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

(11) EP 3 536 851 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.09.2019 Bulletin 2019/37

(21) Application number: **18160137.8**

(22) Date of filing: **06.03.2018**

(51) Int Cl.:
D21C 9/00 (2006.01) *D21H 11/00* (2006.01)
D21H 13/00 (2006.01) *D21H 13/02* (2006.01)
D21H 13/08 (2006.01) *D01F 2/02* (2006.01)

(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:
KH MA MD TN

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(54) LYOCELL FIBER WITH INCREASED TENDENCY TO FIBRILLATE

(57) The present invention provides a lyocell fiber with increased tendency to fibrillate, requiring a time of less than 80 minutes to obtain a 50° SR value according to ISO 5267-1:1999 while the reduction of the working capacity [cN/tex*%] at the 50° SR value is less than 50%, as well as a method for producing same and products comprising same.

Figure 1

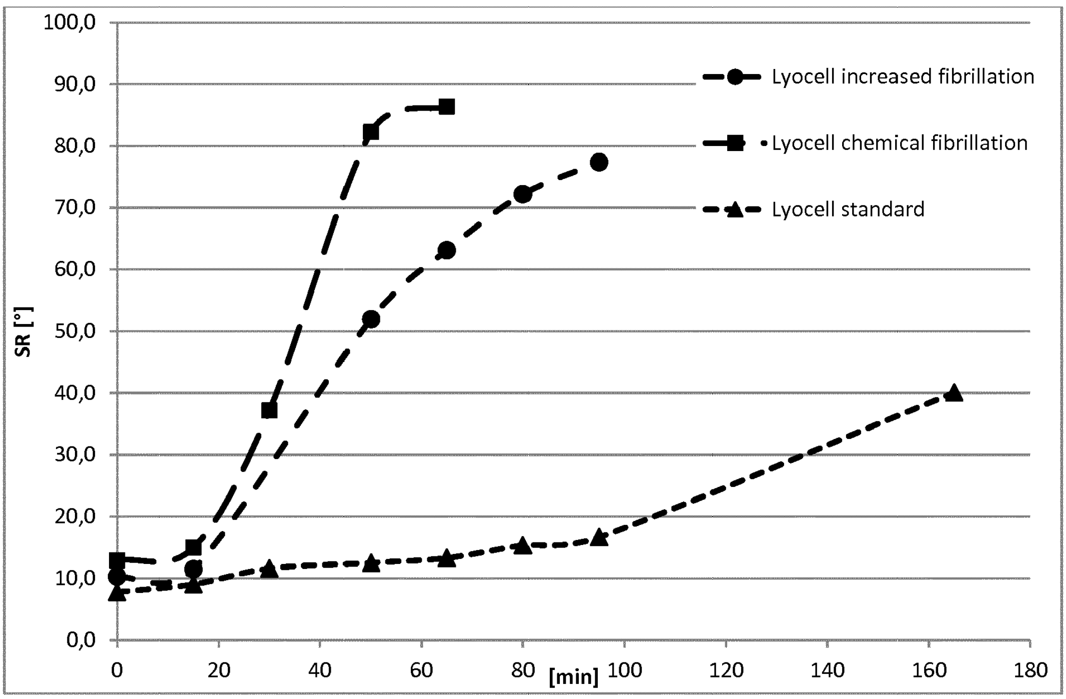

Figure 1: Fibrillation dynamics of three types of fibers

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Description

[0001] The present invention relates to a lyocell fiber with increased tendency to fibrillate, a method for producing same as well as products comprising the lyocell fiber.

State of the art:

[0002] Fibers of various types are employed for producing products such as wipes and tissues. Typically such fibers do show a high degree of fibrillation in order to enable uptake of other materials (during use or to provide functionalized wipes for example). One example of fibers employed in this field are cellulose based fibers. For example in the so-called wet-laid process fibrillated regenerated cellulose fibers, milled in refiners, which are well known to experts, are used in blends with pulps. Products from this process can be used in numerous applications - e.g. in wipes for cleaning and wiping and tissues and technical applications. The fibrillated fibers generate increased stability and improved uptake for cleaning purposes and a decreased air permeability and porosity.

[0003] US 8187422 describes a blend with fibrillated lyocell-microfibers and paper pulp to optimize cleaning performance of the final wipe product resulting in increased opacity and porosity and enhanced softness of the final product. In the patent it is indicated that lyocell fibers can be fibrillated in an aqueous medium with low solid content using a disk refiner or a similar device. Usually a chemical pre-treatment is employed for such fibers as to fibrillate the fibers without any chemical pre-treatment would consume enormous amounts of energy and time. US 8187422 discloses that the already fibrillated fibers (obtained from an external supplier) are processed to produce disposable wipes containing 25-75% of these fibrillated fibers.

[0004] US 6042769 shows an example of chemical treatments to enhance fibrillation tendency. It discloses chemical treatments to reduce the DP (degree of polymerization) by 200 units, thereby increasing fibrillation tendency. Chemical treatments mentioned in this patent refer to the use of bleaching reagents, such as sodium hypochlorite or mineral acids, such as hydrochloric acid, sulfuric acid or nitric acid. A commercialization of this procedure did not succeed up to now.

[0005] US 9222222 discloses mixtures of lyocell fibers and low DP or standard DP cellulose pulp fibers with a CSF (Canadian Standard Freeness) of 250 ml or less, retaining the CSF values even after drying. The pulp fibers account for 10-75% of total weight of fibers in the mixture. The low DP pulp contains higher amounts of hemicelluloses, but is only added to the mixtures as a low DP pulp, without mentioning any relevance of the hemicellulose content. The fibrillation tendency is measured using the CSF-method (Canadian Standard of Freeness) according to TAPPI Standard T227 om-94.

[0006] WO 2016065377 describes a wipe containing 5-20 wt% of a fast fibrillating lyocell fiber produced by chemical treatments with mineral acids. This fiber is characterized by a very fast fibrillation. During refining this fast fibrillation is not always feasible. Whilst the standard lyocell fibers tend to fibrillate too slow, this fiber fibrillates too fast. In addition it has to be taken into consideration that chemical treatment induced fibrillation has detrimental effects on fiber properties. US 6706237 discloses that meltblown fibers obtained from hemicelluloses rich pulps show a decreased or reduced tendency to fibrillate. US 8420004 discloses another example of meltblown fibers for producing non-woven fabrics.

[0007] Zhang et al (Polymer Engineering and Science, 2007, 47, 702-706) describe fibers with higher hemicellulose contents. The authors postulate that the fibers tend to show an enhanced fiber fibrillation resistance, lower crystallinity and better dyeability. They also postulate that the tensile strength only decreases insignificantly and that the fiber properties could be even increased further by higher hemicelluloses concentrations in the spinning dope. Zhang et al (Journal of Applied Polymer Science, 2008, 107, 636-641), Zhang et al (Polymer Materials Science and Engineering, 2008, 24, 11, 99-102) disclose the same figures as the paper by Zhang (Polymer Engineering and Science, 2007, 47, 702-706), while Zhang et al (China Synthetic Fiber Industry, 2008, 31, 2, 24-27) describe better mechanical properties. The same authors postulate this same theory in Journal of Applied Science, 2009, 113, 150-156.

Object of the present invention

[0008] In view of the increasing demands for fibers based on cellulose raw materials suitable for products such as wipes and tissues, a fiber with a well-balanced fibrillation tendency between standard lyocell fibers and fast fibrillating fibers described in WO 2016065377 and US 6042769 is desired. At the same time it would be advantageous if chemical pre-treatments disclosed in the prior art as being essential to achieve the desired fibrillation tendency could be avoided, as these add costs to the final product and decrease mechanical properties, so that the fibers obtained are not always suitable for all desired applications. Therefore the task for the present inventors was to provide fibers that can be fibrillated in a cost-effective way, whilst maintaining most of its working capacity for good mechanical properties of the wipe. Additionally well-balanced fibrillation dynamics are in embodiments desired during the refining process. In many non-woven applications a fast fibrillating fiber with good fiber properties is desired, as it enables easier processing of the fiber and results in improved strength and porosity properties of the wipe.

Brief description of the invention

[0009] The present inventors accordingly provide the fiber as defined in claim 1, the method for producing same as described in claim 11 as well as products containing same as defined in claim 16 as well as the use defined in claim 8. Preferred embodiments are described in the respective subclaims as well as in the specification.

[0010] In particular the present invention provides the following embodiments, which are further explained and illustrated below.

1.) Lyocell fiber with increased tendency to fibrillate without chemical treatment, requiring a time of less than 80 minutes to obtain a 50° SR value according to ISO 5267-1:1999 while the reduction of the working capacity [cN/tex*%] at the 50° SR value is less than 50%.

2.) Lyocell fiber according to embodiment 1, wherein the time required to obtain the 50° SR value is less than 60 minutes but more than 40 minutes.

3.) Lyocell fiber according to embodiment 1 and/or 2, wherein the reduction of the working capacity is less than 40%, preferably less than 30%.

4.) Lyocell fiber according to any one of embodiments 1 to 3, having a titer of 9 dtex or less, such as 6 dtex or less, preferably 3 dtex or less.

5.) Lyocell fiber according to any one of embodiments 1 to 4, produced from a pulp having a hemicelluloses content of 7 wt.-% or more and 25 wt.-% or less.

6.) Lyocell fiber according to embodiment 5, wherein the hemicellulose comprises a ratio of C5/xylan to C6/mannan of from 125:1 to 1:3, preferably of from 25:1 to 1:2.

7.) Lyocell fiber according to any one of embodiments 5 or 6, wherein the pulp comprises 5 wt.-% or more xylan, preferably 8 wt.-% or more, more preferably 10 wt.-% or more and/or 3 wt.-% or more mannan, preferably 5 wt.-% or more mannan, and/or 1 wt.-% or less mannan.

8.) Use of a pulp for producing a fiber according to any one of embodiments 1 to 7, wherein the pulp has a hemicelluloses content of 7 wt.-% or more and 25 wt.-% or less.

9.) Use according to embodiment 8, wherein the hemicellulose comprises a ratio of C5/xylan to C6/mannan of from 125:1 to 1:3, preferably of from 25:1 to 1:2.

10.) Use according to any one of embodiments 8 or 9, wherein the pulp comprises 5 wt.-% or more xylan, preferably 8 wt.-% or more, more preferably 10 wt.-% or more and/or 3 wt.-% or more mannan, preferably 5 wt.-% or more mannan, and/or 1 wt.-% or less mannan.

11.) Method for producing the lyocell fiber according to any one of embodiments 1 to 7 using a direct dissolution process.

12.) Method for producing the lyocell fiber according to embodiment 11 using an amine oxide process, where an aqueous solution of the amine oxide and the pulp form a cellulose suspension and a shapeable solution which gets shaped and coagulated in a spin bath obtaining the lyocell fiber after washing and pre-treatment steps.

13.) Method for producing the lyocell fiber according to embodiment 12 using an aqueous tertiary amine oxide, preferably aqueous NMMO.

14.) Method according to any one of embodiments 11 to 13, wherein the spinning solution contains a pulp with a hemicelluloses content of greater than 10 wt.-% based on the total weight of cellulose and hemicelluloses contained.

15.) Lyocell fiber, use or method according to any one of the preceding embodiments, wherein the pulp has a scan viscosity of from 300 to 440 ml/g.

16.) Product, comprising the lyocell fiber according to any one of embodiments 1 to 7 or 15, or the fiber produced according to any one of claims 11 to 15.

17.) Product according to embodiment 16, wherein the product is a non-woven fabric.

18.) Product according to embodiment 16 and/or 17, selected among tissues and wipes.

19.) Product according to embodiment 16, wherein the product is a speciality paper.

20.) Product according to embodiment 19, wherein the speciality paper is a filter.

Brief description of the Figure

[0011] Figure 1 shows the fibrillation dynamics of a fiber in accordance with the present invention in comparison with a standard lyocell fiber and a lyocell fiber subjected to chemical fibrillation.

Detailed description of the invention

[0012] As defined in claim 1 the fiber in accordance with the present invention is a lyocell fiber with an increased tendency to fibrillate without requiring a chemical pre-treatment. Such a chemical pre-treatment step is for example described in AT 515693 B1.

[0013] The lyocell process is well known in the art and relates to a direct dissolution process of cellulose wood pulp or other cellulose-based feedstock in a polar solvent (for example N-methylmorpholine N-oxide [NMMO, NMO] or ionic liquids). Commercially, the technology is used to produce a family of cellulose staple fibers (commercially available from Lenzing AG, Lenzing, Austria under the trademark TENCEL® or TENCEL™) which are widely used in the textile and nonwoven industry. Other cellulose bodies from lyocell technology have also been produced.

[0014] According to this method the solution of cellulose is extruded in a so called dry-wet-spinning process by means of a forming tool and the moulded solution is guided for example over an air gap into a precipitation bath, where the moulded body is obtained by precipitation of the cellulose. The molding is washed and optionally dried after further treatment steps.

[0015] Such lyocell fibers are well known in the art and the general methodology to produce same is for example disclosed in US 4,246,221 and its analytics in the BISFA (The International Bureau for the Standardization of Man-Made Fibers) publication "Terminology of Man-Made Fibres", 2009 edition. Both references are included herewith in their entirety by reference.

[0016] The term lyocell fiber as employed herein defines a fiber obtained by this process, as it has been found that fibers in accordance with the present invention differ greatly from fibers for example obtained from a meltblown process, even if using a direct dissolution process of cellulose wood pulp or other cellulose-based feedstock in a polar solvent (for example N-methylmorpholine N-oxide [NMMO, NMO] or ionic liquids) in order to produce the starting material.

[0017] The term hemicelluloses as employed herein refers to materials known to the skilled person which are present in wood and other cellulosic raw material such as annual plants, i.e. the raw material from which cellulose typically is obtained. Hemicelluloses are present in wood and other plants in form of branched short chain polysaccharides built up by pentoses and/or hexoses (C5 and / or C6-sugar units). The main building blocks are mannose, xylose, glucose, rhamnose and galactose. The back bone of the polysaccharides can consist of only one unit (f.e. xylan) or of two or more units (e.g. mannan). Side chains consist of arabinose groups, acetyl groups, galactose groups and O-acetyl groups as well as 4-O-methylglucuronic acid groups. The exact hemicellulose structure varies significantly within wood species. Due to the presence of sidechains hemicelluloses show much lower crystallinity compared to cellulose. It is well known that mannan predominantly associates with cellulose and xylan with lignin. In sum, hemicelluloses influence the hydrophilicity, the accessibility and degradation behavior of the cellulose-lignin aggregate. During processing of wood and pulp, side chains are cleaved off and the degree of polymerization is decreased. The term hemicelluloses as known by the skilled person and as employed herein comprises hemicelluloses in its native state, hemicelluloses degraded by ordinary processing and hemicelluloses chemically modified by special process steps (e. g. derivatization) as well as short chain celluloses and other short chain polysaccharides with a degree of polymerization (DP) of up to 500.

[0018] The pulps preferably employed in the present invention do show as outlined herein a high content of hemicelluloses. Compared with the standard low hemicellulose content pulp employed for the preparation of standard lyocell fibers the preferred pulps employed in accordance with the present invention do show also other differences, which are outlined below.

[0019] Compared with standard pulps the pulps as employed herein display a more fluffy appearance, which results after milling (during preparation of starting materials for the formation of spinning solutions for the lyocell process), in the presence of a high proportion of larger particles. As a result the bulk density is much lower, compared with standard pulps having a low hemicellulose content. This low bulk density requires adaptions in the dosage parameters (f.e. dosage from at least 2 storage devices). In addition the pulps employed in accordance with the present invention are more difficult to impregnate with NMMO. This can be seen by evaluating the impregnating behavior according to the Cobb evaluation. While standard pulps do show a Cobb value of typically more than 2.8 g/g (determined according to DIN EN ISO 535 with the adaptation of employing an aqueous solution of 78% NMMO at 75° C with an impregnation time of 2 minutes), the pulps employed in the present invention do show Cobb values of about 2.3 g/g. This requires an adaptation during spinning solution preparation, such as increased dissolution time (f.e. explained in WO 9428214 and WO 9633934) and/or temperature and/or increased searing during dissolution (f.e. WO9633221, WO9805702 and WO 9428217). This ensures the preparation of a spinning solution enabling the use of the pulps described herein in standard lyocell spinning processes.

[0020] In one preferred embodiment of the present invention the pulp employed for the preparation of the lyocell products, preferably fibers, as described herein, has a scan viscosity in the range of from 300-440 ml/g, especially 320-420 ml/g, more preferably 320 to 400 ml/g. The scan viscosity is determined in accordance with SCAN-CM 15:99 in a cupriethylenediamine solution, a methodology which is known to the skilled person and which can be carried out on commercially available devices, such as the device Auto PulpIVA PSLRheotek available from psl-rheotek. The scan viscosity is an important parameter influencing in particular processing of the pulp to prepare spinning solutions. Even if two pulps seem to be of great similarity as raw material for the lyocell-process, different scan viscosities will lead to completely different behaviour during processing. In a direct solvent spun process like the lyocell-process the pulp is dissolved in NMMO as such. No ripening step exists comparable to the viscose process where the degree of polymerization of the cellulose is adjusted to the needs of the process. Therefore, the specifications for the viscosity of the raw material pulp typically are within a small range. Otherwise, problems during production may arise. In accordance with the present invention it has been found to be advantageous if the pulp viscosity is as defined above. Lower viscosities compromise mechanical properties of the lyocell products. Higher viscosities in particular may lead to the viscosity of the spinning dope being higher and therefore, spinning will be slower. With a slower spinning velocity lower draw ratios will be attained, which significantly alters the fiber structure and its properties (Carbohydrate Polymers 2018, 181, 893-901; Structural analysis of loncell-F fibres from birch wood, Shirin Asaadia; Michael Hummel; Patrik Ahvenainen; Marta Gubitosic; Ulf Olsson, Herbert Sixta). This will require process adaptations and will lead to a decrease in mill capacity. Employing pulps with the viscosities as defined here enables smooth processing and production of high quality products.

[0021] As employed herein the terms lyocell process and lyocell technology relate to a direct dissolution process of cellulose wood pulp or other cellulose-based feedstock in a polar solvent (for example N-methylmorpholine N-oxide [NMMO, NMO] or ionic liquids). Commercially, the technology is used to produce a family of cellulose staple fibers (commercially available from Lenzing AG, Lenzing, Austria under the trademark TENCEL® or TENCEL™) which are widely used in the textile and nonwoven industry. Other cellulose bodies from lyocell technology have also been produced. According to this method the solution of cellulose is usually extruded in a so called dry-wet-spinning process by means of a forming tool and the moulded solution gets for example over an air gap into a precipitation bath, where the moulded body is obtained by precipitation of the cellulose. The moulding is washed and optionally dried after further treatment steps. A process for production of lyocell fibers is described, for instance, in US 4,246,221, WO 93/19230, WO95/02082 or WO97/38153. As far as the present application discusses the drawbacks associated with the prior art and the unique properties for novel products as disclosed and claimed herein in the context of using laboratory equipment (in particular in the prior art) or (semi-commercial) pilot plants and commercial fiber spinning units, the present invention is to be understood to referring to larger scale plants/units, which may be considered as follows concerning their respective production capacity:

semi-commercial pilot plant: about1 kt/a

commercial unit >30 kt/a

[0022] The task mentioned above was solved by lyocell fibers with enhanced fibrillation tendencies, which were produced without any chemical pre-treatment. The chemical pre-treatment step weakens the fiber properties (working capacity) on the one hand and adds cost to the fiber production on the other hand. Additionally the fiber in accordance with the present invention shows well-balanced fibrillation dynamics between standard lyocell fibers and fast fibrillated fibers obtained with additional chemical pre-treatments.

[0023] Accordingly, the lyocell fiber in accordance with the present invention avoids the need for chemical pre-treatment whilst achieving fast fibrillation.

[0024] Standard lyocell fibers are currently commercially produced from high quality wood pulps with high α-cellulose content and low non-cellulose contents such as hemicelluloses. Commercially available lyocell fibers such as TENCEL™fibers produced from Lenzing AG, show excellent fiber properties for non-wovens and textile applications.

[0025] As mentioned in the patents referred to above, if a high fibrillation tendency is required these lyocell fibers are chemically pre-treated using f.e. mineral acids or bleaching reagents. By this chemical treatment the fiber properties are weakened drastically and the working capacity decreases.

[0026] The present invention overcomes the shortcomings of the state of the art by providing lyocell fibers as described herein.

[0027] Preferably these are produced from hemicellulose-rich pulps with a hemicelluloses content of at least 7 wt.-%. Contrary to the disclosure in the prior art discussed above, such high hemicellulose content surprisingly, for lyocell fibers in accordance with the definition as provided herein, gives rise to an increased tendency to fibrillate while having only minor effect on the mechanical properties of the fibers. At the same time this increased tendency to fibrillate is achieved without need for a chemical treatment considered necessary in the prior art. Accordingly the present invention surprisingly achieves the tasks as outlined above while using a cellulose based raw material with a higher hemicelluloses content, as compared for standard lyocell fibers. Since the present invention does not require the use of chemical pre-treatments to achieve the desired fibrillation the decrease in mechanical fiber properties associated with the prior art can be overcome.

[0028] As already outlined above, Zahng et al (Polym. Engin. Sci., 2007, 47, 702-706) describe fibers with high hemicellulose contents. The authors postulate that the fibers received tend to show an enhanced fiber fibrillation resistance.

[0029] The fibrillation tendencies of the fibers are analyzed according to ISO 5267-1:1999 - determination of drainage - Part 1: Schopper-Riegler (SR) method. The SR method provides a degree of drainage velocity of a diluted cellulose fiber suspension. Surprisingly the present invention provides fibers with completely different properties as with the higher hemicelluloses content the fibrillation tendency increases drastically. One possible explanation for these contrasting findings may be the fact that the fibers in accordance with the present invention are fibers produced using large scale production equipment, while the fibers described in the paper by Zhang et al are produced with lab equipment not allowing the production of lyocell fibers in commercial quality (as for example drawing ratios, production velocities and after treatment do not reflect scale-up qualities). The fibers, not being produced with sufficient drawing and a sufficient after-treatment therefore show different structure and properties compared to the fibers produced at production scale at titers reflecting market applications.

[0030] The fibers in accordance with the present invention were produced on a semi-commercial pilot plant (~1 kt/a) and a complete, commercial-like after-treatment of the fiber. A straightforward scale-up from this production unit to a commercial unit (>30 kt/a) is feasible and reliable.

[0031] The hemicellulose content may be adjusted according to procedures known in the art. The hemicellulose may be the hemicelluloses originating from the wood from which the pulp is obtained, it is however also possible to add individual hemicelluloses depending on the desired fiber properties from other sources to high purity cellulose with a low original hemicellulose content. The addition of individual hemicelluloses may also be employed to adjust the composition of the hemicelluloses content, for example to adjust the ratio of hexoses to pentoses.

[0032] The pulp enabling the preparation of the fibers in accordance with the present invention preferably shows a ratio of C5/xylan to C6/mannan of from 125:1 to 1:3, preferably in the range of 25:1 to 1:2. The hemicellulose content may be 7 wt.-% or more, preferable 10 wt.-% or more and in embodiments up to 25 wt.-% or even 30 wt.-%. In embodiments the xylan content is 5 wt.-% or more, such as 8 wt.-% or more, and in embodiments 10 wt.-% or more. In embodiments, either in isolation or in combination with the above mentioned hemicelluloses and/or xylan contents, the mannan content is 3 wt.-% or more, such as 5 wt.-% or more. In other embodiments the mannan content, preferably in combination with a high xylan content as defined above, may be 1 wt.-% or less, such as 0.2 wt.-% or 0.1 wt.-% or less.

[0033] As mentioned above, the hemicelluloses content in the fibers of the present invention generally is higher, as compared to standard lyocell fibers. Suitable contents are 5 wt.-% or more and up to 30 wt.-%. Preferably the fiber in accordance with the present invention shows a ratio of C5/xylan to C6/mannan of from 125:1 to 1:3, preferably in the range of 25:1 to 1:2. As regards the xylan and/or mannan content the above provided embodiments described in relation with the pulp are applicable also for the fiber as such.

[0034] The fibers in accordance with the present invention typically have a titer of 9 dtex or less, such as 3.3 dtex or less, such as 2.2 dtex, depending on the desired application. If the fiber is intended to be used in non-woven applications a titer of 1.3 or higher such as 1.7 dtex typically is suitable. However, the present invention also covers fibers with much lower titers, with suitable lower limits for titers being 0.5 dtex or higher, such as 0.8 dtex or higher, and in embodiments 1.3 dtex or higher. These upper and lower values as disclosed here define ranges of from0.5 to 9 dtex, and including all further ranges formed by combining any one of the upper values with any one of the lower values.

[0035] The fiber in accordance with the present invention may be prepared using lyocell technology employing a solution of cellulose and a spinning process employing a precipitation bath according to standard lyocell processes, known to the skilled person. Furthermore the fiber employed does not require any chemical pre-treatment known to enhance fibrillation tendencies, as the present invention achieves fibrillation to the required extend without such treatment, which typically decreases DP by several hundred units.

[0036] The fibers in accordance with the present invention may be employed for a variety of applications, such as the production of non-woven fabrics. Examples of products include tissues, wipes and speciality papers (f.e. filter applications) produced by wet-laid and/or air-laid techniques. The fibers in accordance with the present invention may by employed as the only fiber of a desired product or they maybe mixed with other types of fibers. The mixing ratio can depend from the desired end use. If for example a wipe with increased mechanical properties is desired the fibers in accordance with the present invention may be present in a higher amount, relative to other high fibrillation fibers according to the prior art, in order to secure the desired mechanical properties, while in other applications a lower relative amount of fibers of the present invention may be sufficient.

[0037] As far as the present application refers to parameters, such as crystallinity, scan viscosity etc., it is to be understood that same are determined as outlined herein, in the general part of the description and/or as outlined in the following examples. In this regard it is to be understood that the parameter values and ranges as defined herein in relation to fibers refer to properties determined with fibers derived from pulp and containing only additives, such as processing aids typically added to the dope as well as other additives, such as matting agents (TiO_2, which often is added in amounts of 0.75 wt.-%), in a total amount of up to 1 wt.-% (based on fiber weight). The unique and particular properties as reported herein are properties of the fibers as such, and not properties obtained by addition of particular additives and/or post spinning treatments (such as fibrillation improving treatments etc.).

[0038] However, it is clear to the average skilled person that the fibers as disclosed and claimed herein may comprise additives, such as inorganic fillers etc. in usual amounts as long as the presence of these additives has no detrimental effect on dope preparation and spinning operation. The type of such additives as well as the respective addition amounts are known to the skilled person.

Examples:

Example 1: Comparison of fibrillation dynamics

[0039] 3 different fiber types were compared:

The standard 1.7 dtex / 4 mm lyocell fibers are commercially available as TENCEL™ fibers from Lenzing AG ("lyocell standard").

[0040] Lyocell fibers subjected to a chemical pre-treatment ("lyocell chemical fibrillation") were produced as described in WO 2016065377. A fiber tow with single titers of 1.7 dtex was impregnated with diluted sulfuric acid at room temperature with a liquor ratio 1:10 and afterwards pressed to -200% moisture. After-treatment of the fiber tow in a steamer for -10 min allows application of water vapor under pressure. The fiber bundle is washed acid-free, a soft-finish is applied and the fibers are dried. The dried fiber tow is cut into 4 mm shortcut fibers subsequently ending up with 1.7 dtex / 4 mm "lyocell chemical fibrillation" fibers.

[0041] "Lyocell increased fibrillation" fibers were produced from a hemicellulose-rich pulp with a hemicelluloses content of >10% (xylan, mannan, arabinan,...), yielding after post-spinning treatment 1.7 dtex / 4 mm "lyocell increased fibrillation" fibers.

[0042] The composition of the hemicellulose-rich pulp compared to the standard pulp used to produce lyocell fibers is shown in table 1.

Table 1: Comparison of different hemicellulose contents of pulps

Sugar [%ATS]	Standard lyocell pulp	Hemicellulose-rich pulp
Glucan	95.5	82.2
Xylan	2.3	8.3
Mannan	0.2	5.7
Arabinan	<0.1	0.3
Rhaman	<0.1	<0.1
Galactan	<0.1	0.2

[0043] The 3 different fiber types were refined in an Andritz Laboratory plant 12-1C plate refiner (NFB, S01-218238) at a starting concentration of 6 g/l, 1400 rpm and 172 l/min flow rate. The gap was fixed at 1 mm.

[0044] The refining results are illustrated in figure 1. It can be seen that lyocell increased fibrillation and lyocell chemical fibrillation fibers fibrillate at a significant higher rate compared to lyocell standard fibers, meaning a decrease in time- and energy effort. The lyocell increased fibrillation fiber however showed a slower increase in fibrillation than the chemical fibrillation fibers.

Example 2: Comparison fibrillation time and tenacity

[0045] In table 2 the time to achieve a 50° SR (analyzed according to ISO 5267-1:1999) and the fiber tenacities of lyocell increased fibrillating and lyocell chemical fibrillation fibers are compared. In the observed fibrillation window the lyocell standard fiber did not achieve a 50° SR.

Table 2: Comparison of time to achieve 50° SR and tenacity of fibers (working capacity determined in accordance with BISFA definitions).

Property	lyocell increased fibrillation	lyocell chemical fibrillation
50° SR	48 min	35 min
Working capacity [cN/tex*%]	380	228

[0046] It can be seen that the two fiber types show a high fibrillation tendency. To achieve a 50° SR both types of fibers require a time of less than 60 minutes.

[0047] It is also obvious; however, that the chemical treatment also has a detrimental effect on the fiber properties as the working capacity is lowered significantly to about 60% of its initial value. On the other hand, the fiber in accordance with the present invention only shows, if at all, a minor decrease in working capacity thereby proving the superiority of the lyocell increased fibrillation fiber of the present invention.

[0048] In table 4 the CSF (analyzed according to TAPPI Standard T227 om-94) values of different fiber types are compared. The CSF values after 8 min of mixing are shown.

[0049] The fibers are produced according to example 1 with a cutting length of 38 mm. The nonwoven fibers (NW) are incorporated with 0,75% TiO_2 as a dulling agent. The composition of the hemicellulose-rich pulp used to produce the lyocell increased fibrillation II is shown in table 3.The results again confirm that in accordance with the present invention lyocell fibers are obtained with an increased tendency to fibrillate, without need for a chemical treatment and without the detrimental effects associated in the prior art with such treatments.

Table 3: Sugar content of hemicellulose-rich pulp employed to produce lyocell increased fibrillation II.

Sugar [%ATS]	Hemi-rich pulp II
Glucan	82.3
Xylan	14
Mannan	<0.2
Arabinan	<0.1
Rhaman	<0.1
Galactan	<0.1

Table 4: Comparison of CSF values of different fibers after 8 min of mixing time.

Fiber type	CSF [ml]
lyocell standard	405
lyocell standard NW	285
lyocell chemical fibrillation	167
lyocell increased fibrillation	276
lyocell increased fibrillation NW	115
lyocell increased fibrillation II NW	269

Claims

1. Lyocell fiber with increased tendency to fibrillate without chemical treatment, requiring a time of less than 80 minutes to obtain a 50° SR value according to ISO 5267-1:1999 while the reduction of the working capacity [cN/tex*%] at the 50° SR value is less than 50%.

2. Lyocell fiber according to claim 1, wherein the time required to obtain the 50° SR value is less than 60 minutes but more than 40 minutes.

3. Lyocell fiber according to claim 1 and/or 2, wherein the reduction of the working capacity is less than 40%, preferably less than 30%.

4. Lyocell fiber according to any one of claims 1 to 3, having a titer of 9 dtex or less, such as 6 dtex or less, preferably 3 dtex or less.

5. Lyocell fiber according to any one of claims 1 to 4, produced from a pulp having a hemicelluloses content of 5 wt.-% or more, preferably 7 wt.-% or more, and 25 wt.-% or less.

6. Lyocell fiber according to claim 5, wherein the hemicellulose comprises a ratio of C5/xylan to C6/mannan of from

125:1 to 1:3, preferably of from 25:1 to 1:2.

7. Lyocell fiber according to any one of claims 5 or 6, wherein the pulp comprises 5 wt.-% or more xylan, preferably 8 wt.-% or more, more preferably 10 wt.-% or more and/or 3 wt.-% or more mannan, preferably 5 wt.-% or more mannan, and/or 1 wt.-% or less mannan.

8. Use of a pulp for producing a fiber according to any one of claims 1 to 7, wherein the pulp has a hemicelluloses content of 7 wt.-% or more and 25 wt.-% or less.

9. Use according to claim 8, wherein the hemicellulose comprises a ratio of C5/xylan to C6/mannan of from 125:1 to 1:3, preferably of from 25:1 to 1:2.

10. Use according to any one of claims 8 or 9, wherein the pulp comprises 5 wt.-% or more xylan, preferably 8 wt.-% or more, more preferably 10 wt.-% or more and/or 3 wt.-% or more mannan, preferably 5 wt.-% or more mannan, and/or 1 wt.-% or less mannan.

11. Method for producing the lyocell fiber according to any one of claims 1 to 7 using a direct dissolution process.

12. Method for producing the lyocell fiber according to claim 11 using a amine oxide process, where an aqueous solution of the amine oxide and the pulp form a cellulose suspension and a shapeable solution which gets shaped and coagulated in a spin bath obtaining the lyocell fiber after washing and pre-treatment steps.

13. Method for producing the lyocell fiber according to claim 12 using an aqueous tertiary amine oxide, preferably aqueous NMMO.

14. Method according to any one of claims 11 to 13, wherein the spinning solution contains a pulp with a hemicelluloses content of greater than 10 wt.-% based on the total weight of cellulose and hemicelluloses contained.

15. Lyocell fiber, use or method according to any one of claims 1 to 14, wherein the pulp has a scan viscosity of from 300 to 440 ml/g.

16. Product, comprising the lyocell fiber according to any one of claims 1 to 7 or 15, or the fiber produced according to any one of claims 11 to 15.

17. Product according to claim 16, wherein the product is a non-woven fabric.

18. Product according to claim 16 and/or 17, selected among tissues and wipes.

19. Product according to claim 16 wherein the product is a speciality paper.

20. Product according to claim 19 wherein the speciality paper product is a filter.

Figure 1

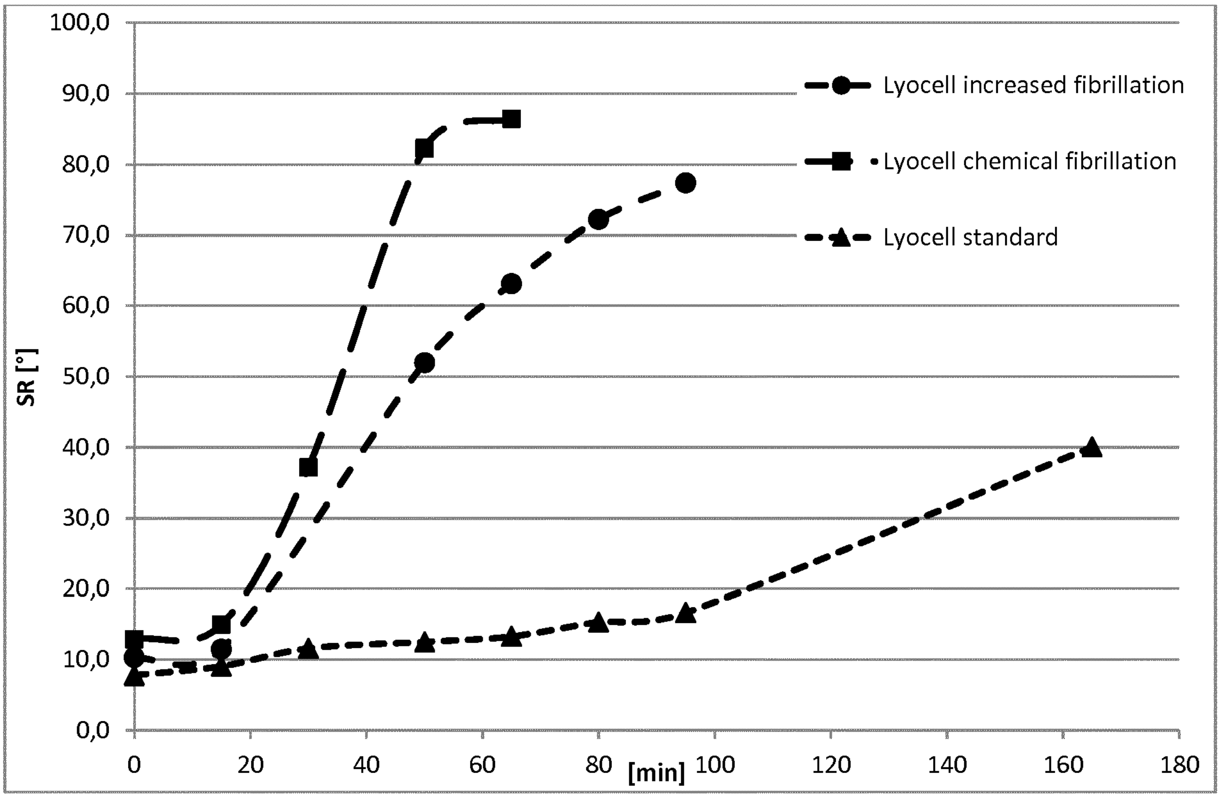

Figure 1: Fibrillation dynamics of three types of fibers

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EUROPEAN SEARCH REPORT

Application Number
EP 18 16 0137

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 April 2018	Ponsaud, Philippe

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