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(54) **FOOTWEAR THAT CONTAINS A LYOCELL CONTINUOUS FILAMENT YARN**

(57) The invention relates to a footwear, in particular a shoe, that contains a lyocell continuous filament yarn.

EP 3 747 295 A1

Description

Technical area

[0001] It has been found that the use of fabrics and other articles made from continuous filament lyocell in the manufacture of shoes gives surprisingly enhanced performance including improved moisture handling, greatly improved sustainability and improved frictional characteristics. This invention relates to a footwear, in particular a shoe, characterized in that it contains a lyocell continuous filament yarn

Prior art

[0002] Continuous filament yarns are widely used in the textile industry to produce fabrics with a distinct character compared to fabrics produced from yarns made using staple fibre. A continuous filament yarn is one in which all of the fibres are continuous throughout any length of the yarn. A continuous filament yarn will commonly consist of 20 to 200 or more individual fibres 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.

[0003] 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 fibres 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.

[0004] 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.

[0005] 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 neutralised causing the cellulose xanthate to precipitate. At the same time, the cellulose xanthate is converted back to cellulose by reaction with the acid. The newly formed fibre is drawn to orient the cellulose molecules, washed to remove reactants from the fibre 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 winding onto a bobbin.

[0006] 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.

[0007] Cellulosic continuous filament yarn produced by either the viscose or the cupro process can be made into fabrics by weaving or knitting or other fabric forming processes. Fabrics produced are used for a variety of applications including linings for outerwear, ladies blouses and tops, lingerie and prayer rugs. Yarns are also produced for use in the reinforcement of tyres and other rubber products.

[0008] Fabrics made from continuous filament cellulose yarns can have a high lustre. 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.

[0009] However 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.

[0010] Due to these deficiencies, the products which were originally made using continuous filament cellulose yarns now use mainly synthetic polymer continuous filament yarns such as polyester and nylon. Continuous filament polyester yarns are used extensively in the construction of footwear such as sports shoes and trainers.

[0011] 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 shoes made from the synthetic yarns are uncomfortable to wear.

[0012] Synthetic yarns are produced from petrochemical sources which are not sustainable in the long term. Disposal of synthetic yarns is problematic as they do not readily biodegrade and can accumulate in the environment.

[0013] Lyocell is the generic name given by BISFA (The International Bureau for the Standardization of Man-Made Fibers) to a type of cellulosic man-made fiber produced by a direct dissolution process in an organic solvent. The lyocell process is described e.g. in US 4,246,221 and, WO 93/19230, EP0787694, EP1425441 and WO2019/068922. 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 ves-

sel. 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 fibres which are then immediately immersed in water where the dilution of the amine oxide causes the cellulose to precipitate.

[0014] To produce staple fibre, the newly formed fibre is washed to remove residual amine oxide before drying and crimping and cutting into staple fibre. The washing is done by forming a sheet of parallel fibres which then pass through a continuous counter current washing system. At the end of the washing system the sheet of fibre is passed through a drying oven and then drawn together to form a tow. The tow is crimped in a stuffer box crimper and then cut into staple fibre of the required length.

[0015] In another version of the process, the tow of newly formed fibre is cut into staple fibre of the required length and then washed on a moving wash bed. The washed fibre is dried in a flat bed dryer.

[0016] The same process can also be used in a different arrangement 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 fibres 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 fibre. A finish may be applied to aid further processing and the yarn is dried. The washed and dried yarn is wound onto a bobbin.

[0017] In the lyocell process, cellulose in the form of wood pulp is the only raw material used. The pulp used preferably may be a wood pulp used which comes from sustainable managed forests. The pulp also may partly come from the recycling of cellulosic textile materials such as cotton or cellulosic wood-based fibers. The fibre 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 fibre. 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 fibre produced is solvent free.

[0018] 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 by-product of the process.

[0019] In the cupro process there is a risk of releasing copper compounds into the environment with consequential negative effects.

[0020] The fibre produced by the lyocell process has considerably higher tensile strength than fibre produced by the viscose process. This can result in fabrics with

better strength, tear strength and abrasion resistance.

[0021] The loss of strength when lyocell fibres are wetted is much lower than for viscose fibres. 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.

[0022] The process of shoe making is influenced by many factors, such as construction, style, design or choice of materials.

[0023] The construction describes the connection between the top of the shoe (upper) and the sole. This may be done by sewing, gluing and direct moulding or vulcanized shoes. It has a big impact on the price and durability of the shoe.

[0024] The style and design define what components are used for the shoe - and depending on the design a shoe can consist of up to 50 components. The top of the shoe consists for example of upper and lining materials, intermediate linings, reinforcing and upholstery or padding materials as well as laces, eyelets, etc. The sole construction may include for example the outsole, midsole, insole (insole board and sockliner), heel counter and toppings. Designing for good ecological practice and to make claims of recyclability have resulted in a reduction in the number of components used.

[0025] The upper material has the biggest influence on the character of the shoe. In addition to visual appearance and design, upper materials are there to protect from external factors such as weather, dirt and abrasion (or for safety shoes also from other external influences).

[0026] The largest share of shoes traded worldwide in 2018 were made of plastic or rubber (47%). These include synthetic leather shoes and rubber boots. Approximately 14% are made of leather. Textile materials are of growing importance. In 2009 only 17% of the footwear exported worldwide had textile uppers; by 2018 this percentage had increased to 32%.

[0027] The textiles used as shoe upper are knitted or woven fabrics, e.g. for casual shoes and sneakers, mesh fabrics for sports shoes or felt for home slippers. The majority of traditional shoe uppers does not consist of a single layer, but multiple layers. Under the fabric or leather upper is usually an adhesive lining or interlining glued to the upper. In order to increase comfort, paddings are often added. At the end is the innerlining. Winter shoes can also be lined with fur, faux fur, felt or non-woven fabric. Especially in hiking boots membranes are also often used under the upper.

[0028] Reinforcing materials are incorporated under the upper material, which stabilize the shoe on the eyelets, the heel and the toe. Reinforcing materials are often thin nonwovens with a thermoplastic coating.

[0029] For sports shoes, the lining is usually a polyester or polyamide textile, for example a spacer mesh for air circulation for moisture transport and quick re-drying. Between the upper and inner lining foams are incorporated especially at the shaft edge and in the tongue, which should provide for a higher wearing comfort as well as a

better fit. The collar padding should prevent slipping out of the shoe and blistering.

[0030] Also used in the construction of shoes are laces, ribbons, webbings, seams or glue. The lower the friction of the laces on the eyelets, the better the fit of the shoe as the tension distributes more evenly over the entire length of the lacing.

[0031] The sole consists of several layers. The outsole can be made of leather, rubber or plastic such as polyurethane (PU). The insole can be leather, a PU or EVA foam, with a laminated textile sockliner, such as polyester or polyamide, but also cotton, wool or other natural polymer materials. Cork, felt, artificial suede, coated fabrics and nonwovens are also used in the sole.

[0032] Optimisation of the frictional resistance between the sole and foot is important for stability in the shoe. This is required in dry and damp conditions. Skin compatibility, as well as friction and color fastness must also be ensured in a good insole material. All outsole materials have similar requirements. Leather, rubber and foams should be as durable as possible and dimensionally stable while still providing flexibility for pleasant wearing comfort. Some shoes have special features, such as walking and working shoes, the slip resistance and puncture resistance are important. In sports shoes the damping behaviour and the lightness are the important factors.

[0033] In the sole components, the style plays a major role. Shoes with leather soles are welted, sports shoes with a foam sole are sprayed directly.

[0034] Sports shoes include a midsole, which is mainly used for damping, to give comfort, but also gives energy return on each step as the midsole recovers from compression.

[0035] Removable inserts are also used, for example barefoot insoles or washable insoles for diabetics who have very sensitive feet.

[0036] Textile materials are used as major components in a wide variety of footwear. Fabrics are used to form the outer part of shoes, the insole, the liner, bindings and straps, and as a reinforcing fabric for the sole. Yarns are formed into braids or twisted assemblies for use as laces. Fabrics are also used as decoration.

[0037] Fabrics may be used as produced or may commonly be finished with chemical agents to give them properties such as waterproofing, anti-soiling, moisture handling and reduced friction.

[0038] Fabrics may also be used as a base layer for polymeric coatings. Polyurethane coatings are often used for this purpose.

[0039] Polyester is widely used for fabrics which form components of shoes. Cotton fabrics have been traditionally used as a component in shoes. However as the demands for performance have increased polyester and other synthetic fibres have increased in popularity. The fabrics made from synthetic fibres are stronger and more stable than cotton fabrics.

[0040] Fabrics produced from synthetic fibres rely for their manufacture on oil based raw materials extracted

from the ground. This type of process is recognised as being unsustainable in the long term.

[0041] Disposal of synthetic fibre fabrics is recognised to be a problem. When buried in landfill sites synthetic fibres do not biodegrade. Incinerating the fabric releases fossil carbon into the atmosphere. There is always the danger of releasing waste materials into the environment in an uncontrolled way such as into oceans and rivers.

10 Disclosure of the invention

[0042] Considering the state of the art outlined above there is a need for sustainable footwear. The present invention solves a number of problems with the use of synthetic fibres in footwear while giving the performance needed for use in shoes.

[0043] Continuous filament lyocell can be used to produce footwear with surprisingly good moisture handling properties, frictional properties while at least matching the physical performance of incumbent materials.

[0044] Fabrics made from or containing significant amounts of continuous filament lyocell are strong and stable and give to the footwear performance similar to fabrics made from synthetic continuous filament fibres. Continuous filament lyocell can be used as a direct replacement for incumbent materials used in the manufacture of textile based footwear without significant changes in the design of the shoe.

[0045] Continuous filament lyocell can be woven to form a fabric for use in footwear components either on its own or in combination with other yarns.

[0046] Continuous filament lyocell can be knitted to form a fabric for use in footwear components either on its own or in combination with other yarns.

[0047] Therefore the invention consists in a footwear, in particular a shoe, which contains a lyocell continuous filament yarn.

[0048] The lyocell continuous filament yarn may be a component or the whole of a fabric.

[0049] Preferably, according to the invention, the fabric furthermore contains one or more other yarns selected from the group including polyester, nylon and polypropylene continuous filament yarns, cotton, viscose, modal, lyocell, hemp, wool, linen, cashmere, polyester, nylon polypropylene and acrylic staple spun yarns.

[0050] The fabric may be a woven fabric.

[0051] In a preferred embodiment according to the invention the warp is lyocell continuous filament yarn and the weft is the other yarn.

[0052] Preferably the weft is lyocell continuous filament yarn and the warp is the other yarn.

[0053] The fabric may be a satin or sateen weave.

[0054] In another preferred embodiment according to the invention the fabric is a knitted fabric.

[0055] Preferably the yarns are arranged in the fabric in a way to give one face of mainly or solely continuous filament lyocell and the other face of mainly or solely the other yarn.

[0056] The fabric may be a fake fur.

[0057] In a preferred embodiment according to the invention the lyocell continuous filament yarn is texturized by air texturizing or some other suitable technique.

[0058] In a preferred embodiment according to the invention the fabric is produced by coating on one face with a polymeric coating such as polyurethane to produce artificial leather or similar coated fabric.

[0059] Preferably the footwear is a shoe, in particular a trainer, sports shoe, running shoe, casual shoe or any other shoe which is normally made from fabric or include fabric in its construction.

[0060] In a preferred embodiment according to the invention the footwear contains a shoe lace produced from lyocell continuous filament yarn by braiding, weaving or knitting or by twisting individual yarns together to produce the shoe lace of the required dimensions.

[0061] In another preferred embodiment according to the invention a lyocell continuous filament yarn is contained in a decorative according to the invention item of the footwear, such as for example in a binding, zipper base, strap, label or other decorative item.

[0062] The construction of the woven or knitted fabric may be the same as those currently used for footwear components or may be purpose designed to make maximum use of the properties of the yarn. For example a continuous filament lyocell woven satin fabric will give excellent frictional properties if used as a lining fabric for trainers.

[0063] The present invention includes the use of continuous filament lyocell as a major part in any component of a shoe including but not limited to the liner, the insole, the outer fabric, laces, bindings and straps, reinforcing fabric for the sole.

[0064] The present invention also includes all shoes in which continuous filament lyocell is used as a component and the fabrics used to make those components.

[0065] Lyocell fibres absorb and transport moisture. This is an essential property in order to maximise comfort of the wearer of footwear with textile components. When exercising or exerting, the skin produces sweat which is intended to cool the body removing excess heat. In order for this to happen, the moisture must be transferred from the skin to where it can be evaporated, the outside of the shoe. Using lyocell fabrics allows the moisture handling properties of the fibre to be used to make the transport of moisture happen. Synthetic fibres are hydrophobic and hence their moisture handling properties are not as good as lyocell which is made from cellulose. The improved moisture handling properties of continuous filament lyocell will give enhanced comfort for the wearer.

[0066] Fabrics made from continuous filament lyocell have a smooth surface giving low friction. This means that shoes according to the invention lined with lyocell fabric are easier to get onto the foot and cause less friction against the skin during wear. This reduces the likelihood of frictional damage to the skin.

[0067] Lyocell is produced from cellulose extracted

from trees grown in managed forests with FSC or equivalent certification. No fossil based carbon is used in the product so the effect on atmospheric CO₂ levels is very low. At the end of the life of the product the cellulose will biodegrade and not leave a long term residue of particulate polymer like the synthetic fibres do.

[0068] The use of continuous filament lyocell according to the invention in the manufacture of shoes provides a method of reducing the carbon footprint of the finished product. Lyocell is produced from cellulose which is a renewable resource using a process with minimal environmental impact

[0069] Disposal of the shoe at the end of its life is easier than for shoes made using incumbent materials because the lyocell components are readily biodegradable.

[0070] Continuous filament lyocell can be used according to the invention as a direct replacement for continuous filament yarns currently used in shoe manufacture. The polyester yarns used in the production of fabric for use as shoe liners for example can be replaced with an equivalent count of CF lyocell yarn without changing the construction of the fabric.

[0071] The same is true for all components of the shoe where continuous filament yarns made from polyester, nylon, polypropylene or other synthetic polymers are the incumbent products.

[0072] Fabrics according to the invention may be produced from continuous filament lyocell by knitting, weaving or any other process that will produce a fabric from a continuous filament yarn. Prior to knitting or weaving, the continuous filament lyocell yarn may be texturized using techniques developed for synthetic continuous filament yarns such as ACY (air covered yarn) and ATY (air texturized yarn).

[0073] Continuous filament lyocell yarns according to the invention may be combined with other yarns in the fabric for in shoes. For example a woven fabric may be produced with a continuous filament lyocell warp and a continuous filament polyester weft for use as a liner. Alternatively the lyocell may be the weft and polyester the warp. Lyocell and other yarns may be mixed in either the warp or the weft.

[0074] Similarly, knitted fabrics may be produced according to the invention using a combination of lyocell with other yarns.

[0075] Continuous filament lyocell yarns may therefore be used according to the invention as components of a wide variety of styles of shoes and footwear for a range of applications.

[0076] According to the invention they can be used as components in sports shoes including but not limited to trainers, sports shoes and sneakers. The fabrics of the invention can be used as the outer fabric, upper and lining materials, intermediate linings, reinforcing and upholstery or padding materials. They can also be used for trim, laces, binders and other auxiliary components. The fabrics of the invention may also be used as a component of the parts of the sole including outsole, midsole, insole

(insole board and sockliner), heel counter and toppings.

[0077] The fabrics according to the invention can also be used as components of leisure shoes, slippers, casual shoes, formal shoes, boots and any other footwear that includes a fabric as a component.

Examples

[0078]

1. A fabric according to the invention made of continuous filament polyester yarn in the warp and continuous filament lyocell yarn in the weft was used as a liner in a trainer. The performance of this shoe was comparable to a trainer made merely of conventional materials and the wear comfort was significantly improved.

2. Continuous filament lyocell yarn was used as a coating substrate for a coated fabric (i.e. artificial leather) for use in a casual shoe. The performance of this shoe was comparable to a casual shoe made merely of conventional materials and the wear comfort was significantly improved.

3. Continuous filament lyocell yarn was used for a fabric for the outer layer of an insole for use in slippers. The performance of this insole was comparable to an insole made merely of conventional materials and the wear comfort was significantly improved.

4. Continuous filament lyocell yarn was used as the surface layer in a fabric made according to the invention of continuous filament polyester yarn in the warp and continuous filament lyocell yarn in the weft for a trainer. The performance of this shoe was comparable to a trainer made merely of conventional materials and the wear comfort was significantly improved.

Claims

1. A footwear, in particular a shoe, **characterized in that** it contains a lyocell continuous filament yarn.
2. Footwear according to claim 1, wherein the lyocell continuous filament yarn is a component or the whole of a fabric.
3. Footwear according to claim 2, wherein the fabric furthermore contains one or more other yarns selected from the group including polyester, nylon and polypropylene continuous filament yarns, cotton, viscose, modal, lyocell, hemp, wool, linen, cashmere, polyester, nylon polypropylene and acrylic staple spun yarns.

4. Footwear according to claim 2, wherein the fabric is a woven fabric.

5. Footwear according to claim 4, wherein the warp is lyocell continuous filament yarn and the weft is the other yarn.

6. Footwear according to claim 4, wherein the weft is lyocell continuous filament yarn and the warp is the other yarn.

7. Footwear according to claim 4, wherein the fabric is a satin or sateen weave.

8. Footwear according to claim 2, wherein the fabric is a knitted fabric.

9. Footwear according to claim 8, wherein the yarns are arranged in the fabric in a way to give one face of mainly or solely continuous filament lyocell and the other face of mainly or solely the other yarn.

10. Footwear according to claim 2, wherein the fabric is a fake fur.

11. Footwear according to claim 1, wherein the lyocell continuous filament yarn is texturized by air texturizing or some other suitable technique.

12. Footwear according to claim 1, wherein the fabric is produced by coating on one face with a polymeric coating such as polyurethane to produce artificial leather or similar coated fabric.

13. Footwear according to claim 1, wherein the footwear is a shoe, in particular a trainer, sports shoe, running shoe, casual shoe and any other shoe which is normally made from fabric or include fabric in its construction.

14. Footwear according to claim 1, wherein the footwear contains a shoe lace produced from lyocell continuous filament yarn by braiding, weaving or knitting or by twisting individual yarns together to produce the shoe lace of the required dimensions.

15. Footwear according to claim 1, wherein the lyocell continuous filament yarn is contained in a decorative item of the footwear, such as for example in a binding, zipper base, strap, label or other decorative item.



EUROPEAN SEARCH REPORT

Application Number
EP 20 15 2874

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 8 June 2020	Examiner Baysal, Kudret
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 20 15 2874

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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