(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 202 959 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.08.2017 Bulletin 2017/32

(21) Application number: **15847023.7**

(22) Date of filing: **30.09.2015**

(51) Int Cl.:
D01F 2/10 (2006.01) ***D01F 2/00*** (2006.01)

(86) International application number:
PCT/KR2015/010319

(87) International publication number:
WO 2016/052998 (07.04.2016 Gazette 2016/14)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **30.09.2014 KR 20140131932**
25.09.2015 KR 20150136000

(71) Applicant: **Kolon Industries, Inc.**
Gwacheon-si, Gyeonggi-do 13837 (KR)

(72) Inventors:
- **KIM, Seong Hun**
  Yongin-si
  Gyeonggi-do 446-797 (KR)
- **JEONG, Young Han**
  Yongin-si
  Gyeonggi-do 446-797 (KR)

(74) Representative: **Ter Meer Steinmeister & Partner**
Patentanwälte mbB
Nymphenburger Straße 4
80335 München (DE)

(54) LYOCELL CRIMPED FIBER

(57) Disclosed is a lyocell crimped fiber manufactured by crimping a lyocell multi-filament. The lyocell multi-filament is manufactured by spinning a lyocell spinning dope containing a cellulose pulp and an N-methylmorpholine-N-oxide (NMMO) aqueous solution. The lyocell crimped fiber has a blooming index of 800 to 2,000.

EP 3 202 959 A1

Description

Technical Field

[0001] The present invention relates, in general, to a lyocell fiber and, more particularly, to a lyocell crimped fiber.

Background Art

[0002] Fibers are linear objects that are flexible and thin and have a very large ratio of length to thickness, that is, very large fineness, in terms of shape. Fibers may be classified into long fibers, quasi-long fibers, and short fibers in terms of morphology, and into natural fibers and artificial fibers in terms of raw materials.

[0003] From the past, fibers have had a close relationship with human life. Early fibers were mainly used as raw materials for garments, and were natural fibers such as cotton, hemp, wool, and silk fibers. However, in accordance with the development of science and technology since the Industrial Revolution, the use of fibers has been expanded to industrial materials in addition to materials for coating. Further, the field of artificial fibers has been newly exploited in order to meet the rapidly growing demand for fibers according to the cultural development and population growth.

[0004] Artificial fibers have a tactile sensation and wearing sensation that are not inferior to those of natural fibers, and also have excellent strength and fast moisture absorption and discharge functions, thus being steadily preferred by consumers. Particularly, among artificial fibers, regenerated fibers synthesized from natural materials, such as wood pulp, have a tactile sensation that is almost the same as that of natural fibers and are considered to be harmless to the human body. Accordingly, interest in regenerated fibers is gradually increasing.

[0005] Among regenerated fibers, viscose rayon has been extensively used in the past as a fiber having excellent gloss and colorability, comparable to those of silk. However, in the case of the viscose rayon, the manufacturing process thereof is somewhat complicated and many chemicals are used during a process of melting wood pulp. Accordingly, the environmental problems and wastewater treatment have been continuously at issue. Therefore, regenerated fibers such as rayon-based regenerated fibers and cellulose acetate, which may replace conventional viscose rayon fibers such as cupra-rayon and lyocell, have begun to receive attention.

[0006] Particularly, lyocell fibers manufactured using natural pulp and amine oxide hydrates have excellent tensile properties and tactile sensation compared to conventional regenerated fibers, and amine oxide-based solvents used in the manufacture of the lyocell fibers may be recycled and biodegradable when discarded, and thus do not generate any pollutants during a manufacturing process. Accordingly, research on lyocell fibers, which serve as eco-friendly regenerated fibers, has been more actively conducted in recent years.

[0007] In a method of manufacturing a lyocell fiber described in, for example, U.S. Patent Nos. 4,416,698 and 4,246,221, a spinning dope containing cellulose dissolved in amine oxide (NMMO) is spun and solidified to manufacture a filament, and the filament is washed, dried, and processed. Further, the lyocell fibers are not naturally crimped. Accordingly, in order to beneficially use the lyocell fibers, wet fibers may be compressed according to the method described in EP No. 797,696, or crimping may be provided through a stuffer-box crimping process using dry steam according to the method described in EP No. 703,997.

[0008] In the case of conventional lyocell fibers, a blooming property obtained due to the formation of the crimps is not excellent. In addition, most research on lyocell fibers has only been made to improve the physical properties, for example, strength. Accordingly, there is a steady demand for technical research that effectively improves the blooming property of the lyocell fibers.

Disclosure

Technical Problem

[0009] Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and an object of the present invention is to provide a lyocell crimped fiber having an excellent crimp number and crimp stability, thus improving a blooming property.

Technical Solution

[0010] In order to accomplish the above object, the present invention provides a lyocell crimped fiber manufactured by crimping a lyocell multi-filament, the lyocell multi-filament being manufactured by spinning a lyocell spinning dope containing a cellulose pulp and an N-methylmorpholine-N-oxide (NMMO) aqueous solution, the lyocell crimped fiber having a blooming index of 800 to 2,000, which is defined by the following Equation 1.

(Equation 1) Blooming index = blooming factor (BF) X crimp number (CN) per inch

[0011] In Equation 1, the blooming factor is defined by the following Equation 2.

(Equation 2) Blooming factor = {(change in width of fiber before and after permanent deformation) ÷ (change in length of fiber before and after permanent deformation)} X 100

[0012] In an embodiment, the lyocell spinning dope may include 6 to 16 wt% of the cellulose pulp and 84 to 94 wt% of the N-methylmorpholine-N-oxide aqueous solution based on the total weight of the spinning dope.

[0013] The cellulose pulp may have an alpha-cellulose content of 85 to 97 wt% based on the total weight of the pulp, and may have a degree of polymerization (DPw) of 600 to 1700.

[0014] In the embodiment, the crimp number (CN) per inch may be 25 to 39/inch and the blooming factor (BF) defined by Equation 2 may be 30 to 50 in the lyocell crimped fiber.

[0015] In the embodiment, the lyocell multi-filament may include lyocell mono-filaments having a tensile strength of 2.0 to 3.5 g/d.

[0016] The lyocell mono-filaments may have a fineness of 1.0 to 8.0 denier and a ductility of 5 to 13%.

Advantageous Effects

[0017] According to the present invention, it is possible to provide a lyocell crimped fiber having an improved blooming property. The lyocell crimped fiber according to the present invention has an improved volume effect and excellent shape stability of crimps compared to a conventional lyocell fiber. Therefore, it is possible to expect physical properties equal to or better than those of the prior art even using a small amount of fiber when the lyocell crimped fiber is applied to clothing and industrial materials.

Best Mode

[0018] An aspect of the present invention may provide a lyocell crimped fiber manufactured by crimping a lyocell multi-filament. The lyocell multi-filament is manufactured by spinning a lyocell spinning dope containing a cellulose pulp and an N-methylmorpholine-N-oxide (NMMO) aqueous solution. The lyocell crimped fiber has a blooming index of 800 to 2,000, which is defined by the following Equation 1.

(Equation 1) Blooming index = blooming factor (BF) X crimp number per inch (CN)

[0019] In Equation 1, the blooming factor is defined by the following Equation 2.

(Equation 2) Blooming factor = {(change in width of fiber before and after permanent deformation) ÷ (change in length of fiber before and after permanent deformation)} X 100

[Blooming factor and blooming index]

[0020] Generally, crimping refers to a process for forming a crimp in a filament, in other words, a crimping process, and also to a process for forming a wrinkle in order to impart a natural fiber-like texture to artificial fibers manufactured by performing artificial spinning to obtain a fiber form. Since a space in which air may be present is formed between bundles of crimped fibers, a larger volume may be ensured even with the same weight, thereby providing a soft feeling and warmth. Further, air permeability may be ensured, thereby exhibiting an antibacterial effect. Further, when the material of the fiber is an eco-friendly biodegradable material, like the lyocell of the present invention, the effect of crimping may be doubled.

[0021] Accordingly, the crimped lyocell fiber may be used as a fiber material such as a winter garment, including an outdoor garment, innerwear, a hat, a sports sock, and underwear, a duvet, a medical fiber, and a sanitary article. The crimped lyocell fiber may also be used for an MRG (mechanical rubber good) such as a tire cord, various filters, and a hose reinforcement, a cement reinforcement, and vehicle interior reinforcements as industrial materials in the construction and vehicle fields.

[0022] In the present invention, a blooming index defined by Equation 1 is a value depending on the number of crimps formed per inch in the lyocell fiber and a blooming factor, which is a ratio of the change in width before/after the permanent deformation to the change in length before/after the permanent deformation. The greater the blooming index value, the greater the blooming factor or the crimp number per inch. Therefore, the degree of blooming of the lyocell fiber may be easily checked using the blooming index. When the blooming index is less than 800, it is difficult to sufficiently satisfy both the desired crimp number and blooming factor. When the blooming index is more than 2000, there may be a technical limit. Accordingly, it is preferable that the blooming index satisfy the above-described range.

[0023] In order to satisfy the above-described range of the blooming index in the present invention, the blooming factor, which is defined as the percentage value of the change in width of the fiber before/after permanent deformation to the change in length of the fiber before/after permanent deformation, as shown in Equation 2, is more preferably set to satisfy the range of 30 to 50, and the measured number of crimps (CN) per inch is preferably set to satisfy the range of 25 to 39/inch.

[0024] The term "permanent deformation" as used in the present invention means deformation at a time point at which the crimp is not returned to its original shape when the crimped fiber is pulled and then released. In the experiment of the present invention, the lyocell crimped fiber exhibited behavior of permanent deformation when a load is 4 kg.f. Accordingly, in the present invention, the tension at a load of 4 kg.f may be set as a reference for permanent deformation.

[0025] In the case of the preferably crimped fiber, since the crimp number per inch is sufficiently high, the degree of blooming of the fiber is favorable due to the crimping before permanent deformation, but after permanent deformation, the degree of blooming is significantly reduced, and accordingly, the change in width of the fiber is observed to be very large. On the other hand, in the case of the poorly crimped fiber, there is little difference in the degree of blooming caused by the crimp before and after the permanent deformation. As described above, as the blooming factor is increased, the blooming property may be improved due to the sufficient number of crimps, and thus a satisfactory blooming index value may be obtained.

[0026] However, since the crimp number per inch and the blooming factor are not conceptually in inverse proportion to each other, the blooming factor may be 30 or more, considering the minimum crimp number to be ensured (25/inch). Since the crimp number cannot be increased indefinitely, it may be undesirable for the blooming factor to be more than 50.

[0027] Meanwhile, the lyocell crimped fiber having the blooming property according to the present invention may be manufactured through the following steps (S1) to (S5).

[Step (S1)]

[0028] During the step (S1), the lyocell spinning dope containing the cellulose pulp and the N-methylmorpholine-N-oxide (NMMO) aqueous solution is spun. According to a preferable aspect of the present invention, the lyocell spinning dope may contain 6 to 16 wt% of the cellulose pulp and 84 to 94 wt% of the N-methylmorpholine-N-oxide aqueous solution. The cellulose pulp may have an alpha-cellulose content of 85 to 97 wt% and a degree of polymerization (DPw) of 600 to 1700.

[0029] When the content of the cellulose pulp is less than 6 wt%, it may be difficult to realize a fibrous structure and characteristic, and when the content of the cellulose pulp is more than 16 wt%, it may be difficult to dissolve the cellulose pulp in the aqueous solution, and the tensile strength may be unnecessarily increased. Further, when the content of the N-methylmorpholine-N-oxide aqueous solution is less than 84 wt%, it is disadvantageous in that a dissolution viscosity may be greatly increased. When the content of the N-methylmorpholine-N-oxide aqueous solution is more than 94 wt%, spinning viscosity may be greatly reduced, which makes the manufacture of the homogeneous fiber difficult during the spinning step.

[0030] Further, the step of discharging the spinning dope from a spinneret may be performed at a spinning temperature of 80 to 130°C. The spinneret serves to discharge the spinning dope on the filament into a solidifying solution in a solidifying bath through an air gap section. When the temperature deviates from the above-described spinning temperature range, the flowability of the spinning dope may be poor or the viscosity of the spinning dope may be reduced, and accordingly, it may be difficult to control a discharged amount.

[Step (S2)]

[0031] During the step (S2), the lyocell spinning dope spun during the step (S1) is solidified to obtain the lyocell multi-filament. The solidification of the step (S2) may include a primary solidifying step of supplying cooling air to the spinning dope to solidify the spinning dope using air quenching (Q/A), and a secondary solidifying step of adding the primarily solidified spinning dope to the solidifying solution to solidify the spinning dope.
[0032] During the step (S1), after the spinning dope is discharged through the spinneret, the spinning dope may be passed through the air gap section, which is a space between the spinneret and the solidifying bath. In the air gap section, cooling air is supplied from an air cooling section located inside the doughnut-shaped spinneret to the outside of the spinneret. The primary solidification may be performed using air quenching for supplying the cooling air to the spinning dope.
[0033] The factor affecting the physical properties of the lyocell multi-filament obtained during the step (S2) includes the temperature and the wind speed of the cooling air in the air gap section. Cooling air at a temperature of 4 to 15°C and a wind speed of 5 to 50 m/s may be supplied to the spinning dope, thereby performing the solidification of the step (S2). When the temperature of the cooling air is less than 4°C during the primary solidification, the surface of the spinneret is quickly cooled and the lyocell multi-filament is heterogeneously solidified, resulting in poor spinning processability. When the temperature of the cooling air is more than 15°C, primary solidification using the cooling air is insufficiently performed, which may negatively affect spinning processability.
[0034] Further, when the wind speed of the cooling air is less than 5 m/s during primary solidification, since primary solidification using the cooling air is insufficiently performed, spinning processability is reduced, thus causing yarn cutting. When the wind speed is more than 50 m/s, the spinning dope discharged from the spinneret may be shaken by air, thus reducing spinning processability.
[0035] After the primary solidification using air quenching, the spinning dope may be supplied to the solidifying bath containing the solidifying solution to thus perform the secondary solidification. In order to appropriately perform secondary solidification, the temperature of the solidifying solution is preferably 30°C or lower. Since the solidification temperature is not excessively high, the solidification rate may be appropriately controlled. The solidifying solution is not particularly limited, as long as it is manufactured so as to have a typical composition in the technical field to which the present invention belongs.

[Step (S3)]

[0036] During the step (S3), the lyocell multi-filament obtained during the step (S2) is washed with water. Specifically, the lyocell multi-filament obtained during the step (S2) may be introduced into a traction roller and then added into a washing bath to be washed with water. During the step of washing the filament, a washing solution at a temperature of 0 to 100°C may be used in consideration of ease of recovery and reuse of the solvent after washing with water. Water may be used as the washing solution, and if necessary, other additive components may be further included.

[Step (S4)]

[0037] During the step (S4), the lyocell multi-filament washed with water during the step (S3) is treated with an emulsion, and it is preferable to perform drying after the emulsion treatment. The emulsion treatment may be performed in such way that the multi-filament is completely immersed in the emulsion, and the amount of the emulsion applied on the filament is maintained using squeezing rollers attached to an entry roll and a discharge roll of an emulsion treatment device. The emulsion contributes to reducing the friction that occurs when the filaments come into contact with a drying roller and a guide during a crimping step, so that the crimp may be formed well.
[0038] According to the preferable aspect of the present invention, the strength of the lyocell mono-filament constituting the lyocell multi-filament manufactured through the steps (S1) to (S4) is preferably 2.0 to 3.5 g/d. The mono-filament refers to a single filament separated from the multi-filament that is discharged through a plurality of holes in the spinneret, solidified, washed with water, and treated with the emulsion, thus being made fibrous. The strength of the mono-filament may mean the strength of a single filament separated from the fibrous multi-filament.
[0039] Generally, the crimped fiber has improved physical properties such as a tactile sensation, bulkiness, warmth, and absorbency. Accordingly, a predetermined strength needs to be ensured, but it is unnecessary to excessively increase the strength. In other words, when the strength of the lyocell mono-filament is less than 2.0 g/d, the spinning processability may be reduced. When the strength of the lyocell mono-filament is more than 3.5 g/d, a very high load must be applied in order to cause blooming through carding after the crimp is formed, which negatively affects process efficiency.
[0040] Further, it is preferable for the lyocell mono-filament to have a fineness of 1.0 to 8.0 de in consideration of the blooming property. When the fineness of the mono-filament is less than 1.0 de (denier), twisting may occur between the

adjacent mono-filaments during carding after the crimps are formed, thus reducing a carding rate. When the fineness of the mono-filament is more than 8.0 de, a lot of steam and pressure must be provided in order to increase the crimp number, which negatively affects energy efficiency, and the weight of the final product may be relatively increased even when the degree of blooming is not changed.

[0041] Moreover, the ductility of the lyocell mono-filament may be 5 to 13%. When the ductility is less than 5%, the fiber may be easily broken during carding after the crimps are formed, thus reducing the yield. Due to the characteristic of the process, it is difficult to perform control so that the ductility of the mono-filament exceeds 13%, and it is also unnecessary to satisfy ductility that is more than 13%, considering the application field of the crimped fiber.

[Step (S5)]

[0042] During the step (S5) of the present invention, the lyocell multi-filament treated with the emulsion during the step (S4) is crimped. The blooming property of the lyocell crimped fiber of the present invention may be determined during the step (S5), and the crimps may be formed by applying steam to the lyocell multi-filament and applying pressure thereto. The specific crimping means is a stuffer box, which may be a means including a steam box and a press roller.

[0043] In the specific crimping method, preferably, the lyocell multi-filament is passed through the steam box to provide steam under 0.1 to 1.0 kgf/cm^2, thereby being heated. When the amount of steam supplied into the steam box is less than 0.1 kgf/cm^2, the press roller may not smoothly form the crimps, or even if the crimps are formed, the structural shape including the crimps may not be maintained because heat setting is not performed. When the amount is more than 1.0 kgf/cm^2, the temperature in the stuffer box rises to 120°C or higher, whereby the filaments stick to each other, so that the filaments cannot pass through the stuffer box.

[0044] After passing through the steam box, the lyocell multi-filament may be supplied to the press roller and then pressed under a pressure of 1.5 to 2.0 kgf/cm^2, thereby forming the crimp. When the pressure applied by the press roller is less than 1.5 kgf/cm^2, the desired crimp number is not obtained. When the pressure is more than 2.0 kgf/cm^2, the pressing force is too strong to pass the filaments through the stuffer box.

[0045] In the present invention, the number of crimps formed while passing through the stuffer box is very important. The crimp number is preferably 25 to 39/inch. When the crimp number is less than 25/inch, since it is not easy to perform carding, the blooming factor defined by Equation 1 is less than 30, and accordingly, the blooming characteristics in a width direction may be poor. Further, even if the pressure of the press roller is increased, there is a limit in increase of the crimp number to 39/inch or more.

Mode for Invention

[0046] A better understanding of the present invention may be obtained through the following Examples which are set forth to illustrate, but are not to be construed to limit the present invention.

Preparation Example 1

[0047] A cellulose pulp having a degree of polymerization (DPw) of 820 and an alpha-cellulose content of 93.9% was mixed with an NMMO/H_2O mixed solvent (weight ratio of 90/10) having a propylate content of 0.01 wt% to manufacture 12 wt% of a spinning dope for producing a lyocell fiber.

[0048] First, the spinning dope was maintained at a spinning temperature of 110°C in a spinning nozzle of a spinneret, and was spun while adjusting the discharge amount and the spinning speed of the spinning dope so that the single fineness of filaments was 3.37 denier. The filament shaped spinning dope discharged from the spinning nozzle was added to a solidifying solution in a solidifying bath through an air gap section. The spinning dope was primarily solidified in the air gap section using cooled air at a temperature of 8°C and a wind speed of 10 m/s.

[0049] The solidifying solution included 85 wt% of water and 15 wt% of NMMO at 25°C. The concentration of the solidifying solution was continuously monitored using a sensor and a refractometer. The filament drawn in an air layer using a traction roller was washed with a washing solution sprayed in a washing device, thus removing the remaining NMMO and uniformly applying an emulsion on the filament. The resulting filament was then squeezed so that the filament had an emulsion content of 0.2%, and was dried using a drying roller at 150°C, thus manufacturing a lyocell filament.

[0050] The manufactured lyocell multi-filament was passed through a stuffer box (press roller pressure of 1.5 kgf/cm^2) without separate steam treatment so that crimping was provided using only the press roller, thereby manufacturing a final lyocell crimped fiber.

[0051] The manufactured lyocell crimped fiber was cut to a length of 200 mm in a tension-free state, and was then fixed at a first point (0 mm position) and a middle point (100 mm position). In addition, tensile force was applied at a position of 200 mm to thus increase the length by 50% (50 mm), and the end point was fixed at the stretched position. Subsequently, the fixation at the position of 100 mm was loosened to divide the tension, and microscopic photographs were taken in order to obtain a crimp number (CN) per 10 mm. The crimp number (CN) was converted into CPI (counts per inch), and the crimp number of preparation Example 1 was 7 (ea/inch) when measured.

Preparation Examples 2 to 6

[0052] The lyocell crimped fiber was manufactured using the same method as in Preparation Example 1, except that the pressure of the press roller was changed, thereby obtaining Preparation Examples 2 to 6 having crimp numbers of 15 (ea/inch), 20 (ea/inch), 25 (ea/inch), 30 (ea/inch), and 39 (ea/inch). However, the crimp number was not increased any further even when the pressure of the press roller was changed to 39 ea/inch or more. Accordingly, in the Preparation Examples, the crimp number was varied up to 39 ea/inch.

Examples 1 to 3

[0053] The same method as in Preparation Examples 4 to 6 was applied to manufacture lyocell crimped fibers (Examples 1 to 3) having crimp numbers of 25 (ea/inch), 30 (ea/inch), and 39 (ea/inch), except that steam (120°C) under a pressure of 1.0 kgf/cm^2 was provided using a steam box in order to heat-set a lyocell fiber before the lyocell fiber were passed through press rollers in a stuffer box.

Comparative Examples 1 to 3

[0054] The same method as in Preparation Examples 1 to 3 was applied to manufacture lyocell crimped fibers (Comparative Examples 1 to 3) having crimp numbers of 7 (ea/inch), 15 (ea/inch), and 20 (ea/inch), except that steam treatment was performed in a stuffer box as in Examples 1 to 3.

Measurement Example

[0055] Each of Preparation Examples 1 to 6, Examples 1 to 3, and Comparative Examples 1 to 3 was left under conditions of constant temperature and humidity (temperature: 22°C and humidity: 55%) for 48 hours. A tensile strength test was then performed using a UTM (universal testing machine, INSTRON, model name: 5566, test mode: tension test). As a result of the tensile strength test, when a load was 4 kgf, permanent deformation of the crimped fiber began to appear. The length (I.length) and the width (I.width) of the sample before the tensile strength test and the length (A.length) and the width (A.width) of the permanently deformed sample after the tensile strength test were substituted into the following Calculation Equation 1, thereby calculating a blooming factor (BF).

Calculation Equation 1) Blooming factor = {(change in width of fiber before and after permanent deformation) ÷ (change in length of fiber before and after permanent deformation)} X 100

[0056] In Calculation Equation 1, the change ΔL in length of the fiber before and after the permanent deformation is |(A. length) - (I. length)|, and the change ΔW in width of the fiber before and after the permanent deformation is |(A.width) - (I.width)|.

[0057] Further, as shown in the following Calculation Equation 2, the crimp number of each of Examples 1 and 2 and Comparative Examples 1 and 2 was multiplied by the measured blooming factor to obtain a blooming index, and the obtained values are described in the following Table 1.

[0058] Calculation Equation 2) Blooming index = blooming factor (BF) X crimp number per inch (CN)

[Table 1]

Sample	Heat setting treatment	Cr. No. (CN)	ΔL[1)]	ΔW[2)]	Blooming factor	Blooming index (BFxCN)
Preparation Example 1	X	7	80	4	5.0	35.0

(continued)

Sample	Heat setting treatment	Cr. No. (CN)	ΔL[1)]	ΔW[2)]	Blooming factor	Blooming index (BFxCN)
Preparation Example 2	X	15	77	5	6.5	97.5
Preparation Example 3	X	20	76	7	9.2	184.0
Preparation Example 4	X	25	70	10	14.3	357.5
Preparation Example 5	X	30	68	10	14.7	441.0
Preparation Example 6	X	39	65	10	15.4	600.6
Comparative Example 1	○	7	78	4	5.1	35.7
Comparative Example 2	○	15	73	5	6.8	102.0
Comparative Example 3	○	20	65	7	10.7	214.0
Example 1	○	25	62	22	35.4	885.0
Example 2	○	30	60	24	40.0	1,200.0
Example 3	○	39	58	27	46.5	1,813.5
1) ΔL: Change in length of fiber before and after permanent deformation 2) ΔW: Change in width of fiber before and after permanent deformation						

[0059] From comparison of the results of the blooming factor and the blooming index in Table 1, it could be confirmed that the blooming factor and the blooming index were remarkably increased when the crimp number per inch was 25 or more. Particularly, when heat setting was performed, the blooming index was increased to 800 or more, and accordingly, the lyocell crimped fiber exhibited an excellent blooming property.

[0060] Particularly, even when the crimp number was 25 or more, if heat setting was not performed, the blooming factor did not approach 30, whereby the blooming index did not increase any further. Even if heat setting was performed, when the crimp number was less than 25, it was difficult to secure both a high blooming factor and a high blooming index.

Claims

1. A lyocell crimped fiber manufactured by crimping a lyocell multi-filament, the lyocell multi-filament being manufactured by spinning a lyocell spinning dope containing a cellulose pulp and an N-methylmorpholine-N-oxide (NMMO) aqueous solution, the lyocell crimped fiber having a blooming index of 800 to 2,000, which is defined by the following Equation 1:

(Equation 1) Blooming index = blooming factor (BF) X crimp number (CN) per inch,

where the blooming factor is defined by the foloowing Equation 2:

(Equation 2) Blooming factor = {(change in width of fiber before and after permanent deformation) ÷ (change in length of fiber before and after permanent deformation)} X 100.

2. The lyocell crimped fiber of claim 1, wherein the lyocell spinning dope includes 6 to 16 wt% of the cellulose pulp and 84 to 94 wt% of the N-methylmorpholine-N-oxide aqueous solution based on a total weight of the spinning dope.

3. The lyocell crimped fiber of claim 2, wherein the cellulose pulp has an alpha-cellulose content of 85 to 97 wt% based on a total weight of the cellulose pulp, and has a degree of polymerization (DPw) of 600 to 1700.

4. The lyocell crimped fiber of claim 1, wherein the crimp number per inch is 25 to 39/inch and the blooming factor defined by the Equation 2 is 30 to 50 in the lyocell crimped fiber.

5. The lyocell crimped fiber of claim 1, wherein the lyocell multi-filament includes lyocell mono-filaments having a tensile strength of 2.0 to 3.5 g/d.

6. The lyocell crimped fiber of claim 5, wherein the lyocell mono-filaments have a fineness of 1.0 to 8.0 denier.

7. The lyocell crimped fiber of claim 5, wherein the lyocell mono-filaments have a ductility of 5 to 13%.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2015/010319

A. CLASSIFICATION OF SUBJECT MATTER

D01F 2/10(2006.01)i, D01F 2/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D01F 2/10; B65H 63/06; D01F 2/02; D01F 2/00; D02G 1/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: lyocell fiber, crimp, swelling, cellulose pulp, N-methylmorpholine-N-oxide, crimping, swelling index

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-0808724 B1 (LENZING FIBERS LIMITED) 29 February 2008 See abstract; claim 1.	1-7
A	US 2010-0281662 A1 (MANNER, J. et al.) 11 November 2010 See abstract; claim 8; paragraphs [0003], [0022].	1-7
A	WO 95-24520 A1 (COURTAULDS FIBERS (HOLDINGS) LIMITED) 14 September 1995 See abstract; pages 9-11.	1-7
A	KR 10-2012-0032932 A (KOLON INDUSTRIES, INC.) 06 April 2012 See abstract; claims 1, 6.	1-7
A	WO 94-27903 A1 (COURTAULDS FIBRES (HOLDINGS) LIMITED) 08 December 1994 See abstract; claim 1.	1-7

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
11 DECEMBER 2015 (11.12.2015)	**17 DECEMBER 2015 (17.12.2015)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2015/010319

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-0808724 B1	29/02/2008	AU 2001-94030 A1	22/04/2002
		EP 1327013 A1	16/07/2003
		EP 1327013 B1	10/01/2007
		WO 02-31236 A1	18/04/2002
US 2010-0281662 A1	11/11/2010	EP 2173931 A1	14/04/2010
		EP 2173931 B1	01/02/2012
		JP 2010-532827 A	14/10/2010
		KR 10-1495620 B1	25/02/2015
		KR 10-2010-0031638 A	23/03/2010
		WO 2009-006656 A1	15/01/2009
WO 95-24520 A1	14/09/1995	CN 1139961 A	08/01/1997
		EP 0749502 A1	27/12/1996
		JP 09-509987 A	07/10/1997
KR 10-2012-0032932 A	06/04/2012	CN 103025931 A	03/04/2013
		CN 103025931 B	08/07/2015
		EP 2589689 A2	08/05/2013
		KR 10-1430714 B1	18/08/2014
		WO 2012-002729 A2	05/01/2012
WO 94-27903 A1	08/12/1994	EP 0700361 A1	13/03/1996
		EP 0700361 B1	10/09/1997
		JP 09-501471 A	10/02/1997
		US 05601765 A	11/02/1997

Form PCT/ISA/210 (patent family annex) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 4416698 A **[0007]**
- US 4246221 A **[0007]**
- EP 797696 A **[0007]**
- EP 703997 A **[0007]**