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(54) **KNITTED CONTINUOUS FILAMENT LYOCCELL FABRICS**

(57) The invention relates to a knit fabric. There is a need for knit fabrics made that are comfortable to wear, have good washability and high softness. Good washability implies both dimensional stability of the fabric and maintaining positive surface aspects such as hairiness,

pilling and fiber splice even after several washings. This object is solved according to the invention by a knitted fabric made from at least one yarn which consists of or contains lyocell filaments. The resulting fabric has a high wearing comfort and superior mechanical qualities.

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Description

[0001] The invention relates to knitted fabrics comprising at least one yarn which consists of or contains continuous filaments.

[0002] In a knit fabric, a fabric is formed by at least one yarn which is intermeshed in loops. This is in contrast to a woven fabric where two distinct yarns, a warp and a weft yarn are interwoven.

[0003] Continuous filament yarns are used in the textile industry to produce fabrics with a distinct character compared to fabrics produced from yarns made using staple fiber. A continuous filament yarn is one in which all of the fibers (technically: filaments) are continuous throughout any length of the yarn. A continuous filament yarn will commonly consist of 20 to 200 or more individual fibers which are all parallel to each other and the axis of the yarn when produced. The yarn is produced by extruding a solution or melt of a polymer or a polymer derivative and then winding the yarn produced onto a bobbin or reel or by forming a cake by centrifugal winding. The yarn may be twisted or intermingled to alter its characteristics.

[0004] Synthetic polymer continuous filament yarns are common. For example, nylon, polyester and polypropylene continuous filament yarns are used in a wide variety of fabrics. They are produced by melt spinning a molten polymer through a spinneret with a number of holes corresponding to the number of fibers required in the yarn produced. After the molten polymer has started to solidify, the yarn may be drawn to orient the polymer molecules and improve the properties of the yarn.

[0005] Continuous filament yarns can also be spun from cellulose derivatives such as cellulose diacetate and cellulose triacetate by dry spinning. The polymer is dissolved in a suitable solvent and then extruded through a spinneret. The solvent evaporates quickly after extrusion causing the polymer to precipitate in the form of a yarn. The newly produced yarn may be drawn to orient the polymer molecules.

[0006] Continuous filament yarns can be produced from cellulose using the viscose process. Cellulose is converted to cellulose xanthate by reaction with sodium hydroxide and carbon disulphide and then dissolved in a sodium hydroxide solution. The cellulose solution, commonly called viscose, is extruded through a spinneret into an acid bath. The sodium hydroxide is neutralized causing the cellulose to precipitate. At the same time, the cellulose xanthate is converted back to cellulose by reaction with the acid. The newly formed fiber is drawn to orient the cellulose molecules, washed to remove reactants from the fiber and then dried and wound onto a bobbin. In earlier versions of this process, the wet yarn was collected into a cake using a centrifugal winder - a Topham Box. The cake of yarn was then dried in an oven before being wound onto a bobbin.

[0007] Continuous filament cellulose yarns are also produced using the cupro process. Cellulose is dissolved in a solution of cuprammonium hydroxide. The resulting solution is extruded into a water bath where the cuprammonium hydroxide is diluted and the cellulose precipitates. The resulting yarn is washed, dried and wound onto a bobbin.

[0008] Cellulosic continuous filament yarn produced by either the viscose or the cupro process can be made into fabrics by knitting. Applications for knitted continuous filament cellulosic fabrics include lingerie, underwear, hosiery and ladies blouses and tops.

[0009] Knitted fabrics made from continuous filament cellulose yarns can have a high luster. They are good at moisture handling to enhance the comfort of the wearer. They do not generate static electricity as readily as fabrics made using continuous filament synthetic yarns.

[0010] Fabrics made from currently available continuous filament cellulose yarns generally have poor physical properties. The dry strength and the tear strength are poor compared to fabrics made from synthetic polymers such as polyester. The wet strength is much lower than the dry strength due to interactions between the cellulose and water. The abrasion resistance is low. The interactions with water also soften the cellulose causing the fabrics made from the yarn to be unstable when wetted.

[0011] Due to these deficiencies, the knitted fabrics which were originally made using continuous filament cellulose yarns are now produced mainly using synthetic polymer continuous filament yarns such as polyester and nylon.

[0012] However, there can be problems with the synthetic yarns. Fabrics made using them do not have the moisture handling capability of fabrics made from cellulose yarns. Synthetic fabrics can generate static electricity. Some people find garments made from the synthetic yarns are much less comfortable to wear than cellulose containing fabrics.

[0013] There is a need for knitted fabrics made that are comfortable to wear, have good washability and high softness. Good washability implies both dimensional stability of the fabric and maintaining positive surface aspects such as hairiness, pilling and fiber splice even after several washings.

[0014] This object is solved according to the invention by a knitted fabric made from at least one yarn which consists of or contains lyocell filaments.

[0015] It has surprisingly been found that knitted fabrics can be produced from continuous filament lyocell yarns and that such a knitted fabric has greatly superior physical properties compared to fabrics produced from continuous filament viscose or cupro. It has also been surprisingly found that lyocell fabrics can have the luster, moisture handling properties and low static generation that are the desirable characteristics of continuous filament viscose and cupro fabrics. Wash-

ability of the knitted fabric containing at least one lyocell filament yarn is superior to fabrics which use synthetic, wool and/or silk filaments.

[0016] Lyocell is the generic name given to a type of cellulosic manmade fiber produced by a direct dissolution process. The lyocell process is described e.g. in US 4,246,221 and WO 93/19230.

[0017] A slurry of wood pulp is formed with a solution of amine oxide in water. Water is then evaporated from the slurry in a thin film evaporator vessel. When the water level is reduced below a certain level, the cellulose forms a solution in the amine oxide. The resulting viscous liquid solidifies to a glassy solid below about 70 °C. If maintained above this temperature, it can be pumped through a spinneret to form fibers which are then immediately immersed in water where the dilution of the amine oxide causes the cellulose to precipitate.

[0018] The lyocell process can be used in to produce continuous filament lyocell yarns. The spinneret used for extrusion of the amine oxide cellulose solution has a number of holes corresponding to the number of fibers required in the continuous filament yarn. After extrusion, the newly formed yarn is washed clean of amine oxide with a counter current flow of water. This washing may be done on self advancing reels on which water is introduced to wash the fiber. A finish may be applied to aid further processing and the yarn is dried. The washed and dried yarn is wound onto a bobbin.

[0019] In the lyocell process, cellulose in the form of wood pulp is the only raw material used. The wood pulp used comes from sustainable managed forests. The fiber produced is 100% cellulose and it is the only output from the process. The amine oxide solvent is recovered from the washing water and reused to produce further fiber. This recovery can be as high as 99.7%. As a result, the environmental impact of the lyocell process is very low. There are virtually no releases of gaseous or liquid emissions from the process and the fiber produced is solvent free.

[0020] By contrast the viscose process uses carbon disulphide, sodium hydroxide, sulphuric acid and zinc sulphate. Hydrogen sulphide and carbon disulphide can be released from the process unless a great deal of care is taken. Sodium sulphate is produced as a byproduct of the process.

[0021] In the cupro process there is a risk of releasing copper compounds into the environment with consequential negative effects.

[0022] The fiber produced by the lyocell process has considerably higher tensile strength than fiber produced by the viscose process. This can result in fabrics with better strength, tear strength and abrasion resistance.

[0023] The fabric according to the invention can be further improved by the following features, which are all independent of one another.

[0024] The continuous filament lyocell yarns used to produce the products of the invention may be the as produced yarn in an untwisted state or may be twisted by rewinding. It may be a doubled yarn. It may be combined with another continuous filament yarn or staple fiber yarn by twisting the yarns together or by intermingling using for example an air jet.

[0025] The twist of the lyocell filament yarn may be between 0 and 3500 TPM. It may be in particular at least 1000 TPM or at least 2000 TPM if special surface effects are desired.

[0026] The knit fabric according to the invention has preferably good washability, in particular a low shrinkage. This is a unique property of the yarn consisting of or containing, preferably at least 10 % or at least 25 %, lyocell filaments. Due to the low shrinkage of lyocell filament yarn, yarns with 0 TPM or a very low twist, e.g. below 100 TPM, can be used without impairing washability.

[0027] The combined shrinkage, i.e. the sum of the absolute values of shrinkage in two perpendicular directions between TPM 0 and TPM 700 may in one embodiment be less than 12 % or even be less than 5 % after one and/or five washings. For blends of lyocell filaments with at least 3%, preferable 5 to 10%, elastane and/or with synthetic fibers or filaments of at least 10 %, preferably between 30 and 50 %, polyester or polyamide have a combined shrinkage of less than 5 % or even less than 2 %.

[0028] The surface qualities of the knit fabric according to the invention are very good. The knit fabric comprising at least one yarn with lyocell filament, i.e. a lyocell filament yarn, may score at least 40000 cycles, preferably more than 100000 cycles to hole formation and/or no destruction before and after the first wash in a Martindale abrasion test, especially when lyocell filament is blended with synthetic fibers of minimum 30% preferable 50%.

[0029] The lyocell denim according to the invention contains preferably at least 10% lyocell filaments in at least one of the weft and the warp yarn. Preferably, the minimum overall content of lyocell filaments in the lyocell denim is above 10 %. A content of more than 10% can improve the handfeel of the fabric significantly given the soft structure of a yarn containing or consisting of lyocell filaments. Consequently the total content of lyocell of at least 10% already gives a haptical impact independent of whether the lyocell filament is used in warp or weft. Moreover, a blend of at least 10 % lyocell filaments with other synthetic or cellulose filaments, e.g. with viscose or cupro filaments, or with viscose or cupro staple fibers or wool and cotton improves the strength of the yarn. Finally, a blend of at least 10% lyocell filaments and synthetics improves the breathability and moisture management of the fabric significantly.

[0030] Moisture regain of the fabric as measured according to ASTM D 1909 is an indicator for the comfort level. Mulberry silk has 11 % of moisture regain and offers one of the best comfort levels of all fabrics with respect to moisture regain. The test of a lyocell filament shows a moisture regain of at least 13% which is similar or even better than the comfort offered by mulberry silk and better than expected.

[0031] Another advantage of the knitted lyocell filament fabric is its ability to withstand even aggressive finishing agents such as chlorine bleach. It has even been found that application of such finishing agents may increase the softness of the knitted lyocell filament fabric.

[0032] The loss of strength when lyocell fibers are wetted is much lower than for viscose fibers. This means that lyocell fabrics are more difficult to deform when wet giving better fabric stability. Lyocell fabrics are also stronger when wet than equivalent viscose fabrics. Fabrics produced using continuous filament lyocell yarns can have the appearance and aesthetic properties of fabrics produced using continuous filament viscose yarns but they have unexpectedly good physical properties.

[0033] For example, the knit fabric according to the invention may have a grade of not worse than 3, in particular 4 in a Martindale pilling test after 1000 cycles and/or not worse than 3.5 after 2000 cycles in the original state and/or after the first washing

[0034] The hairiness of the knit fabric according to the invention may have a grade of not worse than 3 in the original state and/or after one washing and/or after five washings.

[0035] Spirality of the knit fabric according to the invention measured over 50 cm may be less than 20 mm after one washing and less than 25 mm after five washings. The spirality may be influenced by the finishing and also by the content of elastane in the fabric.

[0036] The products of the invention include products made using lyocell continuous filament yarn as produced or following further processing. The products include but are not limited to knitted fabrics produced using flatbed knitting machines, single cylinder circular knitting machines, double cylinder circular knitting machines and warp knitting machines. Any machine may be used that forms a fabric by knitting with continuous filament lyocell yarn on its own or in combination with other yarns.

[0037] The products of the invention are characterized by the superior physical properties that can be achieved using continuous filament lyocell yarns compared with other continuous filament cellulose yarns.

[0038] The continuous filament lyocell yarn used to produce the products of the invention may be the as produced yarn in an untwisted state or may be twisted by rewinding. It may be a doubled yarn. It may be combined with another continuous filament yarn or staple fiber yarn by twisting the yarns together or by intermingling using for example an air jet.

[0039] Knitted fabrics can be produced from continuous filament lyocell yarn by any knitting technique used in the textile industry. They may be produced by single or double cylinder circular knitting, flat bed knitting, warp knitting or fully fashioned.

[0040] Fabrics may be produced by knitting continuous filament lyocell yarns at the same time as knitting with other yarns on the same machine. The yarns may be fed to the machine through the same feeder to give the same yarns in each knitted lop. The yarns may be fed to the machine through separate feeders to give different combinations of yarns in adjacent courses or wales.

[0041] Knitted fabrics produced using continuous filament lyocell yarns on their own or in combination with other yarns can have aesthetics and appearance similar to a fabric produced from continuous filament viscose yarn, but have significantly better physical properties. The higher strength and modulus of the continuous filament lyocell yarn result in improved fabric breaking strength, tear strength, abrasion resistance and stability. The wet fabric properties are also superior.

[0042] For example, a knitted fabric made using continuous filament lyocell yarn has a similar luster, handle and appearance to a knitted fabric of the same weight and construction produced using continuous filament viscose. However, the properties of the lyocell fabric are considerably better.

[0043] Fabrics made using continuous filament lyocell yarns can be dyed and finished using any of the dyeing methods usually used to dye and finish cellulosic fabrics. They can be dyed using reactive, vat, direct or sulphur dyes.

[0044] Continuous filament lyocell fabrics can be rope dyed, open width dyed or batch dyed. Care must be taken to ensure that the fabric surface is not disturbed or damaged during dyeing and appropriate equipment must be used. It is well known that lyocell fabrics can fibrillate during wet processing. Short fibrils can form on the surface where wet abrasion occurs. Action must be taken to control this fibrillation either by allowing it to happen in an even and controlled way or by preventing fibrillation from occurring at all. Open width dyeing and batch dyeing are known methods of preventing fibrillation from occurring.

[0045] The knit fabric according to the invention may be resinated and/or mechanically polished and/or a peach skin fabric. Such a fabric has superior surface aspects.

[0046] Fibrillation can be used to produce a peach touch fabric using continuous filament lyocell yarns. For example if the fabric is dyed in an air jet dyeing machine where the surface of the fabric is evenly abraded when wet it will produce an even and attractive fibrillated surface.

[0047] Continuous filament lyocell fabrics can be resin finished to prevent fibrillation in use and during laundering. Resin finishing also improves the stability and easy care properties of the fabric. The resin finish cross-links cellulose molecules and prevents them splitting from each other when the fabric is subject to wet abrasion.

[0048] Fibrillation can also be prevented by the use of certain dyestuffs with more than one reactive group on the dye

molecule. These dyes cross-link the cellulose in a similar way to resin finishes and thus prevent the fibers from fibrillating during wet abrasion.

[0049] Knitted fabrics made using continuous filament lyocell yarn can be used for any application where fabrics made using continuous filament viscose or cupro yarns have been or are currently being used. They may also be used for other applications where fabrics made using continuous filament viscose or cupro do not have adequate properties to give the performance required.

[0050] The knit fabric according to the invention may be a jersey.

[0051] Knitted fabrics made using continuous filament lyocell yarn can be used to produce outerwear garments, hosiery, lingerie and underwear.

[0052] It will be clear to those knowledgeable about textiles that fabrics and other articles can be produced from combinations, blends or mixtures of continuous filament lyocell yarns with other yarns and fibers. It is common practice in the textile industry to mix yarns in a fabric to gain the benefits of the properties of the components. For example a knitted fabric can be produced using a continuous filament lyocell yarn and an elastane yarn together on a circular knitting machine. The resultant fabric would have characteristics attributable to both component yarns. For example, the presence of the elastane yarn would give the fabric stretch and recovery properties which would not be shown in a 100% lyocell fabric.

[0053] Knitted products are fashion items which need to be available in a variety of looks and handfeels. It is therefore an advantage that the lyocell filaments allow the knitted fabric according to the invention to be made from a large variety of combinations, blends or mixtures of continuous lyocell filaments with filaments, fibers and yarns made from other synthetic, natural or cellulose materials. The scope of this invention is intended to include in particular any knitted fabric or article in which continuous filament lyocell is a major component.

[0054] The invention also relates to use of a yarn containing or consisting of lyocell filaments in a knit fabric.

TESTS

[0055]

- A Martindale abrasion test according to DIN EN ISO 12947-2;
- a Martindale pilling test according to DIN EN ISO 12945-2;
- washing shrinkage according to DIN EN ISO 5077; from the absolute values of the shrinkage in both samples direction the sum was taken as a combined shrinkage;
- fastness to rubbing according to ISO 105 X12;
- AATCC durable press rating according to DIN EN ISO 15487;
- air permeability according to DIN EN ISO 9237;
- fastness according to DIN EN 20105 - A02;
- yarn strength in the warp and weft according to DIN EN ISO 2062;
- moisture regain according to ASTM D 1909;
- luster of the yarns was determined at an angle of 45° according to EN 14086 - 01/2003; and
- luster of the fabrics was determined at an angle of 75° according to TAPPI T480.

[0056] For the end consumer, it is important how the look of a fabric changes after washing. To assess this the surface aspects hairiness, pilling and fiber splice were determined according to the following methods:

The tests were carried out by 3 persons in a dark room in which a color assessment cabinet "Multilight Datacolor" of Variolux with daylight lamps D65 was provided. The lamps were mounted on an upper side of the cabinet.

[0057] For testing hairiness, the test sample was held oblique by the test person and the hairiness was graded between best (grade 5, no hairiness) and worst (grade 1, long protruding fibers up to 2mm).

[0058] The number of pillings was assessed using reference samples (knits K3 or K2, or wovens W3 or W2) of EMPA Standard SN 198525 analogous to DIN EN ISO 12 945-2. The reference samples are graded with 1 to 5 and are compared to the test samples. For no pills, grade 5 is given. The more pills there are on the surface of the test samples the worse the grade gets. The worst grade is 1.

[0059] Fiber splice is created if fibrillic fibers are moved to the surface by scouring. The fibrillic fibers are brushlike ends with stick out if the scoured sample is analyzed under a microscope. For measuring fiber splice, a microscope SM with an X10 eyepiece made by UHL Technische Mikroskope was used. For a smooth surface which showed no fibrilles, grade 5 was given. If there was a dense fur of long, curved fiber ends that were partly detached from the surface, grade 1 was given.

[0060] In all three tests, intermediate grades were possible.

[0061] If samples were subjected to washing, washing was performed according to DIN EN ISO 6330. Tests to assess parameters in the dry state are performed in the conditioned state 65/20, i.e. in the state where the fabric is at equilibrium with its surroundings which were kept at 65 % humidity and 20 °C.

[0062] Hereby, weight was determined according to DIN EN 12127. Yarn count in the weft and warp was performed in accordance with DIN 53820-3.

[0063] Spirality was determined in measuring the deviation from the course in mm at a distance of 50 cm from the origin.

[0064] All standards mentioned in this application are included by reference in their entirety.

[0065] Samples were prepared as follows.

Samples

[0066] The materials and characteristics of the single jersey blends of samples 1 to 9 are summarized in Table 1 a and 1 b.

[0067] These samples demonstrate the combinations of different filaments in yarns as well as the positive influence of lyocell filaments in the knit fabric with respect to washability, in particular shrinkage, and pilling according to the Martindale test after washing. It is also demonstrated that the shrinkage is strongly influenced by the twist level. The yarn legs of the lyocell filament yarn can have any number of plies and any twist and any direction. Core yarns can be used. And the yarns may be intermingled.

[0068] In the samples, a fabric was considered light if its weight was not more than 100 g/m², medium if its weight was above 100 g/m² and not more than 220 g/m² and heavy if the weight exceeded 220 g/m².

Sample 1 was made as a single jersey with a yarn count of lyocell filament dtex 150f90 with 0 TPM (twists per meter). This resulted in a fabric having 100% lyocell filament. The single jersey had a medium weight of 140 g/m².

Sample 2 was made as a single jersey with a yarn count of lyocell filament dtex 150f90 with TPM 160. This resulted in a fabric having 100% lyocell filament. The single jersey had a light weight of 89 g/m².

Sample 3 was made as a single jersey with a yarn count of lyocell filament dtex 150f90 with TPM 1200. This resulted in a fabric having 100% lyocell filament. The single jersey had a light weight of 99 g/m².

Sample 4 was made as a single jersey with a yarn count of lyocell filament dtex 150f90 with TPM 2100. This resulted in a fabric having 100% lyocell filament. The single jersey had a medium weight of 121 g/m².

Sample 5 was made as a single jersey with a two plies of lyocell filament dtex 100f60 intermingled and twisted with TPM 1200. This resulted in a fabric having 100% lyocell filament. The single jersey had a heavy weight of 289 g/m².

Sample 6 was made as a single jersey with a two plies of lyocell filament dtex 300f180 intermingled. This resulted in a fabric having 100% lyocell filament. The single jersey had a medium weight of 181 g/m².

Sample 7 was made as a single jersey with a yarn count of lyocell filament dtex 60f30 with 0 TPM . This resulted in a fabric having 100% lyocell filament. The single jersey had a light weight of 100 g/m².

Sample 8 was made as a single jersey with a yarn count of lyocell filament dtex 60f30 with 0 TPM plated on the knitting machine with 22 dtex elastane. This resulted in a fabric having 90% lyocell filament and 10% elastane. The single jersey had a medium weight of 129 g/m²

Sample 9 was made as a single jersey with a two-ply twist of lyocell filament dtex 40f30 twisted with TPM 500 plated with 22 dtex elastane. This resulted in a fabric having 90% lyocell filament and 10% elastane. The single jersey had a light weight of 100 g/m². The materials and characteristics after washing and drying of the 100 % lyocell filament single jerseys of samples 1 to 4 are summarized in Table 1 a, those of the single jerseys of samples 5 to 9 in Table 1 b.

Sample 10 was made as a single jersey with a two-ply twist on the base of Lyocell Filament dtex 40f30 with a yarn-twist of TPM 1200 plated on the knitting machine with 22 dtex Elastane. This resulted in a fabric having 90% lyocell filament and 10% elastane. The single jersey had a medium weight of 101 g/m².

Sample 11 is a commercially available comparative sample having 85% polyamide and 15% elastane. The single jersey had a medium weight of 122 g/m²

Sample 12 was made as a single jersey with a yarn count of 80 dtex with 60 filaments bright 0 TPM intermingled with a polyester texturized yarn. This resulted in a fabric having 50% lyocell filament and 50% polyester. The single jersey had a heavy weight of 227 g/m².

Sample 13 is a commercially available comparative sample having 92% polyester filament and 8% elastane. The single jersey had a medium weight of 161 g/m².

The materials and characteristics of the single jersey blends of samples 10 to 13 are summarized in Table 2. These samples demonstrate the combinations of different filaments in yarns as well as the positive influence of lyocell filaments in the knit fabric with respect to washability, in particular shrinkage, and pilling according to the Martindale test after washing. For example, a staple fiber yarn may be plied with at least one lyocell filament. The yarn legs can have any number of plies and any twist and any direction. Core yarns can be used. And the yarns may be intermingled.

Sample 14 was made as an interlock with an yarn count of 150 dtex with 90 filaments and 0 TPM together used with an elastic core yarn of polyamide in a 2 by 2 knitting system. This resulted in a fabric having 60% lyocell filament, 40% polyamide and 10% elastane. The interlock had a heavy weight of 347 g/m².

Sample 15 was made as an interlock with an yarn count of 80 dtex with 60 filaments bright 0 TPM intermingled with a polyester dull filament. This resulted in a fabric having 50% Lyocell Filament and 50% polyester. The interlock had a heavy weight of 270 g/m². Sample 16 was made as an interlock with an yarn count of 80 dtex with 60 filaments dull 0 TPM intermingled with a polyester dull filament. This resulted in a fabric having 50% lyocell filament and 50% polyester. The interlock had a medium weight of 192 g/m².

Sample 17 was made as an interlock with an intermingled yarn on the base of lyocell filament 50 dtex with 30 single filaments bright with 0 TPM and 22 dtex elastane dull. The interlock had a medium weight of 189 g/m².

Table 3 presents an overview of the interlock samples 14 to 17 with respect to the material composition and properties. It can be seen that over a wide range of 50 to 150 dtex and for yarn having 0 TPM, the resulting knit fabrics are washable and have an excellent shrinkage.

Samples 18 to 21 were made as an interlock with an intermingled yarn on the base of lyocell filament 50 dtex with 30 single filaments bright with 0 TPM and 22 dtex elastane dull. The interlock had a medium weight of 204 g/m². The material of samples 18 to 21 is identical. They differ, however, in their treatment as follows to investigate how fibrillation can be influenced and how fibrillation affects surface aspects of the knit such as pilling, hairiness and fiber splice.

Fibrillation Tests

[0069] The material of sample 18 was subjected to resin finishing, which resulted in sample 19, to mechanical polishing, which resulted in sample 20, and to peach skin treatment, which resulted in sample 21. The material of samples 18 to 21 and the change in characteristics due to the different treatment is summarized in Table 4.

Resin Finishing

[0070] The resin recipe for finishing the material of sample 18 was

40 g/l Knittex FEL
12 g/l MgCl₂
squeezing effect: 80%.

[0071] Drying was performed at 130 °C. Curing was performed for 45 sec at 175 °C. Thus, sample 19 was obtained.

Mechanical Polishing

[0072] The material of sample 18 was also subjected to mechanical polishing to obtain sample 21 as follows.

[0073] First, the sample was washed using a Tupesa machine for 60 minutes at 80 °C and 22 rpm using as a detergent 1 g/l Kieralon JET, 2 g/l Soda and 1 g/l Persoftal L (1.2 kg of material and 150 l of water). After washing, the sample was rinsed and centrifugated and then dried hanging. After that, resin finishing took place in a stenter using the above recipe. After resin finishing, mechanical polishing was applied by tumbling the sample in an air tumbler for 7 minutes.

Peach Skin

[0074] For the peach skin treatment, the material of sample 18 was first washed, then enzyme-treated, finished and then tumble-dried.

[0075] First the sample was washed using a Tupesa machine for 60 minutes at 80 °C and 22 rpm using as a detergent 1 g/l Kieralon JET, 2 g/l Soda and 1 g/l Persoftal L (1.2 kg of material and 150 l of water). After washing, the sample was rinsed and centrifugated and then dried hanging. After that, resin finishing took place in a stenter using the above recipe.

[0076] First the sample was washed in a Tupesa machine for 60 minutes at 80 °C and 22 rpm using as a detergent 1 g/l Kieralon JET, 2 g/l Soda and 1 g/l Persoftal L (1.2 kg of material and 150 l of water). After washing, the sample was rinsed.

[0077] In order to achieve a peach skin effect enzyme treatment took place in a Tupesa washing machine at 22 rpm, using 0.6 kg of material and 100 l water with

0.5 g/l Perlavin NIC
4.0 g/l Perilan VF
0.4 g/l Perilan RFC
3.0 g/l Peristal E.

[0078] The enzyme treatment started at 55 °C. After 5 min, the pH value was controlled. If pH reached 5.5, 2.0 g/l Perizym 2000 were added. Then the treatment continued for 45 minutes at 55 °C.

[0079] At the end of the enzyme treatment, heating to 85 °C took place and the treatment continued for 15 minutes. Then the water was drained, the material was rinsed with warm water and then cold water.

[0080] For further finishing, 2 % Tubingal RGH were applied in the Tupesa washing machine and treatment continued for 20 minutes at 40 °C at pH 6.

[0081] After that, the material was centrifugated and dried in a tumbler at 80 °C for 50 minutes. The material was then allowed to cool down for 10 minutes. This resulted in sample 21.

The TSA Test

[0082] The TSA test was carried out to verify that the haptic qualities of the lyocell filament knit are at least equal if not superior to existing knits.

[0083] The TSA test was carried out to assess softness and smoothness, the two haptic qualities that are very important to the end consumer.

[0084] The TSA test is described in Schloßer et al., "Griffbeurteilung von Textilien mittels Schallanalyse", Meiland Textilberichte, 1/2102, p. 43- 45, in the emtec publication Grüner, "A new and objective measuring technique to analyze the softness of tissue" (2012), in the TSA Operating Instructions, and in "Neue und Objektive Messtechnik für Softness-Analyse" in avr-Allgemeiner Vliesstoff Report 5/2015, p. 99-101. Originally developed to measure softness and smoothness of tissues and non-wovens using sound spectra, it has been adapted to also evaluate the softness and smoothness of woven fabrics.

[0085] The TSA test was performed using a TSA Tissue Softness Analyzer device of emtec electronics GmbH, Leipzig, Germany, and the software ESM which is shipped with the TSA. The TSA measures a sound spectrum which results from pressing and rotating a star-like body against a sample fabric with a defined force. For testing, the fabric is clamped around its perimeter and unsupported otherwise, in particular opposite the rotating body. In the TSA test performed here, the software and its evaluation algorithm was not used. Instead, the sound pressure as measured by the TSA at 7 kHz (TS7) was taken as an objective indirect measure of softness and the sound pressure at 750 Hz (TS750) in the sound spectrum measured by the TSA was taken as an objective indirect measure of smoothness. The sound pressure is automatically given by the TSA as dB V² rms, where V is the rotational velocity of the rotating body. Using these values directly avoided any problems that may have arisen due to the EMS algorithm having been developed for tissue, and not for woven fabrics. A total of four probes was subjected to the TSA test for each sample.

[0086] For testing, a fabric sample of 11 cm diameter was clamped as required by the TSA device and tested without stretching.

[0087] Lower values of TS7 indicate higher softness and lower values of TS750 indicate higher value of smoothness.

Handle-O-Meter Tests

[0088] The Handle-O-Meter tests were carried out using a Handle-O-Meter testing device of Thwing-Albert Instrument Company, West Berlin, NJ, USA. Sample size was 10 cm x 10 cm. The ¼ inch slot was used with a 1,000 g beam and

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a stainless steel surface. The tests were conducted on samples cond. 65/20.

[0089] In both the TSA and the Handle-O-Meter tests, only the right side of the knit was considered.

[0090] As a result, the Handle-O-Meter yields two force measurements which are assigned to two orthogonal directions, a machine direction MD which in the chosen set-up corresponded to the warp direction and a cross direction CD which in the chosen setup corresponded to the weft direction. These forces are correlated to the stiffness and smoothness of the tested surface. The force is normalized with the bulk weight of the test sample, resulting in a specific hand in $\text{mN m}^2 \text{g}^{-1}$.

[0091] It can be concluded from the TSA and the Handle-O-Meter tests that the lyocell filament knit according to the invention shows an excellent handfeel.

Table 1a - Samples 1 to 4: 100 % Lyocell Filament Single Jerseys

	Sample 1	Sample 2	Sample 3	Sample 4
Fabric Type	Medium weight single jersey	Light weight single jersey	Light weight single jersey	Medium weight single jersey
fabric material composition	100 % lyocell filament	100 % lyocell filament	100 % lyocell filament	100 % lyocell filament
material analysis	100 % lyocell filament bright dtex 150 f90 TPM 0	100 % lyocell filament bright dtex 150 f90 TPM 160	100 % lyocell filament bright dtex 150 f90 TPM 1200	100 % lyocell filament bright dtex 150 f90 TPM 2100
special finishing	printed	open width dyed	open width dyed	open width dyed
yarn construction	flat 0 TPM	160 TPM	1200 TPM	2100 TPM
yarn count dtex	150	150	150	150
filaments-number	90	90	90	90
weight g/m ²	140	89	99	121
surface aspect after wash-cycles				
hairiness				
grade after 1st wash	2.5	4	4.5	4.5
grade after 5th wash	3	4	4.5	4.5
pilling				
grade after 1st wash	4	4	4.5	4.5
grade after 5th wash	3.5	4	4.5	4.5
fiber splice				
grade after 1st wash	1.5	1.5	1.5	1
grade after 5th wash	1	1	1	1
laundering test 40 °C line. drying after each wash washing shrinkage L %				
after 1st wash cond. 20/65	-3.2	-11.4	-17.4	-31.9
after 5th wash cond. 20/65	-5.3	-15.7	-27.6	-43.5
laundering test 40°C line. drying after each wash washing shrinkage C %				
after 1st wash cond. 20/65	-1.3	3.8	10.5	28.3

(continued)

		Sample 1	Sample 2	Sample 3	Sample 4
	after 5th wash cond. 20/65	-0.6	6	12.1	27
	spirality - over 50 cm				
	after 1st wash mm	16	25	13	43
	after 5th wash mm	0	25	0	50

Table 1b - Samples 5 to 9: 100 % Lyocell Filament Single Jerseys

		Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
	fabric type	Heavy weight single jersey	Medium weight single jersey	Lightweight single jersey	Medium weight single jersey	Medium weight single jersey
	fabric material composition	90 % lyocell filament / 10 % elastane	100 % lyocell filament	100 % lyocell filament	90 % lyocell filament / 10 % elastane	90 % lyocell filament / 10 % elastane
	material analysis	lyocell filament bright dtex 100 f60 Intermingled 2 plies TPM 1200 plated elastane: lycra dull 22 dtex	100 % lyocell filament bright dtex 300 f180 intermingled	100 % lyocell filament bright 60 dtex f30 single filament count: 2.23 dtex	lyocell filament bright 60 dtex f30 single filament count: 2.17 dtex plated elastane: lycra dull 22 dtex	lyocell filament bright single yarn count: 1.48 dtex dtex 40 f30 2 plies TPM 500 plated elastane: lycra dull 22 dtex
	special finishing	open width dyed	open width dyed	open width dyed	open width dyed	printed
	yarn construction	intermingled - 1200 TPM	flat 0 TPM - intermingled	flat 0 TPM	flat 0 TPM	500 TPM
	yarn count dtex	100	300	64	65	82
	filaments number	60	180	30	30	60/2
	single yarn count dtex					41
	weight g/m²	269	181	100	129	103
	surface aspect after wash-cycles					
	hairiness					
	grade after 1st wash	3.5	3	3	4	3.5
	grade after 5th wash	4	4	4	5	3.5
	pilling					
	grade after 1st wash	3.5	3	3.5	3.5	4
	grade after 5th wash	3.5	3.5	3.5	3.5	4
	fiber splice					

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(continued)

		Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
5	grade after 1st wash	2	1.5	2	2	2
	grade after 5th wash	1	1	1	1	1.5
10	laundering test 40°C line. drying after each wash washing shrinkage L %					
	after 1st wash cond. 20/65	-0.7	-7.8	0.3	0	-0.7
15	after 5th wash cond. 20/65	0.3	-10.8	-3.1	-0.7	-2
20	laundering test 40°C line drying after each wash washing shrinkage C %					
	after 1st wash cond. 20/65	3.6	-1.9	-1	-2	-2.6
25	after 5th wash cond. 20/65	2.3	-4.1	-1.7	-3.7	0
	spirality - over 50 cm					
	after 1st wash mm	0	20	13	0	0
30	after 5th wash mm	0	23	18	0	0

Table 2 - Single Jersey Blends

35		Sample 10	Comparative Sample 11	Sample 12	Comparative Sample 13
	fabric type	Medium weight single jersey	Medium weight single jersey	Heavy weight single jersey	Heavy weight single jersey
40	design code	red single jersey	dark blue single jersey	melange single jersey	blue single jersey
45	fabric material ratio	90% lyocell filament / 10% elastane	85 % polyamide 15 % elastane	50% lyocell filament / 50% polyester	92 % polyamide 8 % elastane
50	material	lyocell filament dtex40f30 bright two plies twisted Z-twist + S-twist with TPM 1200 plated with elastane 22 dtex	85 % polyamide 15 % elastane	lyocell filament dtex80f60 bright intermingled with draw textured yarn dtex75f36	92 % polyester filament 8 % elastane
55	special finishing	open width dyed	dyed	open width dyed only lyocell filaments	dyed

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(continued)

	Sample 10	Comparative Sample 11	Sample 12	Comparative Sample 13
material analysis	two plies twist: 1 yarn: 100 % lyocell filament single filament count: 1.29 dtex S-twist 1 yarn: 100 % lyocell filament single filament count: 1.29 dtex Z-twist filament on the machine plated with elastane (100 % lycra dull 22 dtex - filament)	100 % polyamide dull 1.14 dtex (optical n=20) fused elastane (100 % lycra dull 22 dtex - filament)	4 yarns: 100 % polyester dull -filament 1 yarn: 100 % lyocell filament single filament count: 1.44 dtex	60 % polyester dull 1.68 dtex 40 % polyester dull 1.06 dtex (optical n=20) filament fused (pointwise fixed) elastane (100 % lycra bright 22 dtex-filament)
yarn construction:	2-ply twisted with TPM 1200		Intermingled	
yarn count dtex	40 x 2	44	476	100
single yarn count dtex	40		80	
filaments number	S-twist: 60 Z-twist: 60	41	57	84
yarn twist	TPM 1200	-	-	-
weight g/m ²	101	122	227	200
laundering test 40°C gentle. del. tumble drying after each wash washing shrinkage L %				
after 1st wash cond. 20/65	-1.9	-3.3	-1.9	-1.3
after 5th wash cond. 20/65	-2.4	-3.6	-5.6	-1.7
washing shrinkage C %				
after 1st wash cond. 20/65	1.8	-0.7	0	-0.3
after 5th wash cond. 20/65	1.4	-0.3	-0.7	0
spirality-over 50 cm				
after 1st wash mm	19		0	
after 5th wash mm	25		0	
surface aspect after wash-cycles				
hairiness				
grade after 1st wash	3		5	

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(continued)

		Sample 10	Comparative Sample 11	Sample 12	Comparative Sample 13
5	grade after 5th wash	3.5		4.5	
	pilling				
10	grade after 1st wash	3.5		5	
	grade after 5th wash	2.5		4.5	
	grade fiber splice				
15	grade after 1st wash	2.5		4.5	
	grade after 5th wash	2		2.5	
20	yarn strength cN/tex				
	original	15.6	30.9	22.9	33.5
25	after 1st wash	17.6	19.7	24.9	31.9
	after 5th wash	16	22.1	24.7	28.2
30	yarn elongation %				
	original	2.7	23.9	24.3	26.7
	after 1st wash	3.1	17.1	30.5	23.3
35	after 5th wash	3.1	19.1	29.6	19.4
	abrasion test Martindale				
40	original				
	cycles-sample not destroyed	1875	>100000	100000	41250
45	cycles to hole formation	2375	>100000	>100000	46250
	after 1st wash				
	cycles-sample not destroyed	1875	>100000	100000	57500
50	cycles to hole formation	2375	>100000	>100000	67500
	pilling test of Martindale				
55	original				

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(continued)

	pilling				
5	grade after 1000 cycles	3.5	5	4	4.5
	grade after 2000 cycles	4	4.5	5	4.5
10	grade after 5000 cycles	4	4.5	5	4.5
	after 1st wash				
	grade after 1000 cycles	4.5	5	4	5
15	grade after 2000 cycles	4	5	5	5
	grade after 5000 cycles	3.5	5	5	4.5
20					

Table 3 - Interlock Fabrics

		Sample 14	Sample 15	Sample 16	Sample 17
25	fabric type	heavy weight Interlock	medium weight Interlock	medium weight Interlock	heavy weight Interlock
	fabric material ratio	60% lyocell filament / 40% PA / 10% EL	50% lyocell filament / 50% PES	50% lyocell filament / 50% PES	90% lyocell Filament / 10% EL
30	material	lyocell filament dtex 150dtex f90 bright 0 TPM	lyocell filament dtex 80f60 bright 0 TPM intermingled with PES	lyocell filament dtex 80f60 bright 0 TPM intermingled with PES	lyocell filament 50 dtex f30 bright 0 TPM
35	special finishing	open width dyed	open width dyed only lyocell filament dyed	open width dyed only lyocell filament dyed	open width dyed
40	yarn construction	<u>system 2:2: 2 yarns:</u> 100 % lyocell filament single filament count: 1.64 dtex <u>2 yarns:</u> 100 % polyamide 6.6 dull filament with elastane-core: 100 % lycra dull 33 dtex	<u>system2fold - intermingled: 1 yarn:</u> 100 % lyocell filament dull single filament count 1.35 dtex <u>1 yarn:</u> 100 % polyester dull filament	<u>system 2fold - intermingled: 1 yarn:</u> 100 % lyocell filament single filament count: 1.37 dtex <u>1 yarn:</u> 100 % polyester dull filament	core-yarn: 100 % lyocell filament single filament count: 1.79 dtex with core of elastane (100 % lycra dull 22 dtex - filament)
45	yarn construction	lyocell filament 0 TPM	intermingled	intermingled	lyocell filament 0 TPM
50	yarn count dtex	161	270	192	65
	filaments number	90	60	60	30
	yarn twist TPM	0	0	0	0
55	weight g/m ²	347	190	173	189

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(continued)

		Sample 14	Sample 15	Sample 16	Sample 17
5	laundering test 40°C gentle. del. tumble dry after each wash. washing shrinkage L %				
10	after 1st wash cond. 20/65	1	-1	-3.3	-6.9
	after 5th wash cond. 20/65	0	-1.3	-5	-6.6
15	washing shrinkage C %				
	after 1st wash cond. 20/65	-5.5	-0.3	-1	1
20	after 5th wash cond. 20/65	-6	0.3	-1	2
	surface aspect after wash-cycles				
	hairiness				
25	original		3	3	
	grade after 1st wash	4	3	3	3
	grade after 5th wash	3.5	3	3	3
30	pilling				
	original		3	3	
	grade after 1st wash	4	3.5	3	3
	grade after 5th wash	3.5	3.5	2.5	3.5
35	fiber splice				
	original		2	3	
	grade after 1st wash	4.5	2	2	2.5
40	grade after 5th wash	3.5	2	2	1.5
	yarn strength cN/tex				
	original	17.1	22.8	16.3	9.7
45	after 1st wash	21.2	22.2	15.9	13.6
	after 5th wash	8.6	21.9	13.9	11.3
	yarn elongation %				
50	original	7.6	24.3	15.8	4.6
	after 1st wash	9.6	23.4	15	5.1
	after 5th wash	7.3	21.8	14.2	4.6
55	air permeability l/m²/s	569	2370	1435	485
	abrasion test Martindale				

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(continued)

	Sample 14	Sample 15	Sample 16	Sample 17
original				
cycles-sample not destroyed	>100000	>100000	50000	12000*
cycles to hole formation	>100000	>100000	55000	14000*
after 1st wash				
cycles-sample not destroyed	>100000	>100000	47500	14000*
cycles to hole formation	>100000	>100000	52500	14000*
pilling test of Martindale				
original				
grade after 1000 cycles	4.5	3.5	4.5	5
grade after 2000 cycles	3.5	3	4	5
grade after 5000 cycles	2	3	3.5	5
after 1st wash				
grade after 1000 cycles	4.5	4.5	4.5	5
grade after 2000 cycles	3.5	4	4	4.5
grade after 5000 cycles	2	3.5	4	5

Table 4 - Interlock, Effect of Fibrillation

	Sample 18	Sample 19	Sample 20	Sample 21
fabric type	heavy weight Interlock	heavy weight Interlock	heavy weight Interlock	heavy weight Interlock
fabric material ratio	90% lyocell filament / 10% EL ¹	90% lyocell filament / 10% EL	90% lyocell filament / 10% EL	90% lyocell filament / 10% EL
material	100 % lyocell filament dtex 50f30 bright intermingled + elastane 22 dtex	100 % lyocell filament dtex 50f30 bright intermingled + elastane 22 dtex	100 % lyocell filament dtex 50f30 bright intermingled + Elasthane 22 dtex	100 % lyocell filament dtex 50f30 bright intermingled + Elasthane 22 dtex
special finishing	open width dyed	resin finish	mechanical polishing	peach skin

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(continued)

	Sample 18	Sample 19	Sample 20	Sample 21
5	core yarn: 100 % lyocell filaments single filament count: 1,79 dtex with core of elastane (100 % lycra dull 22 dtex - filament)	core yarn: 100 % lyocell filaments single filament count: 1,79 dtex with core of elastane (100 % lycra dull 22 dtex - filament)	core yarn: 100 % lyocell filaments single filament count: 1,79 dtex with core of elastane (100 % lycra dull 22 dtex - filament)	core yarn: 100 % lyocell filaments single filament count: 1,79 dtex with core of elastane (100 % lycra dull 22 dtex - filament)
10	yarn construction	intermingled	intermingled	intermingled
15	yarn count dtex	65	65	65
	filaments number	30	30	30
	yarn twist TPM	0	0	0
20	weight g/m ²	204	204	204
25	laundrying test 40°C gentle, del. tumble drying after each wash washing shrinkage L %			
30	after 1st wash cond. 20/65	-6,3	-5,4	-5,8
	after 5th wash cond. 20/65	-6,3	-5,3	-5,7
	washing shrinkage C %			
35	after 1st wash cond. 20/65	1,6	1,4	1,5
	after 5th wash cond. 20/65	1,6	1,4	1,5
40	surface aspect after wash-cycles			
	hairiness			
	original			
45	grade after 1st wash	3	3,5	4
	grade after 5th wash	4	3	3,5
50	pilling			
	original			
	grade after 1st wash	3,5	3,5	4
55	grade after 5th wash	4,5	3	3
	fiber splice			

(continued)

	Sample 18	Sample 19	Sample 20	Sample 21
original				
grade after 1st wash	2	4	5	2
grade after 5th wash	1,5	3,5	4,5	1,5
¹ EL: Elastan				

Claims

1. Knit fabric made from at least one yarn which contains or consists of lyocell filaments.
2. Knit fabric according to claim 1, wherein the yarn contains at least 10 % lyocell filaments.
3. Knit fabric according to claim 1 or 2, wherein the yarn has at least 2000 TPM.
4. Knit fabric according to any one of claims 1 to 3, wherein the combined shrinkage of the knit fabric after one washing and/or after five washings is less than 10 %.
5. Knit fabric according to claim 4, wherein the combined shrinkage of the knit fabric after one washing and/or after five washings is less than 5 %.
6. Knit fabric according to any one of claims 1 to 5, wherein the spirality over 50 cm is less than 20 mm after one washing and/or less than 25 mm after five washings.
7. Knit fabric according to any one of claims 1 to 6, wherein the hairiness of the knit fabric has a grade not worse than 3 in the original state and/or after one washing.
8. Knit fabric according to any one of claims 1 to 7, wherein the knit fabric has a grade of not worse than 4 in a Martindale pilling test after 1000 and/or 2000 cycles and/or not worse than 3.5 after 5000 cycles in the original state and/or after five washings.
9. Knit fabric according to any one of claims 1 to 8, wherein the knit fabric scores at least 40000 cycles no destruction and/or to hole formation in a Martindale abrasion test.
10. Knit fabric according to any one of claims 1 to 9, wherein the fabric is dyed with at least one of a reactive, vat, sulphur and direct dye.
11. Knit fabric according to claim 10, wherein the dye used is at least one of a bifunctional and a multifunctional dyestuff, and wherein the cellulose in the yarn is cross-linked.
12. Knit fabric according to any one of claims 1 to 11, wherein the fabric is resin finished.
13. Knit fabric according to any one of claims 1 to 12, wherein the fabric is a peach skin fabric.
14. Textile article, such as a garment, containing a knit fabric according to any one of claims 1 to 13.
15. Use of a yarn containing or consisting of lyocell filaments in a knit fabric.



EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2014/161018 A1 (CHEMIEFASER LENZING AG [AT]) 9 October 2014 (2014-10-09) * page 7, line 18 - page 8, line 29; claims 1, 5, 10, 11, 14 *	1,13-15 3,6	INV. D04B21/00 D02G3/04 D04B1/14 D01F2/00
X	WO 2009/079674 A2 (CHEMIEFASER LENZING AG [AT]; CRNOJA-COSIC MARINA [AT]; TAYLOR JAMES MA) 2 July 2009 (2009-07-02) * page 8, line 4 - line 14 * * page 12, line 9 - line 17; table 4 *	1,2,10, 11,14,15	
X	WO 2015/101543 A1 (CHEMIEFASER LENZING AG [AT]) 9 July 2015 (2015-07-09) * page 13 - page 14 *	1,9,14, 15	
X	WO 2012/116384 A1 (CHEMIEFASER LENZING AG [AT]; TAYLOR JAMES MARTIN [GB]; CRNOJA-COSIC MA) 7 September 2012 (2012-09-07) * page 3, line 9 - line 17; claims 1, 3 *	1,4,5, 14,15	
X	US 2010/297905 A1 (ULRICH AMY MCSWAIN [US] ET AL) 25 November 2010 (2010-11-25) * page 4 - page 6; table 1 *	1,2,8, 14,15	TECHNICAL FIELDS SEARCHED (IPC) D04B D02G D01F
X	WO 02/31236 A1 (TENCEL LTD [GB]; ASKEW GREGORY JAMES [GB]; HAYHURST MALCOM JOHN [GB];) 18 April 2002 (2002-04-18) * page 11, line 3 - line 15 *	1,7,12, 14,15	
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 March 2018	Examiner Braun, Stefanie
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
WO 2014161018 A1	09-10-2014	AT 514136 A1	15-10-2014
		CN 105102700 A	25-11-2015
		EP 2981639 A1	10-02-2016
		ES 2620086 T3	27-06-2017
		JP 2016521319 A	21-07-2016
		KR 20150139596 A	11-12-2015
		PL 2981639 T3	30-06-2017
		US 2016060792 A1	03-03-2016
		WO 2014161018 A1	09-10-2014
WO 2009079674 A2	02-07-2009	AT 506241 A1	15-07-2009
		BR PI0821341 A2	16-06-2015
		CN 101903580 A	01-12-2010
		EP 2222909 A2	01-09-2010
		ES 2436719 T3	03-01-2014
		JP 5732653 B2	10-06-2015
		JP 2011509353 A	24-03-2011
		KR 20100099305 A	10-09-2010
		KR 20150139637 A	11-12-2015
		TW 201002885 A	16-01-2010
		US 2010330351 A1	30-12-2010
		WO 2009079674 A2	02-07-2009
WO 2015101543 A1	09-07-2015	CN 105849324 A	10-08-2016
		EP 3090081 A1	09-11-2016
		JP 2017501315 A	12-01-2017
		KR 20160104643 A	05-09-2016
		TW 201540883 A	01-11-2015
		US 2016326671 A1	10-11-2016
		WO 2015101543 A1	09-07-2015
WO 2012116384 A1	07-09-2012	AT 511186 A1	15-09-2012
		WO 2012116384 A1	07-09-2012
US 2010297905 A1	25-11-2010	US 2010297905 A1	25-11-2010
		WO 2010135214 A1	25-11-2010
WO 0231236 A1	18-04-2002	AU 9403001 A	22-04-2002
		CN 1469943 A	21-01-2004
		DE 60125964 T2	18-10-2007
		EP 1327013 A1	16-07-2003
		GB 2368342 A	01-05-2002
		KR 20030061374 A	18-07-2003
		WO 0231236 A1	18-04-2002

EPO FORM P0459

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4246221 A [0016]
- WO 9319230 A [0016]

Non-patent literature cited in the description

- **SCHLOßER et al.** Griffbeurteilung von Textilien mittels Schallanalyse. *Meilland Textilberichte*, vol. 1, 43-45 [0084]
- **GRÜNER.** A new and objective measuring technique to analyze the softness of tissue. *TSA Operating Instructions*, 2012 [0084]
- Neue und Objektive Messtechnik für Softness-Analyse. *avr-Allgemeiner Vliesstoff Report*, 2015, vol. 5, 99-101 [0084]