °C.

- 55 **[0014]** In this specification, the term "different" may mean that one is qualitatively different from another. For example, "A and B are different" means that an amount of A and an amount of B are the same, but A and B are qualitatively distinguished from each other or also mean that A and B are quantitatively different and are qualitatively distinguished from each other. The term "qualitative characteristics" may refer to non-quantitative characteristics. For example, "qualitative" differences

may include differences in color, shape, texture, structure, and composition.

[0015] As used herein, the term "crimp" may refer to a weaved, curled, or undulated configuration imparted to materials such as a fiber, a (mono)filament, a multifilament, and/or yarn inherently or through mechanical, thermal, and/or chemical processes. The crimp may be characterized by a periodic deviation from a straight line axis along a length of a material, a fiber, a filament, a multifilament, and/or yarn. In the material, in the fiber, the filament, the multifilament, and/or the yarn, one crimp may be defined as one repeating unit of the periodic deviation. The presence of the crimp affects properties such as elasticity, bulk, resilience, and texture of a material and a fabric made of the material.

[0016] As used herein, the term "degree of polymerization (DPw)" may refer to the number of monomer units and/or repeating units in a macromolecule, a polymer, or an oligomer molecule. A degree of polymerization may be expressed as M_n/M_0 , wherein M_n is a number average molecular weight of a macromolecule, a polymer, or an oligomer molecule, and M_0 is a molecular weight of a monomer or a repeating unit.

[0017] Hereinafter, the disclosure is described in more detail.

[0018] The present application relates to a lyocell material. The lyocell material may be used in a smoking article, and although not particularly limited, the lyocell material may be used in a filter for a smoking article.

[0019] According to an aspect, there may be provided a lyocell material including a first lyocell multifilament, and a second lyocell multifilament, wherein the first lyocell multifilament includes a first monofilament having a first single fineness, and the second lyocell multifilament includes a second monofilament having a second single fineness, wherein the first single fineness is different from the second single fineness. The term "first single fineness" may also refer to "fineness per first monofilament" and/or "first monofilament fineness." The term "second single fineness" may also refer to "fineness per second monofilament" and/or "second monofilament fineness."

[0020] In some embodiments, at least one of the first lyocell multifilament and the second lyocell multifilament may be crimped.

[0021] In some embodiments, the first lyocell multifilament and the second lyocell multifilament may each be crimped.

[0022] In some embodiments, the first lyocell multifilament and the second lyocell multifilament may each independently have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch).

[0023] In some embodiments, a cross section of the first monofilament and a cross section of the second monofilament may each independently be a multi-lobal cross section. Alternatively or additionally, the first monofilament may include at least one cross section, and/or the second monofilament may include at least one cross section.

[0024] In some embodiments, the multi-lobal cross section may include three or more protrusions, for example, three protrusions. Here, the term "protrusion" may refer to a distinct and extended segment or arm extending outward from a central core or junction point of a monofilament cross section. A multi-lobal cross section including three protrusions may be referred to as a "Y-shaped cross section."

[0025] In some embodiments, at least one cross section of the first monofilament and at least one cross section of the second monofilament may be similar to each other. Alternatively or additionally, the cross section of the first monofilament and the cross section of the second monofilament may be similar to each other. The term "similar to each other" may mean that (at least one) cross section of the first monofilament and (at least one) cross section of the second monofilament have substantially a similar shape and/or have substantially the similar shape.

[0026] In some embodiments, space occupancy ratios of the first monofilament and the second monofilament may each independently be in a range of about 120 % to about 600 %.

[0027] In some embodiments, the first single fineness may be greater than or equal to the second single fineness. For example, the first single fineness may be greater than the second single fineness.

[0028] In some embodiments, the first single fineness may be in a range of about 2.22 dtex to about 8.89 dtex (about 2.0 denier to about 8.0 denier).

[0029] In some embodiments, the second single fineness may be in a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier).

[0030] In some embodiments, a difference between the first single fineness and the second single fineness may be in a range of about 0.22 dtex to about 7.22 dtex (about 0.2 denier to about 6.5 denier). In addition, the difference between the first single fineness and the second single fineness may be in a range of about 0.44 dtex to about 1.11 dtex (about 0.4 denier to about 1.0 denier).

[0031] In some embodiments, the first lyocell multifilament and the second lyocell multifilament may be co-spun.

[0032] In some embodiments, the lyocell material may have a total fineness of about 1,667 tex to about 6,111 tex (about 15,000 denier to about 55,000 denier).

[0033] In some embodiments, the first lyocell multifilament may be included in a content of about 1 part by weight to about 99 parts by weight with respect to 100 parts by weight of the total weight of the first lyocell multifilament and the second lyocell multifilament.

[0034] In some embodiments, the second lyocell multifilament may be included in a content of about 1 part by weight to about 99 parts by weight with respect to 100 parts by weight of the total weight of the first lyocell multifilament and the second lyocell multifilament.

[0035] In some embodiments, the second lyocell multifilament may be included in a content of about 1 part by weight to about 10,000 parts by weight with respect to 100 parts by weight of the first lyocell multifilament.

[0036] In some embodiments, the lyocell material may be lyocell tow.

[0037] In some embodiments, the lyocell material may be used for a filter for a smoking article.

[0038] In an aspect, there may be provided a filter for a smoking article including any one selected from exemplary lyocell materials.

[0039] In an aspect, there may be provided a smoking article including any one selected from exemplary lyocell materials.

[0040] In an aspect, there may be provided a smoking article including any one selected from exemplary smoking article filters.

[0041] In an aspect, there may be provided a method of preparing a lyocell material, the method including spinning a lyocell dope, and performing coagulation and obtaining a multifilament.

[0042] In some embodiments, in the method of preparing a lyocell material, the spinning of the lyocell dope may include spinning a first lyocell multifilament including a first monofilament and spinning a second lyocell multifilament including a second monofilament, wherein a first single fineness of the first monofilament is different from a second single fineness of the second monofilament.

[0043] In some embodiments, the first lyocell multifilament and the second lyocell multifilament may be spun by using the same lyocell dope or different lyocell dopes.

[0044] In some embodiments, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be sequentially or simultaneously performed.

[0045] In some embodiments, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be performed through the same spinneret or different spinnerets.

[0046] In some embodiments, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be performed simultaneously through the same spinneret.

[0047] In some embodiments, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be performed through the same spinneret, and a cross sectional area of a discharge port (also referred to as a first discharge port) through which the first lyocell multifilament is discharged may be different from a cross sectional area of a discharge port (also referred to as a second discharge port) through which the second lyocell multifilament is discharged.

[0048] In some embodiments, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be sequentially performed, and the first lyocell multifilament and the second lyocell multifilament may be coagulated and obtained in the same coagulation tank.

[0049] A lyocell material according to an embodiment may include a first lyocell multifilament including a first monofilament and a second lyocell multifilament including a second monofilament, wherein a first single fineness of the first monofilament is different from a second single fineness of the second monofilament. Therefore, the lyocell material according to an embodiment may include at least two types of monofilaments having different cross sectional areas.

[0050] As a result, the lyocell material according to an embodiment may uniformly have the properties by the first monofilament having the first single fineness and the properties by the second monofilament having the second single fineness. In addition, shapes of the first single fineness and the second single fineness may each be controlled, thereby more finely adjusting the physical properties of the lyocell material including the first multifilament and the second multifilament.

[0051] Specifically, when the first single fineness is greater than the second single fineness, a range of an implementable filter weight and a range of implementable draw resistance may be greater than those of a lyocell material including only one type of monofilament.

[0052] In addition, the first single fineness may be greater than the second single fineness. Since the first single fineness has a larger value than the second single fineness, the second monofilament may be positioned in an empty space between the first monofilaments, and a surface area per unit weight of the lyocell material including the first lyocell multifilament and the second lyocell multifilament may be further increased.

[0053] As a result, the lyocell material according to an embodiment may be used for both the preparation of a filter for a smoking article having a lower weight and the preparation of a filter for a smoking article having a higher weight as compared to lyocell materials of a related art. Similarly, the lyocell material according to an embodiment may be used to implement lower draw resistance and higher draw resistance as compared to the lyocell materials of the related art.

[0054] Therefore, the lyocell material according to an embodiment may provide a wider range of choices to consumers and manufacturers of smoking articles in terms of diversification and optimization of filters for a smoking article.

[Multi-lobal cross section]

[0055] Both the first monofilament and the second monofilament included in the lyocell material of the present

application may have a multi-lobal cross section. The term "multi-lobal" may mean that a shape of an outline of a cross section is not circular, and the term "cross section" may be a cross section obtained by cutting a lyocell monofilament in a direction virtually or actually perpendicular to a longitudinal direction of a filament.

[0056] The outline of the multi-lobal cross section may touch each of a virtual first circle (circumscribed circle) and a virtual second circle (inscribed circle). In addition, the virtual second circle may be depicted inside the virtual first circle, and/or the virtual second circle may be placed inside the virtual first circle. The "virtual first circle" may also be referred to as a "virtual circumscribed circle" and/or a "circumscribed circle," and/or the "virtual second circle" may also be referred to as a "virtual inscribed circle" and/or a "inscribed circle."

[0057] The multi-lobal cross section may have a shape including a plurality of protrusions and may be, for example, a Y-shaped cross section including three protrusions. It may be understood that the plurality of protrusions are formed as an integral type with the virtual second circle as a central portion and have a shape of which an end touches the virtual first circle.

[0058] A modified ratio of a monofilament may be defined by Equation 1 below.

Equation 1

$$\text{modified ratio} = r1/r2$$

[0059] Here, r1 is a radius of the virtual first circle, and r2 is a radius of the virtual second circle.

[0060] For example, the radius of the virtual first circle may be in a range of about 4 μm to about 40 μm , the radius of the virtual second circle may be in a range of about 2 μm to about 14 μm , and the modified ratio may be in a range of about 1.01 to about 10.

[0061] In addition, a space occupancy ratio of a monofilament may be defined by Equation 2.

Equation 2

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

[0062] Here, S1 is an area of the virtual first circle, and S2 is a cross sectional area of the monofilament included the lyocell fiber.

[0063] For example, a space occupancy ratio of a monofilament having a multi-lobal cross section may be in a range of about 120 % to about 600 %.

[0064] In an embodiment, a cross section of the first monofilament and a cross section of the second monofilament may each independently be a multi-lobal cross section. Specifically, the cross section of the first monofilament and the cross section of the second monofilament may each independently include three or more protrusions. For example, both the cross section of the first monofilament and the cross section of the second monofilament may include three protrusions. For example, at least one cross section of the first monofilament and at least one cross section of the second monofilament may be similar to each other, and/or the cross section of the first monofilament and the cross section of the second monofilament may be similar to each other.

[0065] In addition, space occupancy ratios of the first monofilament and the second monofilament may each independently be in a range of about 120 % to about 600 %, about 150 % to about 550 %, about 180 % to about 500 %, about 200 % to about 450 %, about 250 % to 400 %, or about 300 % to 350 %.

[Fineness]

[0066] A lyocell material of the present application may include a first lyocell multifilament, and a second lyocell multifilament, wherein the first lyocell multifilament includes a first monofilament having a first single fineness, and the second lyocell multifilament includes a second monofilament having a second single fineness, wherein the first single fineness is different from the second single fineness. In this case, the first single fineness and the second single fineness may each refer to a fineness of a single monofilament separated from the first lyocell multifilament or the second lyocell multifilament.

[0067] Since the first single fineness is different from the second single fineness, physical properties determined by the first single fineness (for example, the mechanical properties of the first monofilament) and physical properties determined by the second single fineness (for example, the mechanical properties of the second monofilament) may be exhibited and shown.

[0068] In an exemplary lyocell material, the first single fineness may be in a range of about 2.22 dtex to about 8.89 dtex

(about 2.0 denier to about 8.0 denier). An upper limit of the first single fineness may be 8.89 dtex (8.0 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the first single fineness may be 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the first monofilament may be stably provided.

[0069] In an exemplary lyocell material, the first single fineness may be in a range of about 2.22 dtex to about 8.89 dtex (about 2.0 denier to about 8.0 denier), about 2.78 dtex to about 8.89 dtex (about 2.5 denier to about 8.0 denier), about 3.33 dtex to about 8.89 dtex (about 3.0 denier to about 8.0 denier), about 3.89 dtex to about 8.89 dtex (about 3.5 denier to about 8.0 denier), about 4.44 dtex to about 8.89 dtex (about 4.0 denier to about 8.0 denier), about 5.00 dtex to about 8.89 dtex (about 4.5 denier to about 8.0 denier), about 5.56 dtex to about 8.89 dtex (about 5.0 denier to about 8.0 denier), about 6.11 dtex to about 8.89 dtex (about 5.5 denier to about 8.0 denier), about 6.67 dtex to about 8.89 dtex (about 6.0 denier to about 8.0 denier), about 7.22 dtex to about 8.89 dtex (about 6.5 denier to about 8.0 denier), about 7.78 dtex to about 8.89 dtex (about 7.0 denier to about 8.0 denier), about 8.33 dtex to about 8.89 dtex (about 7.5 denier to about 8.0 denier), about 2.22 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[0070] According to some embodiments, the second single fineness may be in a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier). An upper limit of the second single fineness may be 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the second single fineness may be 1.67 dtex (1.5 denier) or more, 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the second monofilament may be stably provided.

[0071] In an exemplary lyocell material, the second single fineness may be in a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier), about 2.22 dtex to about 6.67 dtex (about 2.0 denier to about 6.0 denier), about 2.78 dtex to about 6.67 dtex (about 2.5 denier to about 6.0 denier), about 3.33 dtex to about 6.67 dtex (about 3.0 denier to about 6.0 denier), about 3.89 dtex to about 6.67 dtex (about 3.5 denier to about 6.0 denier), about 4.44 dtex to about 6.67 dtex (about 4.0 denier to about 6.0 denier), about 5.00 dtex to about 6.67 dtex (about 4.5 denier to about 6.0 denier), about 5.56 dtex to about 6.67 dtex (about 5.0 denier to about 6.0 denier), about 6.11 dtex to about 6.67 dtex (about 5.5 denier to about 6.0 denier), about 1.67 dtex to about 6.11 dtex (about 1.5 denier to about 5.5 denier), about 2.22 dtex to about 6.11 dtex (about 2.0 denier to about 5.5 denier), about 2.78 dtex to about 6.11 dtex (about 2.5 denier to about 5.5 denier), about 3.33 dtex to about 6.11 dtex (about 3.0 denier to about 5.5 denier), about 3.89 dtex to about 6.11 dtex (about 3.5 denier to about 5.5 denier), about 4.44 dtex to about 6.11 dtex (about 4.0 denier to about 5.5 denier), about 5.00 dtex to about 6.11 dtex (about 4.5 denier to about 5.5 denier), about 5.56 dtex to about 6.11 dtex (about 5.0 denier to about 5.5 denier), about 1.67 dtex to about 5.56 dtex (about 1.5 denier to about 5.0 denier), about 2.22 dtex to about 5.56 dtex (about 2.0 denier to about 5.0 denier), about 2.78 dtex to about 5.56 dtex (about 2.5 denier to about 5.0 denier), about 3.33 dtex to about 5.56 dtex (about 3.0 denier to about 5.0 denier), about 3.89 dtex to about 5.56 dtex (about 3.5 denier to about 5.0 denier), about 4.44 dtex to about 5.56 dtex (about 4.0 denier to about 5.0 denier), about 5.00 dtex to about 5.56 dtex (about 4.5 denier to about 5.0 denier), about 1.67 dtex to about 5.00 dtex (about 1.5 denier to about 4.5 denier), about 2.22 dtex to about 5.00 dtex (about 2.0 denier to about 4.5 denier), about 2.78 dtex to about 5.00 dtex (about 2.5 denier to about 4.5 denier), about 3.33 dtex to about 5.00 dtex (about 3.0 denier to about 4.5 denier), about 3.89 dtex to about 5.00 dtex (about 3.5 denier to about 4.5 denier), about 4.44 dtex to about 5.00 dtex (about 4.0 denier to about 4.5 denier), about 1.67 dtex to about 4.44 dtex (about 1.5 denier to about 4.0 denier), about 2.22 dtex to about 4.44 dtex (about 2.0 denier to about 4.0 denier), about 2.78 dtex to about 4.44 dtex (about 2.5 denier to about 4.0 denier), about 3.33 dtex to about 4.44 dtex (about 3.0 denier to about 4.0 denier), about 3.89 dtex to about 4.44 dtex (about 3.5 denier to about 4.0 denier), about 1.67 dtex to about 3.89 dtex (about 1.5 denier to about 3.5 denier), about 2.22 dtex to about 3.89 dtex (about 2.0 denier to about 3.5 denier), about 2.78 dtex to about 3.89 dtex (about 2.5 denier to about 3.5 denier), about 3.33 dtex to about 3.89 dtex (about 3.0 denier to about 3.5 denier), about 1.67 dtex to about 3.33 dtex (about 1.5 denier to about 3.0 denier), about 2.22 dtex to about 3.33 dtex (about 2.0 denier to about 3.0 denier), about 2.78 dtex to about 3.33 dtex (about 2.5 denier to about 3.0 denier), about 1.67 dtex to about 2.78 dtex (about 1.5 denier to about 2.5 denier), about 2.22 dtex to about 2.78 dtex (about 2.0 denier to about 2.5 denier), or about 1.67 dtex to about 2.22 dtex (about 1.5 denier to about 2.0 denier).

[0072] In an exemplary lyocell material, a difference between the first single fineness and the second single fineness may be in a range of about 0.22 dtex to about 7.22 dtex (about 0.2 denier to about 6.5 denier). Specifically, the difference between the first single fineness and the second single fineness may be in a range of about 0.56 dtex to about 7.22 dtex (about 0.5 to about 6.5 denier), about 1.11 dtex to about 7.22 dtex (about 1.0 denier to about 6.5 denier), about 1.67 dtex to about 7.22 dtex (about 1.5 denier to about 6.5 denier), about 2.22 dtex to about 7.22 dtex (about 2.0 denier to about 6.5 denier), about 2.78 dtex to about 7.22 dtex (about 2.5 denier to about 6.5 denier), about 3.33 dtex to about 7.22 dtex (about 3.0 denier to about 6.5 denier), about 3.89 dtex to about 7.22 dtex (about 3.5 denier to about 6.5 denier), about 4.44 dtex to about 7.22 dtex (about 4.0 denier to about 6.5 denier), about 5.00 dtex to about 7.22 dtex (about 4.5 denier to about 6.5 denier), about 5.56 dtex to about 7.22 dtex (about 5.0 denier to about 6.5 denier), about 6.11 dtex to about 7.22 dtex (about 5.5 denier to about 6.5 denier), about 6.67 dtex to about 7.22 dtex (about 6.0 denier to about 6.5 denier), about 0.56 dtex to about 6.67 dtex (about 0.5 denier to about 6.0 denier), about 1.11 dtex to about 6.67 dtex (about 1.0 denier to about 6.0 denier), about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier), about 2.22 dtex to about 6.67 dtex (about 2.0 denier to about 6.0 denier), about 2.78 dtex to about 6.67 dtex (about 2.5 denier to about 6.0 denier), about 3.33 dtex to about 6.67 dtex (about 3.0 denier to about 6.0 denier), about 3.89 dtex to about 6.67 dtex (about 3.5 denier to about 6.0 denier), about 4.44 dtex to about 6.67 dtex (about 4.0 denier to about 6.0 denier), about 5.00 dtex to about 6.67 dtex (about 4.5 denier to about 6.0 denier), about 5.56 dtex to about 6.67 dtex (about 5.0 denier to about 6.0 denier), about 6.11 dtex to about 6.67 dtex (about 5.5 denier to about 6.0 denier), about 0.56 dtex to about 6.11 dtex (about 0.5 denier to about 5.5 denier), about 1.11 dtex to about 6.11 dtex (about 1.0 denier to about 5.5 denier), about 1.67 dtex to about 6.11 dtex (about 1.5 denier to about 5.5 denier), about 2.22 dtex to about 6.11 dtex (about 2.0 denier to about 5.5 denier), about 2.78 dtex to about 6.11 dtex (about 2.5 denier to about 5.5 denier), about 3.33 dtex to about 6.11 dtex (about 3.0 denier to about 5.5 denier), about 3.89 dtex to about 6.11 dtex (about 3.5 denier to about 5.5 denier), about 4.44 dtex to about 6.11 dtex (about 4.0 denier to about 5.5 denier), about 5.00 dtex to about 6.11 dtex (about 4.5 denier to about 5.5 denier), about 5.56 dtex to about 6.11 dtex (about 5.0 denier to about 5.5 denier), about 0.56 dtex to about 5.56 dtex (about 0.5 denier to about 5.0

denier), about 1.11 dtex to about 5.56 dtex (about 1.0 denier to about 5.0 denier), about 1.67 dtex to about 5.56 dtex (about 1.5 denier to about 5.0 denier), about 2.22 dtex to about 5.56 dtex (about 2.0 denier to about 5.0 denier), about 2.78 dtex to about 5.56 dtex (about 2.5 denier to about 5.0 denier), about 3.33 dtex to about 5.56 dtex (about 3.0 denier to about 5.0 denier), about 3.89 dtex to about 5.56 dtex (about 3.5 denier to about 5.0 denier), about 4.44 dtex to about 5.56 dtex (about 4.0 denier to about 5.0 denier), about 5.00 dtex to about 5.56 dtex (about 4.5 denier to about 5.0 denier), about 0.56 dtex to about 5.00 dtex (about 0.5 denier to about 4.5 denier), about 1.11 dtex to about 5.00 dtex (about 1.0 denier to about 4.5 denier), about 1.67 dtex to about 5.00 dtex (about 1.5 denier to about 4.5 denier), about 2.22 dtex to about 5.00 dtex (about 2.0 denier to about 4.5 denier), about 2.78 dtex to about 5.00 dtex (about 2.5 denier to about 4.5 denier), about 3.33 dtex to about 5.00 dtex (about 3.0 denier to about 4.5 denier), about 3.89 dtex to about 5.00 dtex (about 3.5 denier to about 4.5 denier), about 4.44 dtex to about 5.00 dtex (about 4.0 denier to about 4.5 denier), about 0.56 dtex to about 4.44 dtex (about 0.5 denier to about 4.0 denier), about 1.11 dtex to about 4.44 dtex (about 1.0 denier to about 4.0 denier), about 1.67 dtex to about 4.44 dtex (about 1.5 denier to about 4.0 denier), about 2.22 dtex to about 4.44 dtex (about 2.0 denier to about 4.0 denier), about 2.78 dtex to about 4.44 dtex (about 2.5 denier to about 4.0 denier), about 3.33 dtex to about 4.44 dtex (about 3.0 denier to about 4.0 denier), about 3.89 dtex to about 4.44 dtex (about 3.5 denier to about 4.0 denier), about 0.56 dtex to about 3.89 dtex (about 0.5 denier to about 3.5 denier), about 1.11 dtex to about 3.89 dtex (about 1.0 denier to about 3.5 denier), about 1.67 dtex to about 3.89 dtex (about 1.5 denier to about 3.5 denier), about 2.22 dtex to about 3.89 dtex (about 2.0 denier to about 3.5 denier), about 2.78 dtex to about 3.89 dtex (about 2.5 denier to about 3.5 denier), about 3.33 dtex to about 3.89 dtex (about 3.0 denier to about 3.5 denier), about 0.56 dtex to about 3.33 dtex (about 0.5 denier to about 3.0 denier), about 1.11 dtex to about 3.33 dtex (about 1.0 denier to about 3.0 denier), about 1.67 dtex to about 3.33 dtex (about 1.5 denier to about 3.0 denier), about 2.22 dtex to about 3.33 dtex (about 2.0 denier to about 3.0 denier), about 2.78 dtex to about 3.33 dtex (about 2.5 denier to about 3.0 denier), about 0.56 dtex to about 2.78 dtex (about 0.5 denier to about 2.5 denier), about 1.11 dtex to about 2.78 dtex (about 1.0 denier to about 2.5 denier), about 1.67 dtex to about 2.78 dtex (about 1.5 denier to about 2.5 denier), about 2.22 dtex to about 2.78 dtex (about 2.0 denier to about 2.5 denier), about 0.56 dtex to about 2.22 dtex (about 0.5 denier to about 2.0 denier), about 1.11 dtex to about 2.22 dtex (about 1.0 denier to about 2.0 denier), about 1.67 dtex to about 2.22 dtex (about 1.5 denier to about 2.0 denier), about 0.56 dtex to about 1.67 dtex (about 0.5 denier to about 1.5 denier), about 1.11 dtex to about 1.67 dtex (about 1.0 denier to about 1.5 denier), about 0.56 dtex to about 1.11 dtex (about 0.5 denier to about 1.0 denier), or about 0.44 dtex to about 1.11 dtex (about 0.4 denier to about 1.0 denier).

[0073] By satisfying the above range, a difference between the properties of the first monofilament and the properties of the second monofilament may be highlighted, and an additional effect (for example, an increase in surface area per unit weight) due to the mixing of the first monofilament and the second monofilament may be provided.

[0074] In an example, the total fineness of the lyocell material may be in a range of about 1,667 tex to about 6,111 tex (about 15,000 denier to about 55,000 denier), and the total fineness of the lyocell material may be calculated as the sum of the total fineness of the first lyocell multifilament and the total fineness of the second lyocell multifilament. For example, a lower limit of the total fineness may be, for example, 1,778 tex (16,000 denier) or more, 1,833 tex (16,500 denier) or more, 1,889 tex (17,000 denier) or more, 1,944 tex (17,500 denier) or more, 2,000 tex (18,000 denier) or more, 2,056 tex (18,500 denier) or more, 2,111 tex (19,000 denier) or more, 2,167 tex (19,500 denier) or more, 2,222 tex (20,000 denier) or more, 2,278 tex (20,500 denier) or more, 2,333 tex (21,000 denier) or more, 2,389 tex (21,500 denier) or more, 2,444 tex (22,000 denier) or more, 2,500 tex (22,500 denier) or more, 2,556 tex (23,000 denier) or more, 2,611 tex (23,500 denier) or more, 2,667 tex (24,000 denier) or more, 2,722 tex (24,500 denier) or more, 2,778 tex (25,000 denier) or more, 2,833 tex (25,500 denier) or more, 2,889 tex (26,000 denier) or more, 2,944 tex (26,500 denier) or more, 3,000 tex (27,000 denier) or more, 3,056 tex (27,500 denier) or more, 3,111 tex (28,000 denier) or more, 3,167 tex (28,500 denier) or more, 3,222 tex (29,000 denier) or more, 3,287 tex (29,500 denier) or more, 3,333 tex (30,000 denier) or more, 3,389 tex (30,500 denier) or more, 3,444 tex (31,000 denier) or more, 3,500 tex (31,500 denier) or more, 3,556 tex (32,000 denier) or more, 3,611 tex (32,500 denier) or more, 3,667 tex (33,000 denier) or more, 3,722 tex (33,500 denier) or more, 3,778 tex (34,000 denier) or more, 3,833 tex (34,500 denier) or more, 3,889 tex (35,000 denier) or more, 3,944 tex (35,500 denier) or more, 4,000 tex (36,000 denier) or more, 4,056 tex (36,500 denier) or more, 4,111 tex (37,000 denier) or more, 4,167 tex (37,500 denier) or more, 4,222 tex (38,000 denier) or more, 4,278 tex (38,500 denier) or more, 4,333 tex (39,000 denier) or more, 4,389 tex (39,500 denier) or more, 4,444 tex (40,000 denier) or more, 4,500 tex (40,500 denier) or more, 4,556 tex (41,000 denier) or more, 4,611 tex (41,500 denier) or more, 4,667 tex (42,000 denier) or more, 4,722 tex (42,500 denier) or more, 4,778 tex (43,000 denier) or more, 4,833 tex (43,500 denier) or more, 4,889 tex (44,000 denier) or more, 4,944 tex (44,500 denier) or more, 5,000 tex (45,000 denier) or more, 5,056 tex (45,500 denier) or more, 5,111 tex (46,000 denier) or more, 5,167 tex (46,500 denier) or more, 5,222 tex (47,000 denier) or more, 5,278 tex (47,500 denier) or more, 5,333 tex (48,000 denier) or more, 5,389 tex (48,500 denier) or more, 5,444 tex (49,000 denier) or more, 5,500 tex (49,500 denier) or more, 5,556 tex (50,000 denier) or more, 5,611 tex (50,500 denier) or more, 5,667 tex (51,000 denier) or more, 5,722 tex (51,500 denier) or more, 5,778 tex (52,000 denier) or more, 5,833 tex (52,500 denier) or more, 5,889 tex (53,000 denier) or more, 5,944 tex (53,500 denier) or more, 6,000 tex (54,000 denier) or more, or 6,056 tex (54,500 denier) or more. An 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, or 1,722 tex (15,500 denier) or less. When the total fineness is outside the above range, the preparation processability of a filter for a smoking article may not be good (a continuous process is not possible due to cutting), and an amount of tow, with which filter wrapping paper is filled during preparation of a filter for a smoking article, is excessively decreased or increased, it may be difficult to secure sufficient filter physical properties (for example, hardness or draw resistance).

[0075] A method of measuring a fineness is not particularly limited, but for example, a lyocell material to be measured, for example, a 2 m sample of lyocell tow, is taken, left, and stabilized in a room with a constant temperature and humidity at a temperature of 20 °C and a humidity of 65 % for 24 hours. One end of the stabilized lyocell tow is fixed, and a 2 kg weight is attached to the other end thereof. The tow stretched due to a load thereof is maintained (stabilized) for 5 seconds and then cut into 90 cm length to obtain a sample and measure a weight of the sample (total fineness). A fineness is calculated as a measured weight $\times$ 10,000 according to a denier conversion method. A single fineness of a monofilament in the sample is calculated by dividing the total fineness of the sample by the number of monofilaments in the sample.

[0076] In addition, the total fineness of the lyocell material may be determined according to the single fineness of the monofilament and the number of crimps. In the present application, each single fineness and the number of crimps may be controlled, and the total fineness of a lyocell material (for example, lyocell tow) suitable for preparing a filter for a smoking article and securing a function thereof may be secured.

[Number of crimps]

[0077] In an example, the first lyocell multifilament and the second lyocell multifilament may each independently have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch). For example, the number of crimps may be 5.91 ea/cm (15 ea/inch) or more, 7.87 ea/cm (20 ea/inch) or more, 9.84 ea/cm (25 ea/inch) or more, 11.81 ea/cm (30 ea/inch) or more, 13.78 ea/cm (35 ea/inch) or more, 15.75 ea/cm (40 ea/inch) or more, or 17.72 ea/cm (45 ea/inch) or more, and an upper limit thereof may be, for example, 17.72 ea/cm (45 ea/inch) or less, 15.75 ea/cm (40 ea/inch) or less, 13.78 ea/cm (35 ea/inch) or less, 11.81 ea/cm (30 ea/inch) or less, or 9.84 ea/cm (25 ea/inch) or less. The number of crimps and the uniformity thereof may be controlled through pressure and temperature conditions or the like related to a crimping operation which will be described below.

[0078] Although not particularly limited, the number of crimps may be measured by using, for example, a single fiber property evaluation device (for example, Favimat). Specifically, a sample of a prepared lyocell material (for example, lyocell tow) may be left and stabilized for 24 hours under conditions of a temperature of 20 ± 2 °C and a humidity of 65 ± 4 %. A specimen may be taken from the stabilized sample such that the crimp is not damaged. The taken specimen may be mounted on a dedicated jig with a length (gauge length) of 10 mm to 30 mm. An initial load during measurement may be 0.45 g/tex (0.05 g/denier), and crimp sensitivity may be 0.01 mm. The number of crimps may be measured under the above-described conditions (that is, a temperature of 20 ± 2 °C and a humidity of 65 ± 4 %).

[0079] Although not particularly limited, a lyocell material prepared to satisfy the single fineness, the total fineness, and/or the number of crimps described above may be used in a smoking article.

[Emulsion]

[0080] The lyocell material may include a first lyocell multifilament, a second lyocell multifilament, and an emulsion applied onto at least one of the first lyocell multifilament and the second lyocell multifilament. According to some embodiments, the emulsion may be applied onto the first lyocell multifilament and the second lyocell multifilament. The emulsion may include (a) an esterified product of a fatty acid having 16 or more carbon atoms and aliphatic monohydric alcohol, and (b) an esterified product of sorbitan and a fatty acid having 16 or more carbon atoms. The emulsion may be applied onto some or all of monofilaments or multifilaments constituting the lyocell material. In addition, the emulsion may permeate between filaments.

[0081] The emulsion including at least components (a) and (b) may have hydrophobicity. As a result, the lyocell material treated with the emulsion may have excellent spreading properties.

[0082] In a specific example of the present application, the lyocell material may include a certain content of the emulsion. In this case, the content of the emulsion may refer to OPU (wt%) which will be described below. "OPU" may be referred to "oil pick up ratio." For example, the lyocell material may include the emulsion in a content of 0.1 wt% or more with respect to 100 wt% of the total weight of the lyocell material. Specifically, the content 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, or 3.0 wt% or more, or specifically 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. An upper limit of the content 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.

[0083] As a method of measuring the content (OPU) of the emulsion, for example, an extrusion method may be used. For example, a sample (for example, in a content of about 2 g to about 5 g or specifically about 2.5 g) is collected (in this case, a weight of the collected sample is referred to as a sample weight), and the sample is put into a syringe-shaped container. A material of the container is not particularly limited, but may be a stainless steel (SUS) material. Next, a solvent (for example, methanol) is put into the container into which the sample is put (an amount of the input solvent may be 10 ml or less (for example, about 8 ml)). When the solvent is added to the sample, a dropping method may be used, and a dropping speed may be uniformly adjusted. As described above, the solvent put into the container is allowed to drop on a plate from one end of the syringe-shaped container. In this case, the plate is pre-weighed (a measured weight is referred to as plate weight A), and the plate is installed such that the solvent dropped on the plate is removed away (that is, is evaporated) at a temperature of 120 °C to 130 °C (for example, 125 °C). The solvent addition and solvent dropping are performed three times, and pressure (for example, 98 kgf/cm² (10 kgf/cm²) or less, 49 N/cm² (5 kgf/cm²) or less, or 20 N/cm² to 39 N/cm² (2 to 4 kgf/cm²) is applied to the sample by using a syringe-shaped container to press the sample once. Thus, the solvent and emulsion present in the sample are sufficiently extruded. The sample is squeezed out by applying pressure until no solvent comes out. Afterwards, the plate is stored in a desiccator for 5 minutes to 10 minutes, and a weight (plate weight B) of the plate containing the sample is measured. Then, a content of the emulsion is calculated according to a formula below.

content of emulsion by extrusion (OPU, % or wt%) = $\{(plate\ weight\ B - plate\ weight\ A) / (sample\ weight)\} \times 100$ Formula

[0084] In addition, a lyocell material that is used as a reference for the content of the emulsion may include a first lyocell multifilament treated with an emulsion and a second lyocell multifilament treated with an emulsion. For example, the lyocell material may include a first lyocell multifilament and/or a second lyocell multifilament to which primary emulsion treatment (to be described below) has been applied, or a first lyocell multifilament and/or a second lyocell multifilament to which primary emulsion treatment and secondary emulsion treatment (to be described below) have been applied. In addition, the first lyocell multifilament and/or the second lyocell multifilament, which have been treated with an emulsion, may each be crimped.

[0085] In relation to the emulsion of the present application, component (a) may be a compound that may function as a type of lubricant or oil and may be a component that is harmless to the human body enough to be used in food. Component (a) may provide lubricity to fibers put into a crimper. When the lubricity is not sufficient, lyocells may clump together and may not escape the crimper, and when the lubricity is too high, there may be a problem in that a crimp is not formed properly. In consideration of such functions, a content of component (a) may be controlled as described below.

[0086] Regarding component (a), types of fatty acids having 16 or more carbon atoms forming the esterified product are not particularly limited. Fatty acids having 16 or more carbon atoms may be used as long as the fatty acids may provide esterified products that are harmless to the human body enough to be used in food.

[0087] For example, saturated fatty acids and/or unsaturated fatty acids may be used as fatty acids having one or more 16 carbon atoms.

[0088] Examples of the saturated fatty acids may include a palmitic acid (hexadecanoic acid, $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$), a margaric acid (heptadecanoic acid, $\text{CH}_3(\text{CH}_2)_{15}\text{COOH}$), a stearic acid (octadecanoic acid, $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$), a nonadecylic acid (nonadecanoic acid, $\text{CH}_3(\text{CH}_2)_{17}\text{COOH}$), or an arachidic acid (eicosanoic acid, $\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$). However, types of available saturated fatty acids are not limited thereto.

[0089] Examples of the unsaturated fatty acids may include a palmitoleic acid ($\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), an oleic acid ($\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), a linoleic acid ($\text{C}_{18}\text{H}_{32}\text{O}_2$), or an arachidonic acid ($\text{C}_{20}\text{H}_{32}\text{O}_2$). However, types of available saturated fatty acids are not limited thereto. According to some embodiments, the fatty acid may be selected from a palmitic acid, a margaric acid, a stearic acid, a nonadecylic acid, an arachidic acid, a palmitoleic acid, an oleic acid, a linoleic acid, and an arachidonic acid.

[0090] An upper limit of a carbon number of the fatty acid having 16 or more carbon atoms is not particularly limited, but may be, for example, 40 or less, 36 or less, 32 or less, 28 or less, 24 or less, or 20 or less.

[0091] Regarding component (a), types of aliphatic monohydric alcohols forming component (a) are also not particularly limited. Aliphatic monohydric alcohols may be used as long as the aliphatic monohydric alcohols may provide esterified products that are harmless to the human body enough to be used in foods.

[0092] For example, the aliphatic monohydric alcohol may be saturated aliphatic alcohol or unsaturated aliphatic alcohol which may have a linear or branched form.

[0093] In an example, a carbon number of the aliphatic monohydric alcohol may be in a range of 1 to 40. Specifically, the carbon number of the aliphatic monohydric alcohol may be, for example, 4 or more, 8 or more, 12 or more, 16 or more, or 20 or more.

[0094] Examples of the aliphatic monohydric alcohol may include methanol, ethanol, butanol, lauryl alcohol, isotridecanol, or stearyl alcohol, but one or more embodiments are not limited thereto. According to some embodiments, the aliphatic monohydric alcohol may be selected from methanol, ethanol, butanol, lauryl alcohol, isotridecanol, and stearyl alcohol.

[0095] In some embodiments, an esterified product of isotridecanol and a stearic acid (for example, isotridecyl stearate) may be used as component (a). However, types of available component (a) are not limited thereto.

[0096] As will be described below, a content of component (a) included in the emulsion may be adjusted in consideration of the function of the emulsion or the function of component (a).

[0097] Component (b), that is, the esterified product of sorbitan and a fatty acid having 16 or more carbon atoms, is a compound that may function as a type of emulsifier and may be a component harmless to the human body enough to be used in food.

[0098] Since component (b) has both hydrophilicity and hydrophobicity due to polyhydric alcohol (that is, sorbitan), component (b) enables component (a), which provides lubricity to fibers, to be well dispersed in water, which will be described below. In addition, components (a) and (b) used together not only may increase the dispersibility of the emulsion as described above, but also may lower a melting point, thereby ensuring the use/handling and stability of the emulsion. In consideration of such functions, a content of component (b) may be controlled as described below.

[0099] Regarding component (b), types of fatty acids having 16 or more carbon atoms forming component (b) are not particularly limited. Fatty acids having 16 or more carbon atoms may be used as long as the fatty acids may provide esterified products that are harmless to the human body enough to be used in food.

[0100] For example, saturated fatty acids and/or unsaturated fatty acids may be used as fatty acids having one or more 16 carbon atoms.

[0101] Examples of the saturated fatty acids may include a palmitic acid (hexadecanoic acid, $\text{CH}_3(\text{CH}_2)_{14}\text{COOH}$), a margaric acid (heptadecanoic acid, $\text{CH}_3(\text{CH}_2)_{15}\text{COOH}$), a stearic acid (octadecanoic acid, $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$), a nonadecylic acid (nonadecanoic acid, $\text{CH}_3(\text{CH}_2)_{17}\text{COOH}$), or an arachidic acid (eicosanoic acid, $\text{CH}_3(\text{CH}_2)_{18}\text{COOH}$). However, types of available saturated fatty acids are not limited thereto.

[0102] Examples of the unsaturated fatty acids may include a palmitoleic acid ($\text{CH}_3(\text{CH}_2)_5\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), an oleic acid ($\text{CH}_3(\text{CH}_2)_7\text{CH}=\text{CH}(\text{CH}_2)_7\text{COOH}$), a linoleic acid ($\text{C}_{18}\text{H}_{32}\text{O}_2$), or an arachidonic acid ($\text{C}_{20}\text{H}_{32}\text{O}_2$). However, types of available saturated fatty acids are not limited thereto. According to some embodiments, the fatty acid may be selected from a palmitic acid, a margaric acid, a stearic acid, a nonadecylic acid, an arachidic acid, a palmitoleic acid, an oleic acid, a linoleic acid, and an arachidonic acid.

[0103] An upper limit of a carbon number of the fatty acid having 16 or more carbon atoms is not particularly limited, but may be, for example, 40 or less, 36 or less, 32 or less, 28 or less, 24 or less, or 20 or less.

[0104] In a specific example of the present application, an esterified product of sorbitan and an oleic acid (for example, sorbitan monooleate) may be used as component (b). However, types of available component (b) are not limited thereto.

[0105] A content of component (b) may be adjusted in consideration of the function of component (b) and the function of the emulsion as described above.

[0106] In an example, the emulsion may include (b) the esterified product of sorbitan and a fatty acid having 16 or more

carbon atoms in a content of about 20 parts by weight to about 60 parts by weight with respect to 100 parts by weight of (a) the esterified product of a fatty acid having 16 or more carbon atoms and aliphatic monohydric alcohol.

[0107] Specifically, the emulsion of the present application may include component (b) in a content of 25 parts by weight or more, 30 parts by weight or more, 35 parts by weight or more, 40 parts by weight or more, 45 parts by weight or more, or 50 parts by weight or more with respect to 100 parts by weight of component (a). An upper limit of the content of component (b) with respect to 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. When the above content range is satisfied, a surface of a lyocell multifilament or lyocell tow treated with an emulsion may have hydrophobicity.

[0108] In an example, the emulsion may include (a) the esterified product of a fatty acid having 16 or more carbon atoms and aliphatic monohydric alcohol in a content of about 40 wt% to about 80 wt% with respect to 100 wt% of the total weight of the emulsion. Specifically, the content of component (a) may be 45 wt% or more, 50 wt% or more, 55 wt% or more, 60 wt% or more, or 65 wt% or more, 70 wt% or more, or 75 wt% or more with respect to 100 wt% of the total weight of the emulsion. An upper limit of the content 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.

[0109] In an example, the emulsion may include an excess amount of component (a).

[0110] In an example, the emulsion may include (b) the esterified product of sorbitan and a fatty acid having 16 or more carbon atoms in a content of about 15 wt% to about 55 wt% with respect to 100 wt% of the total weight of the emulsion. Specifically, the content 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 with respect to 100 wt% of the total weight of the emulsion. An upper limit of the content 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.

[0111] In an example, the emulsion may further include water. A small amount of water may assist in emulsifying.

[0112] A content of water is not particularly limited, but water may be included in the remaining content excluding the total content of component (a) and component (b) with respect to the total of 100 wt% of the emulsion. The content of water in the emulsion (that is, the remaining content excluding the total content of the remaining components excluding water) may be, for example, 10 wt% or less, 9 wt% or less, 8 wt% or less, 7 wt% or less, 6 wt% or less, 5 wt% or less, 4 wt% or less, 3 wt% or less, 2 wt% or less, or 1 wt% or less. A lower limit of the content of water may be, for example, 0 wt% or more, 0.1 wt% or more, 0.5 wt% or more, or 1 wt% or more.

[0113] In some embodiments, the first lyocell multifilament may be a first lyocell multifilament that is a crimped and/or a first lyocell multifilament that is crimped and treated with emulsion.

[0114] In some embodiments, the second lyocell multifilament may be a second lyocell multifilament that is a crimped and/or a second lyocell multifilament that is crimped and treated with emulsion.

[Method of preparing lyocell material]

[0115] The present application relates to a method of preparing a lyocell material. Through the method, a lyocell material may be prepared and used in a smoking article.

[0116] Specifically, the method of preparing a lyocell material may include a lyocell dope spinning operation, coagulation and multifilament obtaining operations, a washing operation, an emulsion treatment operation, and a crimp providing operation. In addition, the method of preparing a lyocell material may further include typical operations in addition to the above-described operations.

[0117] The emulsion treatment operation may be performed before the crimp providing operation, after the crimp providing operation, or before and after the crimp providing operation.

[0118] Emulsion treatments may each independently be performed, for example, by spraying an emulsion with the above-described composition onto a lyocell multifilament or immersing the lyocell multifilament in the emulsion. As described above, the emulsion treatment may be performed such that a content of an emulsion (for example, OPU (wt%)) in a lyocell material satisfies a certain range.

[0119] The crimp providing operation may be performed, for example, by applying steam and/or pressure to the lyocell multifilament.

[0120] The method of preparing a lyocell material according to a specific embodiment of the present application, including the emulsion treatment operation and the crimp providing operation, will be described in more detail below. The method of the present application may be performed by including one or more of operations described below.

<Lyocell dope spinning operation (a)>

[0121] A corresponding operation may be an operation of spinning a lyocell dope (or a dope) including lyocell cellulose (or cellulose pulp) and N-methylmorpholine-N-oxide (NMMO).

[0122] In addition, the lyocell dope spinning operation may include spinning a first lyocell multifilament and spinning a second lyocell multifilament. Matters related to a first monofilament of the first lyocell multifilament and a second monofilament of the second lyocell multifilament are as described above.

[0123] In an exemplary method of preparing a lyocell material, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be sequentially or simultaneously performed.

[0124] Commercialized cellulose acetate filters are pointed out as the major cause of microplastics. However, since an amine oxide-based solvent used in preparing lyocell fibers is recyclable and biodegradable even when disposed of, lyocell materials do not generate any pollutants during a production process thereof. Furthermore, since lyocell tow is biodegraded and removed within a relatively short period of time, a lyocell is a more environmentally friendly material than cellulose acetate.

[0125] In an exemplary method of preparing a lyocell material, the first lyocell multifilament and the second lyocell multifilament may be spun by using the same lyocell dope. As a result, the chemical properties of the first lyocell multifilament and the second lyocell multifilament may be identical or extremely identical.

[0126] In addition, the first lyocell multifilament and the second lyocell multifilament may be spun by using different lyocell dopes. As a result, the physical properties of the first lyocell multifilament and the second lyocell multifilament may be different, and the physical properties of the lyocell material may be finely adjusted.

[0127] In an example, a content of cellulose in a spinning dope may be in a range of about 5 wt% to about 15 wt% with respect to 100 wt% of the total weight of a dope. When the content of cellulose is too low, it is difficult to implement the characteristics of a lyocell fiber, and when the content exceeds the above range, it is difficult to dissolve cellulose in a solvent. In consideration of this, the content of cellulose in the spinning dope may be 6 wt% or more, 7 wt% or more, 8 wt% or more, 9 wt% or more, or 10 wt% or more, and an upper limit thereof may be, for example, 14 wt% or less, 13 wt% or less, 12 wt% or less, 11 wt% or less, 10 wt% or less, or 9 wt% or less. The term "cellulose" may refer to "lyocell cellulose."

[0128] In an example, the spinning dope may include an aqueous solution of NMMO. The aqueous solution may include, for example, NMMO in a content of about 80 wt% to about 95 wt% and water in a content of about 5 wt% to about 20 wt% in consideration of a degree of dissolution of cellulose and a process temperature.

[0129] In an example, the cellulose or cellulose pulp may include alpha-cellulose in a content of about 85 wt% to about 97 wt% with respect to 100 wt% of the total weight of the cellulose and/or cellulose pulp.

[0130] In an example, the cellulose or cellulose pulp include hemicellulose in a content of about 3 wt% to about 15 wt% with respect to 100 wt% of the total weight of the cellulose and/or cellulose pulp. By controlling the content of hemicellulose within the above range, the stable physical properties (for example, hardness or draw resistance implementation) and processability of the lyocell material may be more easily secured.

[0131] In addition, in a specific example of the present application, a degree of polymerization (DPw) of the cellulose may be in a range of about 600 to about 1,700. In some embodiments, the degree of polymerization refers to the number of repeating units of the cellulose and/or hemicellulose and/or monomers in the cellulose pulp.

[0132] In the spinning operation, a shape of a spinneret for discharging the spinning dope is not particularly limited. For example, a donut-shaped spinneret may be used.

[0133] In an exemplary method of preparing a lyocell material, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be performed through the same spinneret or different spinnerets.

[0134] In addition, when the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament are simultaneously performed through the same spinning device, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be simultaneously performed. As a result, conditions for coagulating and obtaining the first lyocell multifilament and the second lyocell multifilament may be applied identically, and a change in lyocell multifilament according to a coagulation and obtaining operation may be controlled at the same level.

[0135] A nozzle temperature of the spinneret, for example, a spinning temperature thereof, may be appropriately selected by a person skilled in the art. Considering that the viscosity of the spinning dope may vary according to the spinning temperature, and thus discharging may not be performed well, the spinning temperature may be, for example, in a range of about 100 °C to about 120 °C or about 100 °C to about 110 °C.

[0136] In an example, spinning of the spinning dope may be performed under spinning conditions controlled such that a first single fineness and a second single fineness are each adjusted. For example, one or more spinning conditions of a discharge amount and a spinning speed of the spinning dope may be appropriately controlled so that the first single fineness of a filament included in the lyocell material may satisfy a range of about 2.22 dtex to about 8.89 dtex (about 2.0 denier to about 8.0 denier), and the second single fineness may satisfy a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier). In this case, the first single fineness and the second single fineness each refer to a fineness of a single monofilament separated from the first lyocell multifilament and the second lyocell multifilament. For example, the first single fineness may be greater than the second single fineness.

[0137] In addition, the spinning of the spinning dope may be performed under spinning conditions controlled such that the first single fineness is different from the second single fineness. For example, a cross sectional area of a first discharge port through which the first lyocell multifilament is discharged may be different from a cross sectional area of a second

discharge port through which the second lyocell multifilament is discharged. In addition, the cross sectional area of the first discharge port may be larger than the cross sectional area of the second discharge port.

[0138] Specifically, in an exemplary lyocell material, the first single fineness may be in a range of about 2.22 dtex to about 8.89 dtex (about 2.0 denier to about 8.0 denier). An upper limit of the first single fineness may be 8.89 dtex (8.0 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the second single fineness may be 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the first monofilament may be stably provided.

[0139] According to some embodiments, the second single fineness may be in a range of about 1.67 dtex to 6.67 dtex (about 1.5 denier to about 6.0 denier). An upper limit of the second single fineness may be 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the second single fineness may be 1.67 dtex (1.5 denier) or more, 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the second monofilament may be stably provided.

[0140] In an exemplary method of preparing a lyocell material, the cross section of the first discharge port and the cross section of the second discharge port may each independently be a multi-lobal section. In addition, the multi-lobal cross section may include three or more protrusions. In addition, the multi-lobal cross section may be a Y-shaped cross section. The terms described herein have the same meanings as described above.

[0141] In addition, at least one cross section of the first discharge port and at least one cross section of the second discharge port may be similar to each other. In some embodiments, the cross section of the first discharge port and the cross section of the second discharge port may be similar to each other. The terms described herein have the same meanings as described above.

[0142] The spinning dope discharged through the spinneret may undergo the coagulation operation which will be described below.

<Coagulation and multifilament obtaining operations (b)>

[0143] In a corresponding operation, the spun spinning dope may be coagulated, and a lyocell multifilament may be obtained.

[0144] For the coagulation, a method in which the spinning dope comes into contact with air and/or a coagulating solution may be used.

[0145] In an example, the coagulation may include a primary coagulation operation of supplying cooling air to a spun lyocell dope, and a secondary coagulation operation of adding a primarily coagulated spinning dope to a coagulating solution to coagulate the spinning dope.

[0146] According to such a coagulation method, the lyocell dope discharged through the spinneret may be primarily coagulated in a space (air gap section) between the spinneret and a coagulation tank. For example, cooling air may be supplied to the air gap section from an air cooling part positioned inside the spinneret in a direction from the inside to the outside of the spinneret. In addition, primary coagulation may be performed through an air quenching method or means known in the related field.

[0147] In an example, an upper limit of a temperature of the cooling air used for primary coagulation may be, for example, 15 °C or less. Specifically, the cooling air may be air with a temperature of 14 °C or less, 13 °C or less, 12 °C or less, 11 °C or less, or 10 °C or less. When the above temperature is exceeded, the coagulation of the spinning dope by air may not be sufficient, and spinning-related processability may not be good.

[0148] A lower limit of the temperature of the cooling air may be determined in consideration of spinning processability and/or cross-sectional uniformity of a filament. For example, when the temperature of the cooling air is less than 4 °C, a surface of the spinneret may cool, a surface of the filament may become non-uniform, and spinning processability may also deteriorate. In consideration of this, the cooling air may have a temperature of 5 °C or more, 6 °C or more, 7 °C or more, 8 °C or more, or 9 °C or more.

[0149] A degree by which the cooling air is supplied may be controlled in consideration of sufficient coagulation, spinning processability, and an influence on the physical properties of a filament. For example, the cooling air may be supplied to the discharged spinning dope at an air flow rate of about 70 Nm³/h to about 400 Nm³/h. More specifically, the air flow 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 an upper limit thereof 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.

[0150] After the primary coagulation as described above, the cooled spinning dope may be supplied to a coagulation tank or bath containing a coagulating solution (secondary coagulation operation). For proper coagulation, a temperature of the coagulating solution may be, for example, 30 °C or less or 25 °C or less. The temperature of the coagulating solution may be 10 °C or more, 15 °C or more, or 20 °C or more. When the above temperature is maintained, a coagulation speed may be appropriately maintained.

[0151] A type of a coagulating solution for the secondary coagulation operation as described above is not particularly limited. For example, the coagulating solution may include at least one selected from water and NMMO.

[0152] Although not particularly limited, when the coagulating solution includes water and NMMO, with respect to 100 wt% of the total weight of the coagulating solution, a content of water in the coagulating solution may be in a range of about 60 wt% to about 90 wt%, and a content of NMMO may be in a range of about 10 wt% to about 40 wt%. Alternatively, the coagulating solution may include water in a content of about 70 wt% to about 80 wt% and NMMO in a content of about 20 wt% to about 30 wt% with respect to 100 wt% of the total weight of the coagulating solution. By using sensors or the like, a concentration of the coagulating solution may be controlled to be maintained during a preparation process.

[0153] In an exemplary method of preparing a lyocell material, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be simultaneously performed, and the first lyocell multifilament and the second lyocell multifilament may be coagulated and obtained in the same coagulation tank.

[0154] In an exemplary method of preparing a lyocell material, the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament may be sequentially performed, and the first lyocell multifilament and the second lyocell multifilament may be coagulated and obtained in the same coagulation tank.

<Washing operation (c)>

[0155] If necessary, each lyocell multifilament may be washed after the above-described coagulation and multifilament obtaining operations. Due to the washing, NMMO and/or other impurities remaining in the filament may be removed.

[0156] A method of performing washing is not particularly limited. For example, washing may be performed by introducing each coagulated lyocell multifilament into a washing tank by using a traction roller. Alternatively, the washing may be performed by spraying a washing solution while moving to a subsequent operation by a traction roller.

[0157] Components of the washing solution are not particularly limited. For example, the washing solution may include water and may further include known other additives.

[0158] In addition, in consideration of reuse after washing, the washing solution may be used by adjusting a temperature thereof to 100 °C or less.

<Emulsion treatment operation (d)>

[0159] If required, an operation of treating each lyocell multifilament with an emulsion may be performed. The operation may be an operation of applying an emulsion with the above-described components onto a surface of the filament. Friction applied to the filament may be reduced through emulsion treatment, and a crimp may be formed well in the crimp providing operation which will be described below. When the emulsion treatment is performed twice or more as described below, the emulsion treatment may be referred to as primary emulsion treatment and secondary emulsion treatment according to the order.

[0160] Although not particularly limited, the emulsion treatment may be performed by immersing each lyocell multifilament in a bath filled with an emulsion such that each lyocell multifilament is completely immersed in the emulsion. Alternatively, the emulsion treatment may be performed by spraying the emulsion while moving to a subsequent operation by a traction roller.

[0161] In order to ensure that an amount of the emulsion applied onto each lyocell multifilament is constant after the emulsion treatment as described above, a process in which rolls or the like positioned before and/or after the emulsion treatment operation squeeze out an emulsion of a surface of the lyocell multifilament may be additionally performed.

[0162] In an example, the emulsion treatment may be performed such that a content (OPU (w%)) of the emulsion satisfies 1.0 wt % or more with respect to 100 wt% of the first lyocell multifilament and the second multifilament which are at least treated with an emulsion. In this case, the first lyocell multifilament and the second multifilament which are at least treated with an emulsion may each be, for example, a lyocell multifilament to which primary emulsion treatment is applied, or a lyocell multifilament to which primary emulsion treatment and secondary emulsion treatment (see description below) are applied. In addition, the first lyocell multifilament and/or the second lyocell multifilament, which are treated with an emulsion as described above, may be crimped.

[0163] Specifically, a content of the emulsion in the first lyocell multifilament and the second lyocell multifilament which are at least treated with an 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, or 3.0 wt% or more, or specifically 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 with respect to 100 wt% of the total weight of the first lyocell multifilament and/or the second lyocell multifilament which are treated with an emulsion. An upper limit of the content 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 7.6 wt% or less. In this case, the above content may refer to a dry weight after a solvent (for example, water) or liquid component that may be included in the emulsion has evaporated.

[0164] When the emulsion with the above-described composition is treated within the above range of the content, the hydrophilic properties of a lyocell material may be supplemented.

[0165] In some cases, the emulsion may be dried after the emulsion treatment as described above.

[0166] In specific embodiments of the present application, one or more of the above-described operations may be controlled such that the first single fineness may be in a range of about 2.22 to about 8.89 dtex (about 2.0 to about 8.0 denier). In addition, one or more of the above-described operations may be controlled such that the second single fineness may be in a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier). In this case, the first single fineness and the second single fineness may each refer to a fineness of a single monofilament separated from the first lyocell multifilament or the second lyocell multifilament. In an embodiment, one or more of the above-described operations may be controlled such that the first single fineness is greater than the second single fineness.

[0167] Specifically, in an exemplary lyocell material, the first single fineness may be in a range of about 2.22 dtex to about 8.89 dtex (about 2.0 denier to about 8.0 denier). An upper limit of the first single fineness may be 8.89 dtex (8.0 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the second single fineness may be 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the first monofilament may be stably provided.

[0168] According to some embodiments, the second single fineness may be in a range of about 1.67 dtex to about 6.67 dtex (about 1.5 denier to about 6.0 denier). An upper limit of the second single fineness may be 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, or 2.78 dtex (2.5 denier) or less. A lower limit of the second single fineness may be 1.67 dtex (1.5 denier) or more, 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, 7.78 dtex (7.0 denier) or more, or 8.33 dtex (7.5 denier) or more. By satisfying the above range, the properties (for example, relatively improved tensile strength) by the second monofilament may be stably provided.

[0169] Although not particularly limited, an operation controlled to secure the ranges of the first single fineness and/or the second single fineness described above may be the above-described spinning operation. Alternatively, the above-described spinning, coagulation, washing, and emulsion treatment operations may all be controlled to secure the ranges of the first single fineness and/or the second single fineness described above.

<Crimp providing operation (e)>

[0170] The crimp providing operation may be an operation of applying pressure to the first lyocell multifilament and/or the second lyocell multifilament, which are treated with the emulsion, through steam and/or a press roller to obtain a crimped multifilament, for example, a crimped tow. The crimp providing operation may be referred to as a crimping operation. As used herein, the terms "treated with emulsion" and "emulsified" may be used interchangeably.

[0171] Through crimping, waves may be provided to each lyocell multifilament, and fibers may have bulky characteristics. The crimping may be performed by using known crimp machines, such as a stuffer box and/or a steam box, and available crimp machines are not particularly limited as long as the crimp machines are devices capable of applying one or more of pressures which will be described below.

[0172] In an example, the crimp providing operation may be performed by first supplying steam to each lyocell multifilament to preheat and swell each lyocell multifilament, and then pressing each lyocell multifilament with a press roller to form wrinkles in the lyocell multifilament. In this case, a steam box may be used to supply steam, and the steam box may be positioned in front of the crimp machine.

[0173] In an example, the crimp providing operation may be performed in such a manner that pressing of the lyocell multifilament by the press roller and applying of steam are simultaneously performed.

[0174] In an example, the crimp providing operation may be performed in such a manner that steam is supplied to each

lyocell multifilament to preheat and swell each lyocell multifilament, and then applying of pressure with the press roller and applying of steam are simultaneously performed on each lyocell multifilament.

[0175] In an example, the crimp providing operation may be performed by applying steam with a pressure of about 0.98 N/cm² to about 19.61 N/cm² (about 0.1 kgf/cm² to 2.0 kgf/cm²) to each lyocell multifilament before the lyocell multifilament is input into the crimp machine (specifically, the press roller).

[0176] For example, steam with a pressure 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 supplied by the steam box. In addition, steam with 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 supplied. When the amount or pressure of supplied steam is less than the above range, a crimp may not be formed smoothly. When the above range is exceeded, since the flexibility of the filament is increased, excessive crimp may be provided to the filament in the crimp machine, and thus the filament may not pass through the crimp machine.

[0177] In an example, the crimp providing operation may be performed by pressing each lyocell multifilament with a press roller to form wrinkles in each lyocell multifilament. In addition, steam may not be supplied prior to pressing, steam may not be supplied simultaneously with pressing, or steam may not be supplied prior to pressing and simultaneously with pressing.

[0178] In an example, the crimp providing operation may be performed by each independently applying pressures of about 14.71 N/cm² to about 39.23 N/cm² (about 1.5 kgf/cm² to about 4.0 kgf/cm²) to each lyocell multifilament put into the crimp machine by using a press roller.

[0179] 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 through the press roller. In addition, 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 through the press roller.

[0180] When the pressure of the press roller is less than the above range, the desired number of crimps may not be formed sufficiently. When the pressure of the press roller exceeds the above range, a pressing force may be too strong, and thus the filament may not be smoothly put into the crimp machine or may not pass through the stuffer box. Wrinkles may be formed in the lyocell multifilament by the press roller that provides the pressure.

[0181] In an example, by using an upper plate, pressures of about 0.98 N/cm² to about 19.61 N/cm² (about 0.1 kgf/cm² to about 2 kgf/cm²) may each independently be applied to each lyocell multifilament. In addition, the upper plate may apply pressure to each lyocell multifilament when each lyocell multifilament has passed through the press roller or while each lyocell multifilament is passing through the press roller.

[0182] 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. In addition, 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.

[0183] Furthermore, after the lyocell multifilament has passed through the press roller, the upper plate may vertically move to provide an uniform crimp. When the pressure of the upper plate is less than 0.98 N/cm² (0.1 kgf/cm²), since the upper plate may not be fixed due to pressure inside the crimp machine, the lyocell multifilament may remain in the crimp machine for a short period of time, and thus a desired number of crimps may not be provided. In addition, the lyocell multifilament may remain in the crimp machine for a long period of time, and thus the continuity of a process may not be maintained. When the pressure of the upper plate exceeds 19.61 N/cm² (2 kgf/cm²), the lyocell multifilament may not be discharged smoothly from the crimp machine, and a shape of a crimp may be formed irregularly.

[0184] In an example, in the crimp providing operation, a doctor blade that applies a certain pressure to each lyocell multifilament may be applied. The doctor blade may control a residence time of a filament put into a crimper stuffer box, thereby contributing to the control of the number of crimps. The doctor blade may be positioned, for example, on a movement path of each lyocell multifilament that is pressed by the above-described roller and then discharged from a roller pressing point.

[0185] In an example, the crimp providing operation may be performed by each independently applying pressures of about 0.98 N/cm² to about 19.61 N/cm² (about 0.1 kgf/cm² to about 2.0 kgf/cm²) to each lyocell multifilament, which has passed between the rollers of the crimp machine, by using the doctor blade.

[0186] For example, the pressure applied by the doctor blade 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. In addition, 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 doctor blade.

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 doctor blade.

[0187] In an example, the crimp providing operation may be performed at a temperature condition ranging from about 120 °C to about 250 °C. For example, a lower limit of the temperature may be 125 °C, 130 °C, 135 °C, 140 °C, 145 °C, or 150 °C. An upper limit of the temperature condition may be 200 °C, 195 °C, 190 °C, 185 °C, 180 °C, 175 °C, 170 °C, 165 °C, or 160 °C.

[0188] When the crimp providing operation is performed under a temperature condition of less than 120 °C, a shape of a crimp may not be stably maintained. When the crimp providing operation is performed under a temperature condition of more than 250 °C, a concentration of fat and oil in the crimp machine may be increased, and the formation of a crimp may be limited.

<(Other operations (f))>

[0189] After the crimp providing operation, additional appropriate post-treatment may be performed.

[0190] In an example, secondary emulsion treatment (f1) may be additionally performed. Through the secondary emulsion treatment, flexibility may be further provided to a tow. The secondary emulsion treatment may be performed in the same manner as or in accordance with the emulsion treatment operation (d) described above.

[0191] Specifically, the secondary emulsion treatment may be performed by treating a lyocell material (for example, lyocell tow), which has undergone a process using a crimper, with an emulsion. The secondary emulsion treatment may function advantageously in various processes performed during a preparation of a filter for a smoking article. For example, the secondary emulsion treatment may allow fibers and filters to spread well even in air during a spreading process and also may restrict fibers from being cut during a stretching process.

[0192] Even in a case in which the secondary emulsion treatment as described above is performed, a secondary emulsion treatment process may be performed such that a content or an OPU content of an emulsion in a material satisfies the range described above.

[0193] In an example, drying treatment (f2) may be additionally performed. Drying may be performed, for example, at a temperature in a range of about 100 °C to about 130 °C. A drying treatment manner or method is not particularly limited, and known technologies may be used. For example, the drying may be performed by applying hot air to tow, allowing the tow to pass through a temperature-controlled room, or leaving the tow for a certain period of time.

[0194] In an aspect, the disclosure may provide a lyocell material obtained through the method of preparing a lyocell material as described above.

[0195] In an aspect, the disclosure may provide a lyocell material obtainable through the method of preparing a lyocell material as described above.

[Smoking article]

[0196] Although not particularly limited, a lyocell material prepared through the method may be included in a smoking article or the like. The smoking article may be an aerosol-generating article. The aerosol-generating article may include an aerosol-generating material or an aerosol-forming substrate.

[0197] For example, a lyocell material may be included in a combustion-type cigarette. As another example, the lyocell material may be included in a heated cigarette, and the heated cigarette may be used together with an aerosol generating device (not shown).

[0198] For example, when used as a heated smoking article, the smoking article may be separately inserted into an aerosol generating device. Here, the aerosol generating device may include an accommodation groove in which an aerosol-generating article may be accommodated, and in addition, may include a heater for heating the aerosol-generating article to generate aerosol, a control unit for controlling the overall operation of the aerosol generating device, a battery for providing power used for operating the aerosol generating device, and a detector for recognizing that the aerosol-generating article has been inserted into the aerosol generating device.

[0199] The smoking article may include a tobacco medium portion, a filter for a smoking article, and a wrapper, wherein the filter for the smoking article may be positioned at one end portion of the tobacco medium portion, for example, a rear end portion or a front end portion. The tobacco medium portion and the filter for the smoking article may each include a single segment or may each independently include a plurality of segments.

[0200] The tobacco medium portion may include a tobacco material, and the tobacco material may include nicotine. In addition, the tobacco medium may additionally include one or more excipients.

[0201] The excipients may include a binder, a filler, and other additives. For example, the tobacco medium included in the tobacco medium portion may be prepared in the form of granules including a tobacco material, an excipient, and the like.

[0202] For example, a filler may be additionally included to constantly maintain the shape, strength, and mass of the tobacco medium portion. For example, a lyocell material may be included in the tobacco medium portion. In addition, the

lyocell material may be used as a filler.

[0203] The wrapper may be subdivided into cigarette paper for wrapping the tobacco medium portion, filter wrapping paper for wrapping the filter, and a tipping wrapper for coupling the tobacco medium portion and the filter.

5 [Filter for smoking article]

[0204] A lyocell material may be used in a filter for a smoking article. The lyocell material may be lyocell tow. In an example, the lyocell tow may include a first lyocell multifilament that is crimped and a second lyocell multifilament that is crimped.

10 **[0205]** For example, the present application relates to a filter for a smoking article. The filter for the smoking article may include a lyocell material, and the lyocell material may be identical to that described above. In addition, the filter for the smoking article may include lyocell tow, and the lyocell tow may be identical to that described above.

[0206] In addition, the lyocell material may include an emulsion in a content of 0.1 wt% or more with respect to 100 wt% of the total weight of the lyocell material. In addition, an emulsion component and a content according to the specific example of the present application are as described above.

[0207] In an example, single finenesses of filaments constituting the first lyocell multifilament and/or the second lyocell multifilament may each independently be in a range of about 1.67 dtex to about 8.89 dtex (about 1.5 denier to about 8.0 denier). A specific numerical value is as described above.

20 **[0208]** In an example, the total fineness of the lyocell material may be in a range of about 1,667 tex to about 6,111 tex (about 15,000 denier to about 55,000 denier), and for example, the lyocell material may be lyocell tow. A specific numerical value is as described above.

[0209] In an example, the first lyocell multifilament and/or the second lyocell multifilament that are crimped may each independently have 3.94 to 19.69 crimps per centimeter (10 to 50 crimps per inch). A specific numerical value is as described above.

25 **[0210]** In an example, the filter for the smoking article may further include wrapping paper (referred to as wrapper paper, filter paper, or filter wrapping paper). For example, the wrapping paper may be porous paper or non-porous paper that may wrap the above-described lyocell tow and may maintain a filter shape (for example, a cylinder or circular column).

[0211] In a specific embodiment of the present application, the filter for the smoking article may have a certain shape and a certain size.

30 **[0212]** For example, the filter may have a rod shape. More specifically, the filter for the smoking article may have a shape such as a cylinder.

[0213] In addition, the filter may have a length of, for example, about 10 mm to about 50 mm. Specifically, the length of the filter may have a lower limit of 15 mm or more, 20 mm or more, 25 mm or more, 30 mm or more, 35 mm or more, 40 mm or more, or 45 mm or more and an upper limit of 45 mm or less, 40 mm or less, 35 mm or less, 30 mm or less, 25 mm or less, 20 mm or less, or 15 mm or less.

35 **[0214]** In a specific example of the present application, the filter having the length may have a circular cross section, and a circumference of the circular cross section may be in a range of 10 mm to about 40 mm. For example, the circumference of the filter may have a lower limit of 15 mm or more, 20 mm or more, 25 mm or more, 30 mm or more, or 35 mm or more, and an upper limit of 35 mm or less, 30 mm or less, 25 mm or less, 20 mm or less, or 15 mm or less.

40 **[0215]** In an example, the filter for the smoking article may include lyocell tow and filter wrapping paper. The lyocell tow and the filter wrapping paper are as described above, and thus descriptions thereof are omitted.

[0216] The wrapping paper may be porous paper or non-porous paper that may wrap the above-described lyocell tow and may maintain a filter shape (for example, a cylinder or circular column).

45 **[0217]** In an example, when porous wrapping paper is used, the wrapping paper may have a porosity of about 10 coresta unit (CU) to about 50,000 CU. A coresta unit may be defined as a volume flow rate ($\text{cm}^3\text{min}^{-1}$) of air passing through a 1 cm^2 substrate sample (that is, porous wrapping paper) at a pressure difference of 1 kPa. Specifically, a lower limit of the porosity of the wrapping paper may be, for example, 1,000 CU or more, 5,000 CU or more, 10,000 CU or more, 15,000 CU or more, 20,000 CU or more, 25,000 CU or more, 30,000 CU or more, 35,000 CU or more, 40,000 CU or more, or 45,000 CU or more, and an upper limit thereof may be, for example, 45,000 CU or less, 40,000 CU or less, 35,000 CU or less, 30,000 CU or less, 25,000 CU or less, or 20,000 CU or less. In a specific example of the present application, the wrapping paper may have a porosity in a range of about 22,000 CU to about 26,000 CU or about 23,000 CU to about 25,000 CU.

50 **[0218]** In an example, a basis weight of the wrapping paper may be in a range of about 15 g/cm^2 to about 60 g/cm^2 . Specifically, a lower limit of the basis weight of the wrapping paper may be, for example, 20 g/cm^2 or more, 25 g/cm^2 or more, 30 g/cm^2 or more, 35 g/cm^2 or more, 40 g/cm^2 or more, 45 g/cm^2 or more, 50 g/cm^2 or more, or 55 g/cm^2 or more, and an upper limit thereof may be, for example, 55 g/cm^2 or less, 50 g/cm^2 or less, 45 g/cm^2 or less, 40 g/cm^2 or less, 35 g/cm^2 or less, 30 g/cm^2 or less, 25 g/cm^2 or less, or 20 g/cm^2 or less. In a specific example of the present application, the wrapping paper may have a basis weight of 16 g/cm^2 or more, 17 g/cm^2 or more, 18 g/cm^2 or more, 19 g/cm^2 or more, 20 g/cm^2 or more, or 21 g/cm^2 or more, and 25 g/cm^2 or less, 24 g/cm^2 or less, 23 g/cm^2 or less, 22 g/cm^2 or less, or 21 g/cm^2 or less.

[0219] Although not particularly limited, a weight of a filter having a rod shape may be 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 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.

[0220] Other filters for a smoking article and materials included therein are as described above, and thus descriptions thereof are omitted.

[Method of preparing filter for smoking article]

[0221] For example, the present application relates to a method of preparing a filter for a smoking article. The method may be a method of preparing a filter for a lyocell smoking article as described above and may be a method including the above-described method of preparing a lyocell material.

[0222] Regarding the method of preparing a filter for a smoking article, the remaining processes excluding the preparing of the filter are the same as processes described in the lyocell material described above, and thus descriptions thereof are omitted. In addition, descriptions overlapping the above descriptions are also omitted.

[0223] The preparing of the filter may be appropriately performed by a person skilled in the art according to a known method. For example, the filter may be prepared by forming a wrapping paper filled with a lyocell material into a rod shape. Alternatively, the filter may be prepared by cutting filter paper filled with a lyocell material with a rod shape into an appropriate length. The wrapping paper is as described above.

[0224] Although not particularly limited, before the filter paper is filled with the lyocell material, the lyocell material may be further subjected to opening or plasticizer treatment. A surface area of the lyocell material may be increased by opening the lyocell material. For example, the lyocell material may be opened by applying an external force in a length direction, a width direction, and/or a thickness direction.

[0225] For example, the lyocell material used in preparing a filter for a smoking article may be lyocell tow.

[0226] Although not particularly limited, the filter for the smoking article may additionally include known cellulose acetate multifilaments at a level that does not impede the purpose of the disclosure. The cellulose acetate multifilament may be mixed with a lyocell multifilament. The cellulose acetate multifilament may be included in a segment distinguished from a segment including the lyocell multifilament.

Advantageous Effects of Invention

[0227] According to the present application, there may be provided a lyocell material for a smoking article filter, which is capable of replacing commercialized cellulose acetate (CA), and a filter for a smoking article including the same. Specifically, there may be provided a lyocell material which may uniformly have the properties of a first monofilament having a first single fineness and the properties of a second monofilament having a second single fineness.

Mode for the Invention

[0228] Hereinafter, the operations and effects of the disclosure will be described in more detail through specific examples of the disclosure. However, this is presented as an example of the disclosure, and the scope of the disclosure is not limited thereby.

[0229] A lyocell material was prepared through processes as described in Preparation Example below. Conditions not specifically described are within the scope of the above description.

[Preparation Example]

[0230] Cellulose pulp having an alpha-cellulose content of 93.9% and a degree of polymerization (DPw) of 820 was mixed with an NMMO/H₂O solvent having a propyl gallate content of 0.01 wt% to prepare a spinning dope having a concentration of 11 wt%. Then, while a spinning temperature of a spinneret was maintained at 110 °C, a discharge amount and a spinning speed were appropriately adjusted, and the spinning dope was spun.

[0231] The spinning dope on a filament discharged from the spinneret was supplied to a coagulating solution (a coagulating solution having a concentration of 75 wt% water and 25 wt% NMMO and a temperature of approximately 25 °C) in a coagulating tank through an air gap section. In this case, cooling air in the air gap section primarily solidifies the spinning dope at a temperature of 8 °C and an air flow rate of 100 Nm³/h. In addition, the concentration of the coagulating solution was continuously monitored by using a sensor and a refractometer.

[0232] A coagulated lyocell filament was washed. Specifically, the filament was introduced into a traction roller, and NMMO remaining in the filament was removed by using a washing solution sprayed from a washing device. Then, the washed filament was immersed inside a bath designed to have a prescribed emulsion concentration.

[0233] The filament was treated at a pressure of 19.61 N/cm² (2 kgf/cm²) by using a nip roll installed in a bath discharge

portion and put into a crimp machine to provide wrinkles. A pressure of a press roller was set to 24.52 N/cm² (2.5 kgf/cm²), and a pressure of a doctor blade was set to 4.90 N/cm² (0.5 kgf/cm²) to prepare lyocell tow.

[0234] The total fineness of the prepared tow was in a range of 3,333 tex to 5,000 tex (30,000 denier to 45,000 denier), and the number of crimps was in a range of 5.91 ea/cm to 15.75 ea/cm (15 ea/cm to 40 ea/inch).

Example 1

[0235] Lyocell tow was prepared according to Preparation Example, and a spinneret included each of a first discharge port through which a first lyocell multifilament was discharged and a second discharge port through which a second lyocell multifilament was discharged.

[0236] A first single fineness of the first monofilament discharged from the first discharge port was 2.67 dtex (2.4 denier), and a second single fineness of the second monofilament discharged from the second discharge port was 2.22 dtex (2.0 denier).

[0237] In addition, the number of first and second discharge ports was appropriately adjusted such that a weight ratio between the first lyocell multifilament and the second lyocell multifilament included in the lyocell tow was 90 to 10.

Examples 2 to 5

[0238] Lyocell tows were prepared in the same manner as in Example 1, except that the number of first and second discharge ports was appropriately adjusted such that a weight ratio between a first lyocell multifilament and a second lyocell multifilament was as shown in Table 1 below.

Example 6

[0239] Lyocell tow was prepared according to Preparation Example, and a spinneret included each of a first discharge port through which a first lyocell multifilament was discharged and a second discharge port through which a second lyocell multifilament was discharged.

[0240] A first single fineness of the first monofilament discharged from the first discharge port was 7.22 dtex (6.5 denier), and a second single fineness of the second monofilament discharged from the second discharge port was 6.11 dtex (5.5 denier).

[0241] In addition, the number of first and second discharge ports was appropriately adjusted such that a weight ratio between the first lyocell multifilament and the second lyocell multifilament included in the lyocell tow was 90 to 10.

Examples 7 to 10

[0242] Lyocell tows were prepared in the same manner as in Example 6, except that the number of first and second discharge ports was appropriately adjusted such that a weight ratio between a first lyocell multifilament and a second lyocell multifilament was as shown in Table 1 below.

Example 11

[0243] Lyocell tow was prepared according to Preparation Example, and a spinneret included each of a first discharge port through which a first lyocell multifilament was discharged and a second discharge port through which a second lyocell multifilament was discharged.

[0244] A first single fineness of the first monofilament discharged from the first discharge port was 8.89 dtex (8.0 denier), and a second single fineness of the second monofilament discharged from the second discharge port was 1.67 dtex (1.5 denier).

[0245] In addition, the number of first and second discharge ports was appropriately adjusted such that a weight ratio between the first lyocell multifilament and the second lyocell multifilament included in the lyocell tow was 90 to 10.

Examples 12 to 15

[0246] Lyocell tows were prepared in the same manner as in Example 11, except that the number of first and second discharge ports was appropriately adjusted such that a weight ratio between a first lyocell multifilament and a second lyocell multifilament was as shown in Table 1 below.

Example 16

[0247] Lyocell tow was prepared according to Preparation Example, and a spinneret included each of a first discharge port through which a first lyocell multifilament was discharged and a second discharge port through which a second lyocell multifilament was discharged.

[0248] A first single fineness of the first monofilament discharged from the first discharge port was 2.22 dtex (2.0 denier), and a second single fineness of the second monofilament discharged from the second discharge port was 1.67 dtex (1.5 denier).

[0249] In addition, the number of first and second discharge ports was appropriately adjusted such that a weight ratio between the first lyocell multifilament and the second lyocell multifilament included in the lyocell tow was 90 to 10.

Examples 17 to 20

[0250] Lyocell tows were prepared in the same manner as in Example 16, except that the number of first and second discharge ports was appropriately adjusted such that a weight ratio between a first lyocell multifilament and a second lyocell multifilament was as shown in Table 1 below.

Example 21

[0251] Lyocell tow was prepared according to Preparation Example, and a spinneret included each of a first discharge port through which a first lyocell multifilament was discharged and a second discharge port through which a second lyocell multifilament was discharged.

[0252] A first single fineness of the first monofilament discharged from the first discharge port was 8.89 dtex (8.0 denier), and a second single fineness of the second monofilament discharged from the second discharge port was 6.67 dtex (6.0 denier).

[0253] In addition, the number of first and second discharge ports was appropriately adjusted such that a weight ratio between the first lyocell multifilament and the second lyocell multifilament included in the lyocell tow was 90 to 10.

Examples 22 to 25

[0254] Lyocell tows were prepared in the same manner as in Example 21, except that the number of first and second discharge ports was appropriately adjusted such that a weight ratio between a first lyocell multifilament and a second lyocell multifilament was as shown in Table 1 below.

Comparative Example 1

[0255] Lyocell tow was prepared according to Preparation Example, and a spinneret included only a first discharge port through which a first lyocell multifilament was discharged. A first single fineness of the first monofilament discharged from the first discharge port was 2.67 dtex (2.4 denier).

Comparative Example 2

[0256] Lyocell tow was prepared according to Preparation Example, and a spinneret included only a second discharge port through which a second lyocell multifilament was discharged. A second single fineness of the second monofilament discharged from the second discharge port was 2.22 dtex (2.0 denier).

Comparative Example 3

[0257] Lyocell tow was prepared according to Preparation Example, and a spinneret included only a first discharge port through which a first lyocell multifilament was discharged. A first single fineness of the first monofilament discharged from the first discharge port was 7.22 dtex (6.5 denier).

Comparative Example 4

[0258] Lyocell tow was prepared according to Preparation Example, and a spinneret included only a second discharge port through which a second lyocell multifilament was discharged. A second single fineness of the second monofilament discharged from the second discharge port was 6.11 dtex (5.5 denier).

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[Table 1]

		Examples					Comparative Examples	
		1	2	3	4	5	1	2
5	Weight of first lyocell multifilament	90	70	50	30	10	100	0
	Weight of second lyocell multifilament	10	30	50	70	90	0	100
10		Examples					Comparative Examples	
		6	7	8	9	10	3	4
	Weight of first lyocell multifilament	90	70	50	30	10	100	0
	Weight of second lyocell multifilament	10	30	50	70	90	0	100
15		Examples						
		11	12	13	14	15		
	Weight of first lyocell multifilament	90	70	50	30	10		
	Weight of second lyocell multifilament	10	30	50	70	90		
20		Examples					-	
		16	17	18	19	20		
	Weight of first lyocell multifilament	90	70	50	30	10		
	Weight of second lyocell multifilament	10	30	50	70	90		
25		Examples						
		21	22	23	24	25		
	Weight of first lyocell multifilament	90	70	50	30	10		
30		Examples						
		21	22	23	24	25		
	Weight of first lyocell multifilament	90	70	50	30	10		
	Weight of second lyocell multifilament	10	30	50	70	90		
	multifilament							

<Experiment 1: Filter weight evaluations

35 [0259] Filters for a smoking article respectively including the lyocell tows of Examples 1 to 25 and Comparative Examples 1 to 4 were prepared. The filters for the smoking article were prepared in a rod shape. For each lyocell tow, a minimum weight and a maximum weight at which the lyocell tow could be prepared into a filter were measured, respectively. Measurement results are shown in Table 2 below.

40 [Table 2]

		Examples					Comparative Examples	
		1	2	3	4	5	1	2
45	Minimum filter weight (mg ₁)	470	460	450	465	470	480	470
	Maximum filter weight (mg ₂)	1,000	1,050	1,080	1,065	1,050	980	960
	$\Delta mg (mg_2 - mg_1)$	530	590	630	600	580	500	490
50		Examples					Comparative Examples	
		6	7	8	9	10	3	4
	Minimum filter weight (mg ₁)	230	240	250	255	265	290	300
	Maximum filter weight (mg ₂)	530	550	570	570	560	520	520
55	$\Delta mg (mg_2 - mg_1)$	300	310	320	315	295	230	220

(continued)

		Examples					
		11	12	13	14	15	
5	Minimum filter weight (mg ₁)	270	260	250	255	260	
	Maximum filter weight (mg ₂)	510	505	510	505	510	
	Δ mg (mg ₂ -mg ₁)	240	245	260	250	250	
10		Examples					
		16	17	18	19	20	
	Minimum filter weight (mg ₁)	465	455	450	460	465	
	Maximum filter weight (mg ₂)	1,010	1,050	1,050	1,050	1,050	
15	Δ mg (mg ₂ -mg ₁)	545	595	640	600	575	
		Examples					
		21	22	23	24	25	
20	Minimum filter weight (mg ₁)	260	250	240	250	255	
	Maximum filter weight (mg ₂)	500	505	510	505	510	
	Δ mg (mg ₂ -mg ₁)	240	255	270	255	255	

25 **[0260]** As confirmed in Table 2 above, the filters for the smoking article including the lyocell tows according to Examples 1 to 5 and Examples 16 to 20 have a larger Δ mg value than the filters for the smoking article including the lyocell tows according to Comparative Examples 1 to 4. In addition, the filters for the smoking article including the lyocell tows according to Examples 6 to 10, Examples 11 to 15, and Examples 21 to 25 have a larger Δ mg value than the filters for the smoking article including the lyocell tows according to Comparative Example 3 and Comparative Example 4.

30 **[0261]** Specifically, as compared to Comparative Example 1 including only a monofilament having a single fineness of 2.67 dtex (2.4 denier) and Comparative Example 2 including only a monofilament having a single fineness of 2.22 dtex (2.0 denier), since monofilaments having different single finenesses are mixed, the lyocell materials of Examples 16 to 20 including both a monofilament having a first single fineness of 2.22 dtex (2.0 denier) and a monofilament having a second single fineness of 1.67 dtex (1.5 denier) may be used as a filter for a smoking article to provide a larger Δ mg value.

35 **[0262]** In addition, specifically, as compared to Comparative Example 3 including only a monofilament having a single fineness of 6.67 dtex (6.0 denier) and Comparative Example 4 including only a monofilament having a single fineness of 6.11 dtex (5.50 denier), since monofilaments having different single finenesses are mixed, the lyocell materials of Examples 11 to 15 including both a monofilament having a first single fineness of 8.89 dtex (8.0 denier) and a monofilament having a second single fineness of 1.67 dtex (1.5 denier) may be used as a filter for a smoking article to provide a larger Δ mg value.

40 **[0263]** Similarly, as compared to Comparative Example 3 including only a monofilament having a single fineness of 6.67 dtex (6.0 denier) and Comparative Example 4 including only a monofilament having a single fineness of 6.11 dtex (5.50 denier), since monofilaments having different single finenesses are mixed, the lyocell materials of Examples 21 to 25 including both a monofilament having a first single fineness of 8.89 dtex (8.0 denier) and a monofilament having a second single fineness of 6.67 dtex (6.0 denier) may be used as a filter for a smoking article to provide a larger Δ mg value.

45 **[0264]** As a result, since the lyocell materials according to Examples may include two or more monofilaments having different single finenesses, the lyocell materials may be used for both the preparation of a filter for a smoking article having a lower weight and the preparation of a filter for a smoking article having a higher weight as compared to the lyocell materials of Comparative Examples which include a monofilament having substantially one single fineness.

50

<Experiment 2: Evaluation of draw resistance of filter>

[0265] Filters for a smoking article respectively including the lyocell tows of Examples 1 to 25 and Comparative Examples 1 to 4 were prepared. The filters for the smoking article were each prepared in a rod shape. For each lyocell tow, minimum draw resistance and maximum draw resistance at which the lyocell tow could be provided as a filter were measured, respectively.

[0266] A draw resistance value was calculated based on a pressure difference (mmH₂O) measured at both ends of the filter for the smoking article when air passed through the filter at a constant speed (17.5 ml/sec) under standard conditions

(22±2 °C).

[Table 3]

5		Examples					Comparative Examples	
		1	2	3	4	5	1	2
	Minimum draw resistance (mmH ₂ O ¹)	235	225	220	230	235	250	245
	Maximum draw resistance (mmH ₂ O ²)	830	860	890	865	840	820	800
10	ΔmmH ₂ O (mmH ₂ O ¹ -mmH ₂ O ²)	595	635	670	635	605	570	555
		Examples					Comparative Examples	
		6	7	8	9	10	3	4
15	Minimum draw resistance	320	330	370	360	325	400	420
	(mmH ₂ O ¹)							
	Maximum draw resistance (mmH ₂ O ²)	1,050	1,080	1,100	1,090	1,030	1,000	990
	ΔmmH ₂ O (mmH ₂ O ¹ -mmH ₂ O ²)	720	760	790	730	705	600	570
20		Examples						
		11	12	13	14	15		
	Minimum draw resistance (mmH ₂ O ¹)	330	340	380	370	335		
25	Maximum draw resistance (mmH ₂ O ²)	1,060	1,090	1,100	1,080	1,040		
	ΔmmH ₂ O (mmH ₂ O ¹ -mmH ₂ O ²)	730	750	720	710	705		
		Examples						
		16	17	18	19	20		
30	Minimum draw resistance (mmH ₂ O ¹)	225	215	210	225	230		
	Maximum draw resistance (mmH ₂ O ²)	820	850	870	855	835		
	ΔmmH ₂ O (mmH ₂ O ¹ -mmH ₂ O ²)	595	635	660	630	605		
35		Examples						
		21	22	23	24	25		
	Minimum draw resistance (mmH ₂ O ¹)	320	330	375	360	340		
	Maximum draw resistance (mmH ₂ O ²)	1,040	1,070	1,090	1,075	1,045		
40	ΔmmH ₂ O (mmH ₂ O ¹ -mmH ₂ O ²)	720	740	715	715	705		

[0267] As confirmed in Table 3 above, the filters for the smoking article including the lyocell tow according to Examples 1 to 25 have a larger ΔmmH₂O value than the filters for the smoking article including the lyocell tows according to Comparative Example 1 and Comparative Example 2.

[0268] In particular, as confirmed in Table 3 above, the filters for the smoking article including the lyocell tows according to Examples 6 to 15 and Examples 21 to 25 were confirmed to have a ΔmmH₂O value exceeding 700 mmH₂O.

[0269] As a result, the lyocell materials according to Examples may each be used to implement lower draw resistance and higher draw resistance as compared to the lyocell materials of Comparative Examples.

[0270] Therefore, it is expected that the lyocell materials according to embodiments may provide a wider range of choices to consumers and manufacturers of smoking articles in terms of diversification and optimization of filters for smoking articles.

Claims

1. A lyocell material comprising:

a first lyocell multifilament; and
a second lyocell multifilament,
wherein the first lyocell multifilament comprises a first monofilament having a first single fineness, and
the second lyocell multifilament comprises a second monofilament having a second single fineness,
wherein the first single fineness is different from the second single fineness.

2. The lyocell material of claim 1, wherein at least one of the first lyocell multifilament and the second lyocell multifilament is crimped.
3. The lyocell material of claim 1, wherein a cross section of the first monofilament and a cross section of the second monofilament are each independently a multi-lobal cross section.
4. The lyocell material of claim 1, wherein at least one cross section of the first monofilament and at least one cross section of the second monofilament are similar to each other.
5. The lyocell material of claim 1, wherein space occupancy ratios of the first monofilament and the second monofilament are each independently in a range of 120 % to about 600 %.
6. The lyocell material of claim 1, wherein the first single fineness is greater than the second single fineness.
7. The lyocell material of claim 1, wherein the first single fineness is in a range of about 2.0 denier to about 8.0 denier, and/or the second single fineness is in a range of about 1.5 denier to about 6.0 denier.
8. The lyocell material of claim 1, wherein the first lyocell multifilament and the second lyocell multifilament are mixed and/or co-spun.
9. The lyocell material of claim 1, wherein the lyocell material has a total fineness of about 15,000 to about 55,000.
10. The lyocell material of claim 1, wherein a content of the first lyocell multifilament included in the lyocell material is about 1 part by weight to about 99 parts by weight with respect to 100 parts by weight of a total weight of the first lyocell multifilament and the second lyocell multifilament.
11. The lyocell material of claim 1, wherein the lyocell material is lyocell tow and/or is used for a filter for a smoking article.
12. A filter for a smoking article, comprising the lyocell material of any one of claims 1 to 11.
13. A smoking article comprising the filter for a smoking article of claim 12.
14. A method of preparing a lyocell material, the method comprising:
 spinning a lyocell dope; and
 performing coagulation and obtaining a multifilament,
 wherein the spinning of the lyocell dope comprises spinning a first lyocell multifilament comprising a first monofilament and spinning a second lyocell multifilament comprising a second monofilament,
 wherein a first single fineness of the first monofilament is different from a second single fineness of the second monofilament.
15. The method of claim 14, wherein the first lyocell multifilament and the second lyocell multifilament are spun by using a same lyocell dope or different lyocell dopes, and the spinning of the first lyocell multifilament and the spinning of the second lyocell multifilament are sequentially or simultaneously performed and/or are performed through a same spinneret or different spinnerets.



EUROPEAN SEARCH REPORT

Application Number

EP 24 21 8058

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 839 448 A (WOODINGS CALVIN R [GB]) 24 November 1998 (1998-11-24) * column 4, line 3 - line 10; claims 1-12 *	1-15	INV. D04H3/013 A24D3/02 A24D3/06 A24D3/10 D01F2/00
A	US 10 806 174 B2 (KOLON INC [KR]; KT & G CORP [KR]) 20 October 2020 (2020-10-20) * column 6, line 10 - line 18; example 1; table 1 *	1-15	
A	US 2017/156394 A1 (JEONG JONG CHEOL [KR] ET AL) 8 June 2017 (2017-06-08) * paragraph [0042]; example 1; table 1 *	1-15	
A,P	EP 4 437 866 A1 (KOLON INC [KR]; KT & G CORP [KR]) 2 October 2024 (2024-10-02) * claims 1-20; examples 1-3 *	1-15	
A,P	EP 4 335 308 A1 (KOLON INC [KR]; KT & G CORP [KR]) 13 March 2024 (2024-03-13) * claims 1-14; examples 1-3 *	1-15	
E	WO 2025/027345 A1 (NICOVENTURES TRADING LTD [GB]) 6 February 2025 (2025-02-06) * page 9, line 20 - page 10, line 31 * * page 11, line 4 - line 8 * * page 11, line 17 - line 24 * * page 16, line 29 - line 34 * * page 59, line 14 - line 30 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) D04H D01F A24B A24F A24D D01D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 March 2025	Examiner Demay, Stéphane
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5839448	A	24-11-1998	AT E173381 T1	15-12-1998
			AT E185686 T1	15-11-1999
			AU 2744895 A	15-01-1996
			AU 3270295 A	15-01-1996
			BR 9508060 A	18-11-1997
			BR 9508070 A	12-08-1997
			CN 1150746 A	28-05-1997
			CN 1151107 A	04-06-1997
			EP 0758853 A1	26-02-1997
			EP 0766519 A1	09-04-1997
			FI 965076 A	17-12-1996
			FI 965077 A	17-12-1996
			JP H10501416 A	10-02-1998
			JP H10501975 A	24-02-1998
			RU 2130279 C1	20-05-1999
			SK 161996 A3	10-09-1997
			SK 162096 A3	08-10-1997
US 10806174	B2	20-10-2020	US 5839448 A	24-11-1998
			WO 9535043 A1	28-12-1995
			WO 9535044 A1	28-12-1995
			-----	-----
			CN 105658852 A	08-06-2016
			EP 3051011 A1	03-08-2016
			JP 6370890 B2	08-08-2018
US 2017156394	A1	08-06-2017	JP 2016539254 A	15-12-2016
			RU 2016116012 A	31-10-2017
			US 2016235112 A1	18-08-2016
			US 2019223493 A1	25-07-2019
			-----	-----
US 2017156394	A1	08-06-2017	CN 106661768 A	10-05-2017
			EP 3162925 A1	03-05-2017
			JP 6495344 B2	03-04-2019
			JP 2017520689 A	27-07-2017
			KR 20160002603 A	08-01-2016
			US 2017156394 A1	08-06-2017
EP 4437866	A1	02-10-2024	-----	-----
			CA 3241432 A1	06-07-2023
			CN 118475258 A	09-08-2024
			EP 4437866 A1	02-10-2024
			JP 2024543888 A	26-11-2024
			KR 20230100668 A	05-07-2023
EP 4335308	A1	13-03-2024	WO 2023128522 A1	06-07-2023
			-----	-----
			EP 4335308 A1	13-03-2024
			JP 2024523387 A	28-06-2024
			US 2024284970 A1	29-08-2024
			-----	-----

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 24 21 8058

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11 - 03 - 2025

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2023054976 A1			06-04-2023

WO 2025027345	A1	06-02-2025	NONE

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20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82