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(54) **YARN AND FABRIC WITH IMPROVED PROPERTIES AGAINST VANDALISM**

(57) The present invention provides yarns, fabrics and related products with enhanced properties against lacerative aggression, impact, fire and easier to clean and maintain to be used, for example in passenger transport means.

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Description

[0001] The present invention refers to the field of fabrics, more precisely to the field of fabrics with enhanced properties against vandalism and enhanced behaviour against fire, to be used, for example, in seats of passenger transport means.

[0002] In the field of passenger transport means, the fabrics used to upholster or in covers of seats (or other structures) need to meet very restrictive requirements with regard to resistance to lacerative aggressions (for example, due to vandalism), resistance to fire, resistance to impact and cleaning and maintenance.

[0003] Regarding resistance to lacerative and impact or shock aggressions, currently, different composite fabrics can be found in the field of passenger transport means (mainly, in the seats of said passenger transport means). All the fabrics currently available in this field are made by lamination. In this type of technique, normally, the structure is made of two layers of resistant material between which a light material (and, as a general rule, of low density) is positioned. The binding interface between the different layers is very important and is normally an adhesive or fibres.

[0004] Examples of these types of solutions available in the state of the art which make use of a metal mesh or similar can be found in:

- Spanish Patent application ES2345747A1, which discloses a lacerative resistant sandwich-type composite intended for tailoring and manufacture of upholstery with a metal mesh or layer, wherein the different layers are bound by means of an adhesive component.
- Spanish Patent application ES2277510A1, which discloses sandwich-type composite with metal yarns, wherein the different layers are bound during the production procedure and not afterwards (by incorporating yarns of each of the layers within the other layer).
- Spanish Utility Model application ES1017166U, which discloses a laminated composite which has an outer layer of a fabric providing for the fire resistance properties, next a high resistance metal mesh is positioned (providing the required resistance to lacerative aggressions).

[0005] This type of fabrics incorporating metal structures have several drawbacks as, for example:

- The fact that they are very stiff, thick and heavy, causing a very difficult, complex and expensive production, handling and maintenance.
- In addition, due to the fact that they are constituted by layers with different features, when the structure is subject to a force, the behaviour of the different layers will not be the same.
- In a process of manufacturing a seat cover with anti-vandalism properties several layers of products must, hence, be integrated. These layers must be processed separately according to the materials that compose them, that is, they must be presented on a cutting table and cut into pieces, this is: seat and backrest, according to the established patterns. Likewise, the cutting process and its tools vary depending on whether the cut is made by layers or by individual pieces, generating a complexity of the process itself and its logistics. This complexity also occurs at the time of assembling these components in the physical space of the seat to get a synergistic assembly of all of them and to ensure its operation as a single element and not as overlapping layers.
- In addition, they cannot normally be cleaned by means of injection-extraction (a preferred method within the passenger transport industry), because of their excessive capillarity.
- Finally, this types of solutions show a bad behaviour regarding wear.

[0006] Other types of laminated composites can be as disclosed in the French Patent application FR2960886A1, which discloses a laminated fabric without a metallic structure but with, instead, two textile layers covering or surrounding a non-textile aramid layer (which provides for the resistance against aggressions). This solution has to be bound to a conventional fabric which will be the visible part of the seat sheath. The main drawbacks of this solution are its composite structure and its cleaning and maintenance.

[0007] In addition, the solutions currently available in the state of the art normally require the use of additional fire barriers, for example, incorporating additional fabric layers which protect the seat and the foam (avoiding their burning and, as a consequence, the emission of toxic gases and of smoke). The two most used options to provide fire resistance are:

- By using fibres with inherent flame retardant properties: for example, aramids, glass fibre, acrylics, organic aromatic polyamides, oxidized acrylics, phenolic and ceramics.
- By using these very same chemically modified fibres applied to non-woven fabrics.

[0008] Hence, until now, the solutions provided by the state of the art meeting the above-mentioned requirements of the seats (and, in general, fabrics) of passenger transport means are composite structures with several layers and which

use different materials. This leads to suboptimal solutions with difficulties both in the production procedure and during its maintenance and cleaning, due to said composite structure. It would, therefore, be desirable to find a yarn already incorporating all the above-mentioned features which would allow to generate or produce a simple fabric (with one layer), easy to produce and which would incorporate all the required features, hence, avoiding the requirement of a composite structure or additional layers.

[0009] Therefore, in the state of the art there remains the need to provide a yarn with the required properties and which can provide a simple fabric (with only one layer) with all the above-mentioned required properties in the field of passenger transport, hence, avoiding or not requiring the use of a composite structure with several layers (including metal meshes), providing, hence, a product which is, in turn, easier to produce, maintain and clean and more comfortable and user-friendly (for example, with appropriate colour).

[0010] The inventors of the present invention, after extensive and exhaustive research, have surprisingly found a yarn comprising Thermotropic Liquid Crystal Polymer fibres and poly-para-phenylene terephthalamide fibres which provide yarns and fabrics (and related products) with enhanced properties against lacerative aggression, impact, fire and easier to clean and maintain. The yarns and fabrics (and related products) of the present invention solve all the above-mentioned problems. This is, said yarns have the required properties against lacerative aggression, impact, fire and easiness of cleaning as well as the desired appearance or colour, allowing, thus, the production of a simple fabric comprising said yarn and avoiding the need to use a composite and/or laminated fabric with multiple layers. In addition, the improved properties of the yarn and fabric of the present invention allow avoiding the use of a metal mesh. As a consequence of the above, the fabric (and related products) of the present inventions are easier to produce (without requiring complex procedures of producing and bounding several layers and generating a composite fabric and without requiring to handle metal meshes), more comfortable for the passengers and easier to clean and maintain.

[0011] The inventors of the present invention have ascertained that yarns consisting of Thermotropic Liquid Crystal Polymer fibres or poly-para-phenylene terephthalamide fibres are unable to provide all the above-mentioned requirements, for example, a yarn consisting of poly-para-phenylene terephthalamide fibres is unable to provide the required lacerative resistance and a yarn consisting of Thermotropic Liquid Crystal Polymer fibres provides an undesired colour. Therefore, said yarns are unable to solve the above-mentioned problems present in the state of the art. However, a yarn comprising both Thermotropic Liquid Crystal Polymer fibres and poly-para-phenylene terephthalamide fibres does provide all the above-mentioned required features and technical effects and, hence, is able to solve the problem found in the state of the art.

[0012] Therefore, in a first aspect, the present invention refers to a yarn comprising Thermotropic Liquid Crystal Polymer fibres (hereinafter, TLCP fibres) and poly-para-phenylene terephthalamide fibres (hereinafter, PPT fibres).

[0013] In a second aspect, the present invention refers to a fabric comprising at least one yarn of the present invention.

[0014] In a third aspect, the present invention refers to an upholstery comprising at least one fabric of the present invention.

[0015] In a fourth aspect, the present invention refers to a cover comprising at least one fabric of the present invention.

[0016] In a final aspect, the present invention refers to a seat comprising an upholstery, a cover and/or a fabric of the present invention.

[0017] As used herein, "passenger transport mean" and its plural are used in accordance with the meaning they normally acquire in the state of the art. Examples thereof are: adapted industrial vehicle, train, bus, ship or plane.

[0018] As used herein, "composite", "composite fabric" and their plurals refer to a fabric with two or more layers, which can be generated and/or bound by any means known in the state of the art.

[0019] "Simple fabric" and its plural, in the present document, refer to a fabric with one layer, which can be generated by any means known in the art.

[0020] As used herein, "poly-para-phenylene terephthalamide fibre", "p-aramid" and their plural are equivalent and, hence, are used interchangeably and they are used in accordance with their common meaning in the state of the art.

[0021] As used herein, "denier", its plural or "dn", are equivalent and have the common meaning they acquire in the state of the art, this is, they refer to a unit of measure for the linear mass density of fibres. The "denier" (or "dn") is defined as the mass in grams per 9000 meters, or more commonly, weight in milligrams of a 9 meters strand. 1 denier=0.11 mg/m. The "denier" is based on a natural reference, this is, a single strand of silk is approximately one denier. A 9000-meter strand of silk weighs about one gram. The term "microdenier" is used to describe filaments or fibres that weigh less than one gram per 9000 meters. One can distinguish between filament or fibre and total measurements in deniers. Both are defined as above but the first only relates to a single filament of fiber (commonly known as denier per filament or DPF) whereas the second relates to a yarn, a spun agglomeration of filaments or fibres. The denier system of measurement is used on two- and single-filament fibres. Some common calculations are as follows: 1 denier=1 gram per 9000 meters=0.111 milligrams per meter. Regarding measurement, in practice, measuring 9000 meters of filament or fibre is both time-consuming and unrealistic; generally a sample of 900 meters is weighed and the result multiplied by 10 to obtain the denier weight.

[0022] As already stated above, in a first aspect, the present invention refers to a yarn comprising TLCP fibres and

PPT fibres.

[0023] Preferably, the yarn of the present invention comprises:

- between 1 and 99% (percentage in weight, weight/weight, hereinafter w/w) of TLCP fibres; and
- between 1 and 99% (w/w) of PPT fibres.

[0024] More preferably, the yarn of the present invention comprises:

- between 60 and 80% (w/w) of TLCP fibres; and
- between 20 and 40% (w/w) of PPT fibres.

[0025] Even more preferably, the yarn of the present invention comprises:

- between 70 and 80% (w/w) of TLCP fibres; and
- between 20 and 30% (w/w) of PPT fibres.

[0026] In a preferred embodiment, the yarn of the present invention comprises:

- 70% (w/w) of TLCP fibres; and
- 30% (w/w) of PPT fibres.

[0027] In another preferred embodiment, the yarn of the present invention comprises:

- 80% (w/w) of TLCP fibres; and
- 20% (w/w) of PPT fibres.

[0028] In the most preferred embodiment the yarn of the present invention consists of TLCP fibres and PPT fibres

[0029] Preferably, the yarn of the present invention consists of:

- between 1 and 99% (w/w) of TLCP fibres; and
- between 1 and 99% (w/w) of PPT fibres.

[0030] More preferably, the yarn of the present invention consists of:

- between 60 and 80% (w/w) of TLCP fibres; and
- between 20 and 40% (w/w) of PPT fibres.

[0031] More preferably, the yarn of the present invention consists of:

- between 70 and 80% (w/w) of TLCP fibres; and
- between 20 and 30% (w/w) of PPT fibres.

[0032] Even more preferably, the yarn of the present invention consists of:

- 70% (w/w) of TLCP fibres; and
- 30% (w/w) of PPT fibres.

or of:

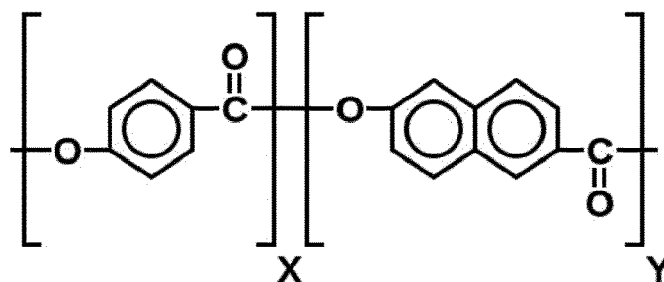
- 80% (w/w) of TLCP fibres; and
- 20% (w/w) of PPT fibres.

[0033] It is contemplated that the TLCP fibres is any TLCP fibre available in the state of the art. Examples of commercially available TLCP fibres are: RTP® LCP, Vectran®, Xydar®, Zenite® or combinations thereof.

[0034] Preferably, the TLCP fibres are polyester-polyarylate fibres. In the most preferred embodiment, the TLCP fibres are a polymer of p-hydroxybenzoic acid (hereinafter, HBA) and 2-hydroxy-6-naphthoic acid (hereinafter, HNA) (see Formula (I)).

[0035] Preferably, the molar ratio between HBA and HNA is 50-90% HBA and 10-50% HNA, more preferably, the

molar ratio is 60-85% HBA and 15-40% HNA, and even more preferably, the molar ratio is 65-75% HBA and 25-35% HNA. In another preferred embodiment, the molar ratio equals about 3 moles HBA to 1 mole HNA. In another preferred embodiment, the molar mass ratio of HBA to HNA is about 73 to 27.



(I)

[0036] The TLCP fibres (preferably, polymer of HBA and HNA) are produced by any means known in the state of the art, preferably, by melt spinning.

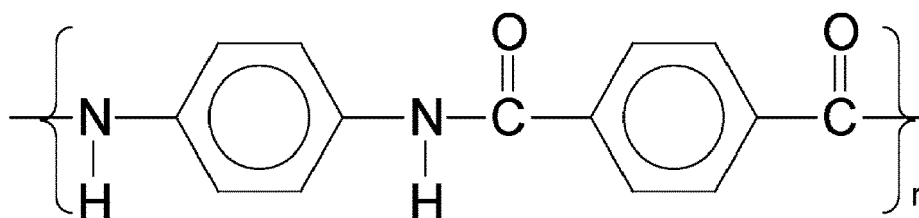
[0037] Preferably, the TLCP fibres (preferably, polymer of HBA and HNA) are obtained from continuous filaments of TLCP comprising a denier selected from the range 200 dn to 2250 dn, even more preferably a denier selected from 200 dn, 400 dn, 750 dn, 1000 dn, 1420 dn, 1500 dn and/or 2250 dn.

[0038] Preferably, the TLCP fibres (preferably, polymer of HBA and HNA) comprise a denier selected from the range 1.5 dn to 7 dn, even more preferably the TLCP fibres have a denier of 5 dn.

[0039] Also preferably, the TLCP fibres have a fibre length of between 20 mm and 110 mm, more preferably of between 60 mm and 90 mm.

[0040] Regarding the PPT fibres, it is contemplated that the PPT fibres is any PPT fibre available in the state of the art. Examples of commercially available PPT fibres are: Kevlar®, Twaron®, Technora®, Heracron®, Tayho® or combinations thereof.

[0041] The PPT fibres are fibres of a polymer of para-phenylene terephthalamide (see Formula (II)). The PPT has 100% paracrystalline structure.



(II)

[0042] The PPT fibres are produced by any means known in the state of the art, preferably, by solvent spun.

[0043] Preferably, the PPT fibres are obtained from continuous filaments of PPT comprising a denier selected from the range 200 dn to 2250 dn, even more preferably a denier selected from 200 dn, 400 dn, 750 dn, 1000 dn, 1420 dn, 1500 dn and/or 2250 dn.

[0044] Preferably, the PPT fibres comprise a denier selected from the range 1.5 dn to 7 dn, even more preferably the PPT fibres have a denier of 1.55 dn.

[0045] Also preferably, the PPT fibres have a fibre length of between 20 mm and 110 mm, more preferably of between 60 mm and 90 mm.

[0046] In a preferred embodiment, the yarn of the present invention is a spun yarn.

[0047] The yarn of the present invention can be of any colour known in the state of the art. Preferably, a coloured yarn is obtained by using PPT fibres of the desired colour or of a combination of colours which, in turn, provides for the desired colour in the yarn. In the most preferred embodiment, the PPT fibres are of black colour.

[0048] PPT fibres with the desired colour can be obtained by any means known in the state of the art. Preferably, said fibres are obtained by adding the appropriate colorant (known in the state of the art) during the extrusion of the fibres.

[0049] Preferably, the yarn of the present invention is for the preparation or production of fabrics to be used in passenger

transport means, preferably in seats of passenger transport means, more preferably in bus and/or train seats.

[0050] The yarn of the present invention can be produced by means of any process known in the state of the art. In the most preferred embodiment, the yarn of the present invention is produced using stretch-broken technology. In the latter, preferably, the yarn of the present invention can be produced by means of any spinning process known in the art.

More preferably, the yarn of the present invention is produced by means of a process comprising the following steps:

- a) stretch breaking continuous filaments of TLCP and PPT to obtain staple fibres of each of the components (TLCP and PPT);
- b) processing the staple fibers produced in step a) into pure slivers of TLCP and pure slivers of PPT;
- c) blending the pure slivers of TLCP and of PPT obtained in step b) to obtain a blend sliver;
- d) tightening and twisting the blended sliver obtained in step c) to produce the yarn of the present invention (preferably, spun yarn).

[0051] In step a) the staple fibres of TLCP and PPT are prepared separately or independently. Preferably, in said step a) the staple fibres of TLCP are prepared by means of stretch-breaking performed using continuous filaments of TLCP comprising a denier selected from the range 200 dn to 2250 dn, even more preferably, a denier selected from 200 dn, 400 dn, 750 dn, 1000 dn, 1420 dn, 1500 dn and/or 2250 dn. Also preferably, in said step a) the staple fibres of PPT are prepared by means of stretch-breaking performed using continuous filaments of PPT comprising a denier selected from the range 200 dn to 2250 dn, even more preferably, a denier selected from 200 dn, 400 dn, 750 dn, 1000 dn, 1420 dn, 1500 dn and/or 2250 dn.

[0052] In addition, in step a), preferably, the generated staple fibres of TLCP comprise a denier selected from the range 1.5 dn to 7 dn, even more preferably the staple fibres of TLCP have a denier of 5 dn. Also preferably, said generated staple fibres of TLCP have a fibre length of between 20 mm and 110 mm, more preferably of between 60 mm and 90 mm. Moreover, in step a), preferably, the generated staple fibres of PPT comprise a denier selected from the range 1.5 dn to 7 dn, even more preferably the staple fibres of PPT have a denier of 1.55 dn. Also preferably, said generated staple fibres of PPT have a fibre length of between 20 mm and 110 mm, more preferably of between 60 mm and 90 mm.

[0053] In step c), the blending of the slivers of TLCP and of PPT is performed so as to obtain the desired percentage of TLCP and PPT in the yarn. Said percentage of TLCP and PPT in the yarn is as explained above.

[0054] In step d), first the blend sliver is tightened and, afterwards, twisted.

[0055] Preferably, tightening comprises processing the blend sliver to obtain a single ply of yarn, even more preferably a single ply of yarn in a count metric range from Nm 1/5 to Nm 1/40.

[0056] Preferably, twisting comprises twisting single plies of yarns in the required number of plies to produce the yarn (preferably, the spun yarn). More preferably, the number of plies is 2, 3 or 4. Also more preferably, the plies are from any of the count metric range from Nm 1/5 to Nm 1/40.

[0057] Alternatively, in the above-mentioned process, steps a) and b) can be as follows:

- stretch breaking and drafting parallel continuous filaments of TLCP and PPT between input rolls and delivery rolls in a stretch break zone or a draft cutting zone to form pure slivers of TLCP of discontinuous fibres and pure slivers of PPT of discontinuous fibres; and

[0058] In a second aspect, the present invention refers to a fabric comprising at least one yarn of the present invention.

[0059] The at least one yarn of the present invention can be a combination of different types of yarns of the present invention or one type of yarn of the present invention. In a preferred embodiment, the fabric of the present invention comprises one type of yarn of the present invention.

[0060] It is contemplated that the fabric of the present invention comprises further yarns. Said further yarns can be any yarn known in the state of the art or which is developed in the future.

[0061] In an embodiment, the fabric of the present invention comprises at least 10% (w/w) of yarns of the present invention, more preferably at least 20% (w/w) of yarns of the present invention, more preferably at least 30% (w/w) of yarns of the present invention, more preferably, at least 40% (w/w) of yarns of the present invention. Even more preferably, the fabric of the present invention comprises at least 47% (w/w) of yarns of the present invention. In the most preferred invention, the fabric of the present invention comprises 47% (w/w) of yarns of the present invention. The yarns of the present invention are as explained above. In a particularly preferred example of the latter most preferred embodiment, the fabric of the present invention consists of 41% (w/w) of wool; 47 % (w/w) of yarns of the present invention consisting of 70% (w/w) of TLCP fibres and 30% (w/w) PPT fibres; 7% (w/w) of polyamide; 3% polyester; and 2% (w/w) of viscose.

[0062] In another embodiment, the fabric of the present invention comprises at least 10% (in number of yarns per square centimetre, percentage of number of yarns per square centimetre regarding the total number of yarns per square centimetre, hereinafter ycm/ycm) of yarns of the present invention, more preferably at least 20% (ycm/ycm) of yarns of the present invention, more preferably at least 30% (ycm/ycm) of yarns of the present invention, more preferably, at

least 40% (ycm/ycm) of yarns of the present invention, more preferably, at least 50% (ycm/ycm) of yarns of the present invention. Even more preferably, the fabric of the present invention comprises at least 57.6% (ycm/ycm) of yarns of the present invention. In the most preferred invention, the fabric of the present invention comprises 57.6% (ycm/ycm) of yarns of the present invention. The yarns of the present invention are as explained above.

[0063] The fabric of the present invention can be made by any means and/or in any configuration known in the state of the art. In the most preferred embodiment, the fabric of the present invention is made by means of ground warp, pile warp and weft.

[0064] In addition, the fabric of the present invention is, preferably, in the form of flat woven and/or woven velvet, more preferably, the fabric of the present invention is in the form of any woven fabric of a single layer produced by means of any of the following technologies: Dobby flat woven, Jacquard flat woven, Dobby woven velvet and Jacquard woven velvet, preferably, with a base structure of yarns of the present invention that forms a net with ground warp, pile warp and weft. In the most preferred embodiment, the fabric of the present invention is in the form of woven velvet, more preferably, in the form of Jacquard woven velvet, preferably, with a base structure of yarns of the present invention that forms a net with ground warp, pile warp and weft. Regarding the net with ground warp, pile warp and weft, preferably, the fabric of the present invention comprises:

- In the ground warp: at least 50% (in number of yarns, percentage of number of yarns regarding the total number of yarns, hereinafter y/y) of the ground warp yarns are yarns in accordance with the present invention.
- In the pile warp: at least 50% (y/y) of the pile warp yarns are yarns of the present invention.
- In the weft: at least 50% (y/y) of the weft yarns are yarns in accordance with the present invention.

[0065] In the ground warp, preferably, 50% (y/y) of the ground warp yarns are yarns of the present invention and 50% (y/y) of the ground warp yarns are of any type of yarn known in the state of the art. Even more preferably, in the ground warp, 50% (y/y) of the ground warp yarns are yarns of the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres; and 50% (y/y) of the ground warp yarns are yarns consisting of polyester and viscose (preferably, consisting of 70% (w/w) polyester and 30% (w/w) viscose).

[0066] In the pile warp, preferably, 50% (y/y) of the pile warp yarns are yarns of the present invention and 50% (y/y) of the pile warp yarns are of any type of yarn known in the state of the art. Even more preferably, in the pile warp, 50% (y/y) of the pile warp yarns are yarns of the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres; and 50% (y/y) of the pile warp yarns are yarns consisting of wool and polyamide (preferably, consisting of 85% (w/w) wool and 15% (w/w) polyamide).

[0067] In the weft, preferably, 100% (y/y) of the weft yarns are yarns in accordance with the present invention. Even more preferably, in the weft, 100% (y/y) of the weft yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres.

[0068] In a preferred embodiment, therefore, regarding the net with ground warp, pile warp and weft, the fabric of the present invention comprises:

- In the ground warp: at least 50% (y/y) of the ground warp yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres.
- In the pile warp: at least 50% (y/y) of the pile warp yarns are yarns of the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres.
- In the weft: 100 % (y/y) of the weft yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres.

[0069] More preferably, as already stated above, regarding the net with ground warp, pile warp and weft, the fabric of the present invention comprises:

- In the ground warp: 50% (y/y) of the ground warp yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres; and 50% (y/y) of the ground warp yarns are yarns consisting of polyester and viscose (preferably, consisting of 70% (w/w) polyester and 30% (w/w) viscose).
- In the pile warp: 50% (y/y) of the pile warp yarns are yarns of the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres; and 50% (y/y) of the pile warp yarns are yarns consisting of wool and polyamide (preferably, consisting of 85% (w/w) wool and 15% (w/w) polyamide).
- In the weft: 100 % (y/y) of the weft yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres.

[0070] In the most preferred embodiment, the Jacquard woven velvet with a base structure of yarns of the present invention that forms a net with ground warp, pile warp and weft is produced by means of a face to face jacquard velvet

weaving process, comprising, preferably, the following structural components:

- Thick warp: at least 50% (y/y) of the thick warp yarns are yarns in accordance with the present invention.
- Slack warp: the slack warp yarns are any type of yarn, preferably any type of yarn known in the state of the art.
- Pile warp: at least 50% (y/y) of the pile warp yarns are yarns of the present invention.
- Weft: at least 50% (y/y) of the weft yarns are yarns in accordance with the present invention.

[0071] The thick warp and the slack warp conform the ground warp.

[0072] In the thick warp, preferably, 100% (y/y) of the thick warp yarns are yarns in accordance with the present invention. Even more preferably, in the thick warp, 100% (y/y) of the thick warp yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres. Also preferably, the thick warp yarns comprise a count metric of Nm 3/22.

[0073] In the slack warp, preferably, 100% (y/y) of the slack warp yarns are yarns consisting of polyester and viscose (preferably, consisting of 70% (w/w) polyester and 30% (w/w) viscose). Also preferably, the slack warp yarns comprise a count metric of Nm 2/40.

[0074] In the pile warp, preferably, 50% (y/y) of the pile warp yarns are yarns of the present invention and 50% (y/y) of the pile warp yarns are of any type of yarn known in the state of the art. Even more preferably, in the pile warp, 50% (y/y) of the pile warp yarns are yarns of the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres (preferably, comprising a count metric of Nm 3/22); and 50% (y/y) of the pile warp yarns are yarns consisting of wool and polyamide (preferably, consisting of 85% (w/w) wool and 15% (w/w) polyamide; and preferably, comprising a count metric of Nm 2/18).

[0075] In the weft, preferably, 100% (y/y) of the weft yarns are yarns in accordance with the present invention. Even more preferably, in the weft, 100% (y/y) of the weft yarns are yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres. Also preferably, the weft yarns comprise a count metric of Nm 3/22.

[0076] Preferably, the fabric of the present invention in any of the above-mentioned embodiments comprises at least one coating. More preferably, the at least one coating is selected from:

- a coating of silane; and/or
- a coating of dioxide titanium (hereinafter, TiO_2).

[0077] In the most preferred embodiment, the fabric comprises a coating of silane and a coating of TiO_2 .

[0078] Preferably, the coating of silane is applied first and, afterwards, the coating of TiO_2 is applied. This is so because the silane coating covers the surface of the fabric and allows to obtain an homogenous surface in which the TiO_2 can be better applied and, as a consequence provide an improved effect.

[0079] The one or more coatings can be applied by means of any technique or procedure known in the state of the art.

[0080] Preferably, when the coating is silane, said silane is applied to the fabric of the present invention by means of a process comprising the followin steps:

- a) immersing the fabric of the present invention in a silane solution;
- b) draining the fabric of the present invention; and
- c) drying and/or thermofixing the fabric of the present invention.

[0081] The silane to be used in the coating can be any silane known in the state of the art in an appropriate form with regard to the coating process to be used.

[0082] Preferably, when the coating is TiO_2 , said TiO_2 is applied to the fabric of the present invention by means of a process comprising the following steps:

- a) spraying the TiO_2 over the fabric of the present invention (preferably, a fabric of the present invention previously coated with silane); and
- b) drying and/or thermofixing the fabric of the present invention.

[0083] The TiO_2 to be used in the coating can be any TiO_2 known in the state of the art in an appropriate form with regard to the coating process to be used. When the TiO_2 coating is applied in accordance with the above-mentioned process (this is, by means of spraying), said TiO_2 is in the form of a solution, preferably comprising:

- water, preferably between 94 and 98,1% (w/w);
- TiO_2 , preferably between 0,1 and 0,5 % (w/w); and
- Dipropylene glycol monomethyl ether (hereinafter, DPGME), preferably between, 1 - 5% (w/w).

[0084] The above-mentioned coatings, mainly contribute to improving the cleaning and maintenance of the fabric of the present invention. In this sense, the silane coating provides full protection and maximum impermeability against soiling and stains. On its side, the TiO₂ coating provides for a continuous disinfection and/or sterilization in the fabric by means of photocatalytic activity with the incidence of ultraviolet rays (UV) (providing a continuous antibacterial protection that provides for the elimination of bacterial colonies and, as a consequence, related odours and preventing possible allergic reactions). In addition, said TiO₂ coating, also due to the photocatalytic activity, provides for a continuous cleaning of the air (inside the passenger transport) by eliminating volatile organic compounds and dust.

[0085] The fabric of the present invention can be a simple fabric or a composite, this is, the fabric of the present invention comprises at least one layer. In the most preferred embodiment, the fabric of the present invention is a simple fabric (this is, with one single layer).

[0086] It is contemplated that the fabric of the present invention is used alone, together with other fabrics and/or is incorporated within a composite (for example, a laminated fabric). Preferably, the fabric of the present invention is used alone, in the form of a simple fabric.

[0087] Preferably, the fabric of the present invention is for passenger transport means, more preferably, for the preparation and/or production of a cover and/or upholstery for passenger transport means, preferably for seats of passenger transport means, more preferably for bus and/or train seats.

[0088] In a third aspect, as stated above, the present invention refers to an upholstery comprising at least one fabric of the present invention.

[0089] The upholstery can be prepared by any means known in the state of the art.

[0090] The at least one fabric of the present invention can be a combination of fabrics of the present invention or one fabric of the present invention.

[0091] It is contemplated that the upholstery of the present invention comprises one or more additional fabrics. Said one or more additional fabrics can be any fabric known in the state of the art (whether simple or as a composite) or which is developed in the future. In a preferred embodiment, the upholstery of the present invention does not comprise one or more additional fabrics other than the at least one fabric of the present invention.

[0092] In a preferred embodiment, the upholstery of the present invention is for passenger transport means, preferably for seats of passenger transport means, even more preferably for bus or train seats.

[0093] In a fourth aspect, the present invention refers to a cover comprising at least one fabric of the present invention.

[0094] In a preferred embodiment, the cover is a seat cover, even more preferably a train or bus seat cover.

[0095] The seat cover can be prepared or produced by any means known in the state of the art.

[0096] The at least one fabric of the present invention can be a combination of fabrics of the present invention or one fabric of the present invention.

[0097] It is contemplated that the cover of the present invention comprises one or more additional fabrics. Said one or more additional fabrics can be any fabric known in the state of the art (whether simple fabric or composite) or which is developed in the future. In a preferred embodiment, the cover of the present invention does not comprise one or more additional fabrics other than the at least one fabric of the present invention.

[0098] In a final aspect, the present invention refers to a seat comprising an upholstery, a cover and/or a fabric of the present invention.

[0099] Preferably, the seat is a passenger transport seat, more preferably a seat of an adapted industrial vehicle, a train, a bus, a ship or a plane. In the most preferred embodiment, the seat is a bus or train seat.

[0100] As will be apparent from the examples included below, the yarn of the present invention provides for the required properties to obtain a fabric with the required properties of resistance against lacerative aggression, impact, fire and easiness to clean and maintain. Therefore, the yarn of the present invention allows to obtain a simple fabric (without the need to use several layers and avoiding the use of a metal mesh) for the protection and security of seats in passenger transport means (preferably, seats of trains). The yarn and fabric of the present invention (and related products) provide for the following technical effects or advantages:

- Fire resistance (passive security): allowing to minimize combustion of the fabric as well as minimizing smoke emission.
- Fire barrier: the yarn and fabric of the present invention have the inherent capacity of acting as a fire barrier and, hence, acting as an active barrier to avoid fire sources (whether accidental or purposeful) from penetrating the fabric and burning the foam of the seats.
- Anti-laceration resistance: allowing to minimize the effects of vandalism (avoiding the breaking and tearing of the fabric).
- Resistance to impacts: given the materials used and the structure of rectangular net, a dynamic response of approximately 6200 N/cm² is achieved.
- Obtaining an end-product (fabric, seat cover, upholstery or seat) which is aesthetically appropriate and comfortable for the users of the passenger transport means.

- Allowing an easier maintenance and cleaning (allowing for the product to keep a good appearance over time and use).

[0101] As already stated above, the yarn, fabric and related products of the present invention avoid the need to use several layers to accomplish the above-mentioned functions and, hence, simplifies and economizes the production and assembly of the product. In addition, given the fact that no metal mesh is required, the production and assembly procedures are safer.

[0102] Even though the present invention (and the technical problem it solves) have been explained in the context of seats and/or other elements of passenger transport means (preferably, train or bus seats), the present invention is also applicable and useful in other fields in which the above-mentioned technical effects may also be required or may be useful and which can be readily determined by the person skilled in the art, for example, seats of cinemas, seats of theaters.

[0103] To allow a better understanding, the present invention is described in more detail below with reference to illustrative and non-limitative examples.

Examples

Example 1. Analysis of lacerative resistance of yarns of the present invention.

[0104] In this example, the cut resistance of several high tenacity yarns was evaluated and compared. The substrate used were 13 plies of yarn (of the corresponding yarn) to emulate the weft density of the fabric and it was checked how this amount of yarn resisted under the shear cutting effect and how many cuts were needed until the yarn was finally cut.

[0105] The results obtained in this experiment appear summarized in table 1.

Table 1. Results obtained for lacerative resistance for the different yarns tested.

Sample	Cut force (number of cuts with shears until the yarn was finally cut)
Yarn consisting of 100% PPT (Twaron®, Teijin Aramid BV, with a fiber denier of 1.55 dn)	2
Yarn consisting of 100% TLCP (Vectran®, Kuraray Europe GmbH, with a fiber denier of 5 dn)	37
Yarn consisting of 20% PPT (Twaron®, Teijin Aramid BV, with a fiber denier of 1.55 dn) and 80% TLCP (Vectran®, Kuraray Europe GmbH, with a fiber denier of 5 dn)	54
Yarn consisting of 30% PPT (Twaron®, Teijin Aramid BV, with a fiber denier of 1.55 dn) and 70% TLCP (Vectran®, Kuraray Europe GmbH, with a fiber denier of 5 dn)	27

[0106] As can be directly derivable, the combination of both TLCP and PPT within a yarn provides an unexpected and synergistic effect. This is so because, on the basis of the results obtained for a yarn consisting of 100% PPT and a yarn consisting of 100% TLCP, the results to be expected would be: 26.50 for the yarn consisting of 30% PPT and 70% TLCP; and 30 for the yarn consisting of 20% PPT and 80% TLCP. Therefore, in both cases the results observed in the experiment were higher than the ones expected showing an unexpected effect for the combination of PPT and TLCP.

Example 2. Analysis of the lacerative resistance of a fabric of the present invention.

[0107] Three samples of fabric (in the form of seat cover positioned in a seat) in accordance with the present invention with the following features were prepared:

- Composition:

- 41% (w/w) of wool;
- 33% (w/w) of TLCP fibres (Vectran®, Kuraray Europe GmbH, with a fibre denier of 5 dn);
- 14% (w/w) of PPT fibres (Twaron®, Teijin Aramid BV, with a fibre denier of 1.55 dn);
- 7% (w/w) of polyamide;
- 3% (w/w) polyester; and
- 2% (w/w) of viscose,

- Type of fabric: Jacquard woven velvet with a base structure of yarns of the present invention that forms a net with ground warp (consisting of the thick warp and the slack warp), pile warp and weft produced by means of a face to face jacquard velvet weaving process with the following structural components:

- Thick warp: 100% (y/y) of the thick warp yarns were yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres with a count metric of Nm 3/22.
- Slack warp: 100% (y/y) of the slack warp yarns were yarns consisting of 70% (w/w) polyester and 30% (w/w) viscose with a count metric of Nm 2/40.
- Pile warp: 50% (y/y) of the pile warp yarns were yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres with a count metric of Nm 3/22; and 50% (y/y) of the pile warp yarns were yarns consisting of 85% (w/w) wool and 15% (w/w) polyamide with a count metric of Nm 2/18.
- Weft: 100% (y/y) of the weft yarns were yarns in accordance with the present invention consisting of 70% (w/w) TLCP fibres and 30% (w/w) PPT fibres with a count metric of Nm 3/22.

- With a thickness of 4 mm and a weight of 1015 g/m².

[0108] The prepared samples were subject to an applied force of 70 N, 80 N and 90 N (in all cases at a temperature of 23 ± 2 °C and a relative humidity of 50 ± 5 %).

[0109] The procedure of this example refers to a full passenger seat, appropriately vandalized. The seats included arm and headrests, back and base shell and, the example was carried out in accordance with EN 45545-2:2013 + Annex-A:2015 specification as follows:

- The lacerative resistance test involved applying a vertical force of 150 N onto a lever (comprising a blade) to allow the tip of the blade to penetrate the seat cover 20 mm. The lever was kept in this position by a blocking system.
- Then, a traction force (of 70 N, 80 N or 90 N, as stated above) was applied by means of a traction device and a speed of traction of (60 ± 5) mm/s. The duration of the test was (5 ± 1) s.
- Then the specimens (fabrics as explained above) were removed from the test apparatus, put on a flat surface and the length of the performed cut or laceration (if any), was measured.

[0110] The obtained results appear summarized in Table 2. In all cases a positive result is that with a length of laceration of ≤ 50 mm; and a negative result is that with a length of laceration of > 50 mm.

Table 2. Results obtained for lacerative resistance of a fabric of the present invention at the different applied forces tested.

Test sample	Applied force (N)	Length of the laceration (mm)	Result
1	70	0	POSITIVE
2	80	0	POSITIVE
3	90	80	NEGATIVE

[0111] Therefore, the fabric of the present invention showed a lacerative resistance of 80 N. Said lacerative resistance is surprising because, as it is derivable from the above, the tested fabrics of the present invention do not comprise a metal mesh. Therefore, the present invention provides a fabric which is the highest for a fabric without metal mesh according to the inventor's knowledge and which meets the foreseen requirements of lacerative resistance or penetration force in the field of seats for passenger transport (for example, bus and train seats).

Claims

1. Yarn comprising Liquid Crystal Polymer fibres and poly-para-phenylene terephthalamide fibres.
2. Yarn in accordance with claim 1, **characterized in that** it comprises:

- Between 1 and 99% (w/w) of Thermotropic Liquid Crystal Polymer fibres; and
- Between 1 and 99% (w/w) of poly-para-phenylene terephthalamide fibres.

3. Yarn in accordance with claim 1 or 2, **characterized in that** it comprises:

- 70% (w/w) of Thermotropic Liquid Crystal Polymer fibres.
- 30% (w/w) of poly-para-phenylene terephthalamide fibres.

4. Yarn in accordance with claim 1 or 2, **characterized in that** it comprises:

- 80% (w/w) of Thermotropic Liquid Crystal Polymer fibres.
- 20% (w/w) of poly-para-phenylene terephthalamide fibres.

5. Yarn in accordance with any one of claims 1 to 4, **characterized in that** it is produced by means of stretch-broken technology.

6. Yarn in accordance with any one of claims 1 to 5, **characterized in that** the yarn is an spun yarn.

7. Fabric **characterized in that** it comprises at least one yarn in accordance with any one of claims 1 to 6.

8. Fabric in accordance with claim 7, **characterized in that** the fabric comprises at least one coating.

9. Fabric in accordance with claim 8, **characterized in that** the coating is selected from:

- a coating of Silane; and/or
- a coating of TiO₂.

10. Fabric in accordance with claim 9, **characterized in that** the coating is a coating of Silane; and a coating of TiO₂.

11. Upholstery **characterized in that** it comprises at least one fabric in accordance with any one of claims 7 to 10.

12. Cover **characterized in that** it comprises at least one fabric in accordance with any one of claims 7 to 10.

13. Cover in accordance with claim 12, **characterized in that** the cover is a train or bus seat cover.

14. Seat **characterized in that** it comprises a fabric in accordance with any one of claims 7 to 10, an upholstery in accordance with claim 11 and/or a cover in accordance with claim 12 or 13.

15. Seat in accordance with claim 14, **characterized in that** the seat is a train or bus seat.



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 38 2346

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