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(54) **PRINTABLE FABRIC FOR MULTIFUNCTIONAL PROTECTION**

(57) The present invention relates to a fabric comprising a series of base yarns B and a series of rip yarns R, wherein the fabric consists of a plain weave or broken twill with rip, the fabric comprising a ratio of 3-5 base yarns B per rip yarn R, the fabric comprising base yarn B comprising 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, and rip yarn R comprising 45-65 wt% of para-aramid fibre,

20-30 wt% viscose fibre, 15-25 wt% of meta-aramid fibre. In a second aspect, the invention relates to protective clothing comprising a fabric according to the first aspect. In a third aspect, the invention relates to the use of a fabric according to the first aspect for camouflage clothing. In a fourth aspect, the invention relates to a method for producing a fabric.

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Description**TECHNICAL FIELD**

5 **[0001]** The invention relates to a fabric suitable for multifunctional protective clothing. In particular, the fabric has a combination of good mechanical properties such as tensile strength, tear strength and dimensional stability, and the fabric is further light, air permeable and easily printable. This makes the fabric well suited for use in military and personal protective clothing (PPE).

10 **PRIOR ART**

[0002] A problem with known protective clothing is the limited printability of the textile. For example, many aramid fibres and their derivatives are difficult or impossible to print on. This is disadvantageous for military clothing as no good camouflage can be applied. Limited printability is also a disadvantage for industrial and commercial applications.

15 **[0003]** EP 1 719 613 describes a cut-resistant composite comprising a matrix, provided on at least one side with a cut-resistant fabric, the fabric comprising at least two layers and/or at least two directions of individual elements, at least one of which is an individual element reinforced, wherein the composite further comprises at least one coating layer arranged between the fabric and the matrix, the coating layer comprising at least two layers and/or at least two directions of individual elements of which at least one individual element is reinforced.

20 **[0004]** This type of protective clothing meets the mechanical properties but can be difficult to print on. Furthermore, this type of textile does not feel pleasant against the body.

[0005] BE 1 019 932 describes protective clothing particularly suitable for military use comprising at least two fabric layers, a first outer fabric and a second inner fabric both with a weight of 25 to 400 g/m². A disadvantage is that this clothing breathes very little. As a result, moisture cannot be removed sufficiently, heat and moisture are accumulated, and this also makes odour a problem. This is not comfortable. US 8 475 919 describes a fibre blend for yarns and fabrics for use in military, firefighting, industrial work clothing and protective clothing for the emergency services to multifunctionally protect the wearer, the fibre blend consisting of aramid fibres, wool fibres and antistatic fibres. Wool, however, is disadvantageous for use in protective clothing due to its low flame retardancy. Unlike other heat-resistant fibres, blends of aramid and wool fibres are not fire-resistant.

30 **[0006]** The present invention aims to find a solution for at least some of the above problems.

[0007] There is a need for improved protective clothing to provide multifunctional protection to a wearer. This clothing must furthermore be sufficiently light and comfortable for it to be worn for long periods.

SUMMARY OF THE INVENTION

35 **[0008]** The invention relates to a fabric comprising a series of base yarns B and a series of rip yarns R, wherein the fabric consists of a plain weave or broken twill with rip, the fabric comprising a ratio of 3-5 base yarns B per rip yarn R, the fabric comprising:

- 40
- base yarn B comprising 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, and
 - rip yarn R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre.

The fabric has a good combination between weight, strength including tensile and tear strength, printability, permeability. This combination leads to an increased wearing comfort. The fabric is also pleasant to the touch.

45 In a second aspect, the invention relates to protective clothing comprising the fabric of the first aspect. This offers the advantage that tear-resistant garments are provided with, among other things, pleasant feel, flame-retardant properties and excellent printability for, among other things, camouflage or the application of labels with good colour fastnesses. Furthermore, the clothing is permeable and light.

50 **[0009]** In the third aspect, the invention comprises the use of a fabric according to the first aspect for camouflage clothing. The fabric according to the present invention is particularly well suited as camouflage clothing, among other things, for military applications. The textile is easy to print on and colour-fast, and at the same time meets good mechanical and protective properties such as high tensile and tear strength, light weight and fire-resistant. Furthermore, the textile is sufficiently permeable and comfortable to be worn for long periods.

55 **[0010]** In a following aspect, the invention relates to a method for producing a fabric, comprising the steps of:

- providing a series of rip yarns R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre,

- providing a series of base yarns B, which base yarns B comprise 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, in a ratio of 3-5 base yarns B per rip yarn R, and
- weaving the base yarns B and the rip yarn R according to a plain weave or broken twill weave with rip.

5 **[0011]** The method can be applied to known looms. This allows production in existing textile centres without the need for further knowledge or adaptation of the equipment. Nevertheless, the method gives rise to a high-performance result.

DETAILED DESCRIPTION

10 **[0012]** The invention relates to a printable and colour-fast, light and multifunctional protective fabric.

[0013] Unless otherwise defined, all terms used in the description of the invention, including technical and scientific terms, have the meaning as commonly understood by a person skilled in the art to which the invention pertains. For a better understanding of the description of the invention, the following terms are explained explicitly.

[0014] In this document, 'a' and 'the' refer to both the singular and the plural, unless the context presupposes otherwise. For example, 'a segment' means one or more segments.

15 **[0015]** The terms 'comprise', 'comprising', 'consist of', 'consisting of', 'provided with', 'have', 'having', 'include', 'including', 'contain', 'containing' are synonyms and are inclusive or open terms that indicate the presence of what follows, and which do not exclude or prevent the presence of other components, characteristics, elements, members, steps, as known from or disclosed in the prior art.

20 By the term 'yarn' is meant a collection of fibres spun or twisted to form a continuous hank that can be used in weaving, knitting, braiding, or otherwise processed into a textile product.

[0016] In a first aspect, the invention relates to a fabric comprising a series of base yarns B and a series of rip yarns R, wherein the fabric consists of a plain weave or broken twill with rip, the fabric comprising a ratio of 3-5 base yarns B per rip yarn R, the fabric comprising:

- base yarn B comprising 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, and
- rip yarn R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre.

30 By 'aramid' is meant an aromatic polyamide with a long chain whose amide linkages are directly attached to two aromatic rings in the para or meta position.

For example, para-aramids include poly (para-phenylene terephthalamide) ('PPD-T'), poly(p-benzamide) and similar fibres. Para-aramids also comprise co-para-aramids. Co-para-aramids are copolymers of two or more different para-aramid monomers, for example co-poly (p-phenylene terephthalamide and 3,4'-oxydiphenylene terephthalamide).

35 **[0017]** Meta-aramids, for example, comprise poly (meta-phenylene isophthalamide) ('MPIA'), such as in fibres sold under the 'NOMEX' trademark by E.I. DuPont de Nemours and Company and sold under the 'TEIJINCONEX' trademark by Teijin Ltd.

[0018] Viscose fibres are known viscose or rayon fibres. In a more preferred embodiment, the viscose fibres comprise flame retardant viscose fibres. Although viscose fibres are softer and less expensive than inherently flame-retardant fibres, they are not naturally resistant to flames. To increase the flame retardancy of these fibres, one or more flame retardants are often included in the viscose fibres. Such flame retardants can be processed by adding the flame retardants during spinning, by dipping or spraying the viscose fibre with the flame retardant, or any other process in which the flame retardant is introduced into or onto viscose fibre. There are a variety of such flame retardants, including, for example, certain phosphorus compounds, such as Sandolast 9000® on the market. Other suitable flame retardants include halogenated flame retardants (e.g., brominated or chlorinated flame retardants), phosphorus-based flame retardants, antimony-based flame retardants, nitrogen-containing flame retardants, and combinations, mixtures or mixtures thereof. Generally, viscose fibres that contain one or more flame retardants are referred to as 'FR' for flame retardant. Methods for making such flame-retardant viscose fibres are generally described in, for example, US 5,417,752 and US 5,609,950. A textile product with improved fire-retardant properties can thus be obtained.

50 **[0019]** The processing of viscose, meta-aramid and para-aramid fibres in these quantities and composition allows providing a textile product with optimum printability, flame resistance, thermal shrinkage, chemical resistance, and mechanical strength; without sacrificing too much the breathability, the pleasant feel, and the wearing comfort of the textile product. Furthermore, these fibres are inherently flame retardant.

[0020] The fabric consists of 3-5 base yarns B, followed by one rip yarn R in both the warp and the weft. Preferably, the fabric consists of 4 base yarns B followed by one rip yarn R. The fabric then has a pattern repeat of 4/1 base yarns B to rip yarns R in both the warp and the weft. The fabric therefore has an advantageous balance between printability and mechanical properties.

[0021] In a preferred form, the rip yarn R has a yarn count between 300 and 500 dtex, preferably the rip yarn R has

a yarn count between 310 and 480 dtex, even more preferably the rip yarn R has a yarn count between 320 and 460 dtex, even more preferably the rip yarn R has a yarn count between 330 and 440 dtex, even more preferably the rip yarn R has a yarn count between 340 and 420 dtex, even more preferably the rip yarn R has a yarn count between 340 and 400 dtex, even more preferably the rip yarn R has a yarn count between 340 and 380 dtex, most preferably, the rip yarn R has a yarn count between 350 and 370 dtex.

[0022] In a preferred form, the base yarn B has a yarn count between 250 and 450 dtex, preferably the base yarn B has a yarn count between 270 and 430 dtex, even more preferably the base yarn B has a yarn count between 290 and 410 dtex, even more preferably the base yarn B has a yarn count between 300 and 400 dtex, even more preferably the base yarn B has a yarn count between 310 and 390 dtex, even more preferably the base yarn B has a yarn count between 320 and 380 dtex, even more preferably the base yarn B has a yarn count between 330 and 370 dtex, most preferably, the base yarn B has a yarn count between 340 and 360 dtex. Higher yarn counts lead to a decrease in elasticity and wearing comfort. Lower yarn counts lead to a decrease in permeability.

[0023] In a preferred embodiment, the rip yarn R consists of:

- a first yarn G_1 , wherein the first yarn G_1 comprises 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre, and 5-20 by weight of para-aramid fibre, and
- a second yarn G_2 , wherein the second yarn G_2 comprises at least 80 wt% of para-aramid fibre.

[0024] The first yarn ensures good printability, light weight and sufficient elasticity. Furthermore, this fibre also provides good flame-retardant properties.

[0025] The second yarn G_2 may comprise a known technical fibre consisting mainly of para-aramid. These are sold, for example, under the trademark 'KEVLAR' by E.I. DuPont de Nemours and Company, the trademark 'TWARON' by Teijin Ltd. and the trademark 'TECHNORA' by Teijin Ltd. These fibres ensure good mechanical properties such as tensile and tear strength and high dimensional stability.

[0026] In a preferred embodiment, the base yarn B comprises the same composition as the first yarn G_1 . This ensures that the base yarn B and the rip yarn R, in which the first yarn G_1 is incorporated, have a similar colour fastness. Furthermore, this is advantageous in the processing of these yarns, wherein both the first yarn G_1 and the base yarn B can be processed using the same methods.

[0027] In a further preferred embodiment, the base yarn B comprises twisted first yarns G_1 . Due to the twisting of G_1 only two types of yarns, G_1 and G_2 , are needed. This is advantageous for the production process as well as the logistics. In a still further preferred embodiment, the base yarn B comprises two twisted first yarns G_1 .

[0028] In a preferred embodiment, the first yarn G_1 has a yarn count between 125 and 225 dtex, preferably the first yarn G_1 has a yarn count between 135 and 215 dtex, even more preferably, the first yarn G_1 has a yarn count between 145 and 205 dtex, even more preferably, the first yarn G_1 has a yarn count between 150 and 200 dtex, even more preferably, the first yarn G_1 has a yarn count between 155 and 195 dtex, even more preferably the first yarn G_1 has a yarn count between 160 and 190 dtex, even more preferably, the first yarn G_1 has a yarn count between 165 and 185 dtex, most preferably, the first yarn G_1 has a yarn count between 170 and 180 dtex.

[0029] In a preferred embodiment, the second yarn G_2 has a yarn count between 150 and 250 dtex, preferably, the second yarn G_2 has a yarn count between 160 and 240 dtex, even more preferably, the second yarn G_2 has a yarn count between 165 and 230 dtex, even more preferably, the second yarn G_2 has a yarn count between 170 and 220 dtex, even more preferably, the second yarn G_2 has a yarn count between 175 and 210 dtex, most preferably, the second yarn G_2 has a yarn count between 180 and 200 dtex.

[0030] In an embodiment, the first yarn G_1 further comprises between 1 and 15 wt% of amide fibres, preferably, the first yarn G_1 comprises between 1 and 14 wt% of amide fibres, even more preferably, the first yarn G_1 comprises between 2 and 13 wt% of amide fibres, even more preferably, the first yarn G_1 comprises between 3 and 12 wt% of amide fibres, even more preferably, the first yarn G_1 comprises between 4 and 11 wt% of amide fibres, even more preferably, the first yarn G_1 comprises between 5 and 10 wt% of amide fibres.

[0031] In an embodiment, the base yarn B further comprises between 1 and 15 wt% of amide fibres, preferably, the base yarn B comprises between 1 and 14 wt% of amide fibres, even more preferably, base yarn B comprises between 2 and 13 wt% of amide fibres, even more preferably, base yarn B comprises between 3 and 12 wt% of amide fibres, even more preferably, base yarn B comprises between 4 and 11 wt% of amide fibres, even more preferably, base yarn B comprises between 5 and 10 wt% of amide fibres.

Suitable amide fibres comprise polyamide 6, polyamide 6,6, polyamide 10 and polyamide 12. Preferably, the first yarn comprises polyamide 6,6. Adding an amide fibre to the first yarn G_1 and/or the base yarn B increases the tensile and tear strength of the fabric.

[0032] In a preferred embodiment, the present invention provides a fabric according to the first aspect of the invention, wherein the fabric comprises an antistatic fibre. The antistatic fibres can be any suitable fibre that aids in dissipating or inhibiting the build-up of a static charge in said textile products. Suitable antistatic fibres for use in said fabric include

various types of core conductors and surface conductors, carbon fibres such as the P140 antistatic carbon fibre (DuPont), and metal particles containing polyester or nylon fibres such as, for example, Beltron white. A textile product can thus be provided that does not build up static charge, does not cling to the body by static charge, and does not attract dust particles. Moreover, the presence of antistatic fibres prevents the occurrence of discharges, which can lead to sparks.

After all, said sparks can in turn give rise to explosions in certain environments.

[0033] In a more preferred embodiment, the first yarn G_1 comprises between 0.1 and 2 wt% of antistatic fibres, preferably, the first yarn G_1 comprises between 0.3 and 1.7 wt% of antistatic fibres, even more preferably, the first yarn G_1 comprises between 0.5 and 1.5 wt% of antistatic fibres, even more preferably the first yarn G_1 comprises between 0.7 and 1.3 wt% of antistatic fibres. Incorporating the antistatic yarn into the first yarn G_1 ensures sufficient dissipation of constructive built up static charge in the fabric. Adding antistatic fibres to the second yarn G_2 leads to a higher production cost that is not accompanied by a proportional increase in antistatic effect.

[0034] In a preferred embodiment, the fabric comprises 15.0 to 25.0 wefts per centimetre, preferably, the fabric comprises 16.0 to 24.0 wefts per centimetre, even more preferably, the fabric comprises 17.0 to 23.0 wefts per centimetre, even more preferably, the fabric comprises 18.0 to 22.0 wefts per centimetre, even more preferably, the fabric comprises 18.5 to 21.5 wefts per centimetre, even more preferably, the fabric comprises 19.0 to 21.0 wefts per centimetre, most preferably the fabric comprises 19.5 to 20.5 wefts per centimetre. More wefts per centimetre result in low permeability and a considerably higher weight. This leads to a reduced wearing comfort due to the weight and a limited breathability. Fewer wefts per centimetre result in a fabric with insufficient tensile and tear strength.

[0035] In a preferred embodiment, the fabric comprises 15 to 30 warp yarns per centimetre, preferably, the fabric comprises 17 to 30 warp yarns per centimetre, even more preferably, the fabric comprises 18 to 28 warp yarns per centimetre, even more preferably, the fabric comprises 19 to 27 warp yarns per centimetre, even more preferably, the fabric comprises 19.5 to 26 warp yarns per centimetre, even more preferably, the fabric comprises 18 to 25 warp yarns per centimetre.

[0036] In a preferred embodiment, the fabric comprises a ratio of warp yarns to weft yarns between 1/1 and 7/5, preferably, the fabric comprises a ratio of warp yarns to weft yarns between 1/1 and 6.5/5, even more preferably, the fabric comprises a ratio of warp yarns to weft yarns between 5.5/5 and 6.5/5, most preferably, the fabric comprises 6 warp yarns per 5 weft yarns. The ratio between warp and weft is advantageous for the dimensional stability, the tensile strength and the tear strength of the fabric.

[0037] In a preferred embodiment, the fabric has a good flame resistance. In a further preferred embodiment, the fabric is fire resistant. Preferably, the fabric complies with A1 and A2 flame resistance according to ISO 15025:2016. This means that the fabric does not melt or drip as a result of heat, flame or burning liquids within the test conditions.

[0038] In a preferred embodiment, the fabric has a weight between 150 and 250 g/m², preferably, the fabric has a weight between 155 and 240 g/m², even more preferably, the fabric has a weight between 160 and 230 g/m², even more preferably, the fabric has a weight between 165 and 220 g/m², even more preferably, the fabric has a weight between 170 and 210 g/m², even more preferably, the fabric has a weight between 175 and 200 g/m², most preferably, the fabric has a weight between 175 and 195 g/m². The weight is determined according to ISO 3801:1977.

[0039] In a preferred embodiment, the fabric has a good abrasion resistance. This comes from the ratio of para-aramid and meta-aramid fibres in the yarns as well as the specific structure of the fabric. Preferably, the fabric does not break after 30,000 cycles with a minimum load of 9 kPa according to ISO 12947/2:1998. Even more preferably, the fabric does not break after 50,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 75,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 100,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 125,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 150,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 175,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 200,000 cycles with a 9 kPa load, even more preferably, the fabric does not break after 225,000 cycles with a 9 kPa load, most preferably, the fabric does not break after 250,000 cycles with a 9 kPa load. A high abrasion resistance allows the fabric to be used intensively for a long period. This is advantageous for the end user and is considered to represent high quality.

[0040] In a preferred embodiment, the fabric has good air permeability. This comes from the yarn count in combination with the number of wefts per centimetre and the weave of the fabric. Preferably, the permeability of the fabric to air is at least 100 mm/s, even more preferably, the permeability of the fabric to air is at least 120 mm/s, even more preferably, the permeability of the fabric to air is at least 140 mm/s, even more preferably, the permeability of the fabric to air is at least 150 mm/s, even more preferably, the permeability of the fabric to air is at least 160 mm/s, even more preferably, the permeability of the fabric to air at least 170 mm/s, even more preferably, the permeability of the fabric to air is at least 180 mm/s, even more preferably, the permeability of the fabric to air is at least 190 mm/s. The permeability of the fabric to air is measured according to ISO 9237-2:1995.

[0041] In a preferred embodiment, the fabric is dimensionally stable. This stability is mainly the result of the yarn composition, the yarn count and the weave of the fabric. Preferably, the dimensional stability after washing in the warp direction is preferably between -3% and +1%, even more preferably, the dimensional stability after washing in the warp

direction is between -2% and +1%, most preferably, between -1% and 0%. The dimensional stability is measured according to ISO 5077:2008 and ISO. The washing was carried out according to the ISO 6330:2012 standard.

[0042] In a preferred embodiment, the fabric has a high tensile strength. This tensile strength comes from the fibre blend of meta-aramid, para-aramid and viscose as well as the optional amid fibre, in combination with the structure of the yarns, the yarn count, the number of wefts per cm and the weave of the fabric. The use of high-performance second yarns G_2 consisting mainly of para-aramid increases the tensile strength considerably. In an embodiment, the fabric has a tensile strength of at least 600 N warp direction, preferably, the fabric has a tensile strength of at least 700 N warp direction, even more preferably, the fabric has a tensile strength of at least 800 N warp direction, even more preferably, the fabric has a tensile strength of at least 850 N warp direction, even more preferably, the fabric has a tensile strength of at least 900 N warp direction, most preferably, the fabric has a tensile strength of at least 950 N warp direction. In an embodiment, the fabric has a tensile strength of at least 500 N weft direction, preferably, the fabric has a tensile strength of at least 600 N weft direction, even more preferably, the fabric has a tensile strength of at least 650 N weft direction, even more preferably, the fabric has a tensile strength of at least 700 N weft direction, most preferably, the fabric has a tensile strength of at least 750 N weft direction. The tensile strength is measured according to ISO 13934-1:2013.

[0043] In a preferred embodiment, the fabric has a high tear strength. The tear strength of the fabric produced is preferably at least 25 N in the warp direction, more preferably, the tear strength of the fabric is at least 40 N in the warp direction, even more preferably, the tear strength of the fabric is at least 60 N in the warp direction, even more preferably, the tear strength of the fabric is at least 80 N in the warp direction, most preferably, the tear strength of the fabric is at least 100 N in the warp direction. The tear strength of the fabric produced is preferably at least 25 N in the weft direction, more preferably, the tear strength of the fabric is at least 40 N in the weft direction, even more preferably, the tear strength of the fabric is at least 60 N in the weft direction, even more preferably, the tear strength of the fabric is at least 80 N in the weft direction, most preferably, the tear strength of the fabric is at least 100 N in the weft direction. The tear strength of a fabric generally decreases considerably after washing of the fabric.

[0044] The tear strength of the fabric after washing is preferably at least 25 N in the warp direction, more preferably, the tear strength of the fabric after washing is at least 35 N in the warp direction, even more preferably, the tear strength of the fabric after washing is at least 45 N in the warp direction, even more preferably, the tear strength of the fabric after washing is at least 55 N in the warp direction, most preferably, the tear strength of the fabric after washing is at least 60 N in the warp direction. The tear strength of the fabric after washing is preferably at least 20 N in the weft direction, more preferably, the tear strength of the fabric after washing is at least 30 N in the weft direction, even more preferably, the tear strength of the fabric after washing is at least 40 N in the weft direction, even more preferably, the tear strength of the fabric after washing is at least 45 N in the weft direction, most preferably, the tear strength of the fabric after washing is at least 50 N in the weft direction. The tear strength of the fabric after washing is measured according to ISO 13937-3:2000. The tear strength of the material is higher when using a broken twill weave, preferably a broken twill weave with equal stress and rip.

[0045] In a preferred embodiment, the textile pills little or not at all. Pilling is a surface defect of textile caused by wear and friction. It happens when washing and wearing fabrics causes loose fibres to begin to push out of the surface of the cloth, and over time wear causes the fibres to develop into small spherical bundles anchored to the surface of the fabric by protruding fibres that are not broken. Pilling is prevented by, among other things, the twisting of the first and second yarn G_1 and G_2 in the preferred embodiments, as well as the structure of this yarn and the weave of the fabric. Preferably, the fabric has a score of at least 3 after 36,000 cycles, preferably, a score of at least 4, most preferably, a score higher than 4, measured according to ISO 12945/2:2000.

[0046] In a preferred embodiment, the fabric is colour-fast. This is necessary for use in military and civilian applications. In addition, colour-fast textile products are seen by consumers as higher quality. The colour-fastness is due to the high amount of viscose fibre, the structure of the yarns and the structure of the material as well as the choice of dyes. In a preferred embodiment, when rubbed (x12) in dry conditions, the fabric has a colour-fastness of 4, preferably a colour-fastness of 5, measured in accordance with ISO 105. In a preferred embodiment, when rubbed (x12) in wet conditions, the fabric has a colour-fastness of 3, preferably a colour-fastness of 4, most preferably a colour-fastness higher than 4, measured in accordance with ISO 105.

[0047] In a preferred embodiment, the fabric is printed. Normally, dyeing or printing of the fabric is done after orders have been received from the end user of the fabric. The dyed or printed fabric is then cut into the right shapes and all kinds of clothing are made with these parts.

[0048] The most common system for applying colour to fabrics is to dye the woven fabric. The fabric is placed in a machine that contains water, (direct) dyes and chemicals. The temperature of the dye bath is set to the desired value. The experienced user will use this process to produce the desired shade on the cotton fabric. The fabric is dried and finished according to customer specifications. The dyeing of fabrics is a capital-intensive operation with expensive dyeing and finishing equipment such as chemical applicators and rolling or folding equipment.

[0049] In contrast to polyaramide fibres, viscose fibres are easily printable. The fabric according to the first aspect can be provided with colour, camouflage and other patterns according to traditional methods. This allows existing dye houses

to be used without the need for more specialised paint equipment. Nevertheless, the result looks aesthetically good. Thanks to the high amount of viscose fibre, the structure of the yarns and the weave of the fabric, the colours also remain colour-fast.

[0050] In a second aspect, the invention comprises a protective clothing comprising a fabric according to the first aspect.

[0051] This offers the advantage of providing tear-resistant garments with, among other things, pleasant feel, flame-retardant properties, good permeability for releasing air and heat and light weight. The combination of these properties ensures wearing comfort, which allows wearing the protective clothing comfortably for long periods. Said garments can be any conceivable garment, and comprise trousers, T-shirts, shirts, body warmers, coats, overalls, hats, uniforms such as for example military uniforms, sleeves, aprons, caps, hair bands, wristbands, leg pieces, gloves, face masks, shoes and socks.

[0052] In a following aspect, the invention relates to the use of a fabric according to the first aspect of the invention, wherein the fabric is printed with a camouflage pattern. This offers the advantage that a textile product can be provided that is less noticeable in a specific environment. Textile products with such patterns are particularly useful for military purposes, where the user of the textile material is often preferably not noticed. For the same reasons, clothing with such patterns is also often preferred for use in a natural environment, such as foresters, nature workers, hunters or hikers.

[0053] In a preferred embodiment, the fabric is also provided with infrared reflection. Infrared-reflective materials, including infrared-reflective pigments, are known. This has the advantage that the wearer is less visible. The wearer will thus be less visible by infrared cameras.

[0054] In a fourth aspect, the invention relates to a method for producing a fabric, comprising the steps of:

- providing a series of rip yarns R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre,
- providing a series of base yarns B, which base yarns B comprise 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, in a ratio of 3-5 base yarns B per rip yarn R, and
- weaving the base yarns B and the rip yarn R according to a plain weave or broken twill weave with rip.

[0055] In this way, a fabric with good printability, tear resistance, flame retardant properties, high tensile and tear strength, light weight and good permeability can be provided.

[0056] The weaving always comprises 3-5 base yarns B followed by one rip yarn R, in both the warp and the weft. Preferably, 4 base yarns B are followed by one rip yarn R, in both the warp and the weft.

[0057] The making of yarns can be realised, for example, via conventional methods for spinning staple fibres into yarns, such as, for example, ring spinning. Alternatively, high-air-speed spinning techniques such as, for example, Murata air-jet spinning, wherein air is used to twist the staple fibres into a yarn, can also be used. Possible compositions of the fibre blend are described in detail above, as well as various possible weaving patterns. A textile material can thus be provided with good printability, tear resistance, flame-retardant and insect-resistant properties, which is also breathable and easily printable.

[0058] In a preferred embodiment, the method for providing a rip yarn R comprises the steps of:

- providing a first yarn G_1 , wherein the first yarn G_1 comprises 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre, and 5-20 by weight of para-aramid fibre,
- providing a second yarn G_2 , wherein the second yarn G_2 comprises at least 80 wt% of para-aramid fibre,
- twisting the first yarn G_1 and the second yarn G_2 thereby obtaining the rip yarn R.

[0059] In a preferred embodiment, the method for providing a base yarn B comprises the steps of:

- providing a first yarn G_1 , wherein the first yarn G_1 comprises 40-70 wt% of viscose fibre, 25-35 wt% of meta-aramid fibre, and 5-10 by weight of para-aramid fibre,
- the two first yarns $2 \times G_1$ thereby obtaining the base yarn B.

[0060] In a further preferred embodiment, the method for producing a fabric according to the first aspect comprises the steps of:

- providing a first yarn G_1 , wherein the first yarn G_1 comprises 40-70 wt% of viscose fibre, 25-35 wt% of meta-aramid fibre, and 5-10 by weight of para-aramid fibre,
- providing a second yarn G_2 , wherein the second yarn G_2 comprises at least 80 wt% of para-aramid fibre,
- twisting the rip yarn R by twisting the first yarn G_1 and the second yarn G_2 ,
- twisting the base yarn B by twisting two first yarns $2 \times G_1$, and
- weaving the base yarns B and the rip yarns according to a plain weave or broken twill weave with rip, wherein 3-5

base yarns B are provided for each rip yarn R.

[0061] In this way, the fabric according to the first aspect can be produced from two yarns G_1 and G_2 , wherein the fabric nevertheless meets the final composition according to the present invention. Twisting the yarns reduces the pilling of the fabric. Use of yarns G_1 and G_2 according to the preferred form of the present invention, allows a high-performance aramid fibre as directly available on the market to be used.

The methods and machines used to twist and fold the base yarns to form the twisted yarn are not particularly limited. Suitable weaving machines for twisting textiles comprise, for example, a ring-spinning frame, a 2-for-1 twisting device, a direct cabling machine and any other turning device known in the art. The base yarns or fibres can be mixed, folded or twisted together at any suitable stage of the yarn manufacturing process. The twisted yarn may, for example, be twisted and optionally treated, for example, dyed or coated before being placed in a loom.

[0062] In a preferred embodiment, the fabric is treated with an insect-resistant and/or water-repellent product. Suitable water-repellent or insect-repellent products are described below. Possible embodiments of the treatment comprise immersion in a bath wherein both sides of the textile product are treated, and techniques wherein only one side of said textile products is treated, such as using foam, sprayers, or a lick roller, for example. These treatments may or may not be followed by a drying step and/or a polymerisation step. Thus, a textile product with excellent water-repellent and/or insect-repellent properties can be provided.

[0063] In a preferred embodiment, the present invention provides a fabric according to the first aspect of the invention, wherein the textile product is further provided with a water-repellent coating. Said water-repellent coating can consist of any component that leads to the repulsion of water on the surface of the textile product. The repulsion of water can be achieved by, for example, lowering the surface tension of the textile product. Suitable water-repellent components comprise hydrofluorocarbons such as, for example, C4, C6, C8, C10, C12, C14 fluorocarbon, fluorurethanes, fluorocarbon resins, fluoropolymer emulsions, perfluoropolyethers, water-repellent resins, and all derivatives, combinations, or mixtures thereof.

[0064] In a preferred embodiment, the present invention provides a fabric according to the first aspect of the invention, wherein the textile product is further provided with an insect repellent effect. This is advantageous for use in both military applications and for work or relaxation in nature. Here mosquitoes, mites and other insects form an irritation or even danger for the person. For this purpose, the fabric is provided with an insect repellent. This can be done using traditional methods such as immersion in a bath. In addition, it is also possible to use fibres which have been extruded with an insect repellent. Preferably, the viscose fibres are extruded with an insect repellent. This is described in PCT application PCT/IB2018/052712.

[0065] Suitable insect repellent agents comprise, among other things, compounds from the class of the organophosphates, pyrethroids, neonicotinoids and carbamates.

[0066] In a preferred embodiment, the present invention provides a fabric according to the first aspect of the invention, wherein the insect repellent is selected from the group consisting of permethrin, pyrethrin, icaridin, cyfluthrin, deltamethrin, pyrethroids, and mixtures thereof. Preferably, permethrin is used as an insect repellent. The use of these insect repellents, in the concentrations described below, leads to adequate biological activity.

[0067] In a preferred embodiment, the present invention provides a fabric according to the first aspect of the invention, provided with an insect repellent, wherein the amount of insect repellent is comprised between 0.25 and 5.00 wt% relative to the total weight of the textile product, preferably between 0.50 and 2.00 wt%. More preferably, said insect-repellent textile product contains between 0.75 and 1.50 wt%, and even more preferably, between 0.90 and 1.40 wt% insect repellent relative to the total weight of the textile product. Most preferably, said insect-repellent textile product contains between 1.00 and 1.30 wt% insect repellent relative to the total weight of the textile product. Such amounts of insect repellent lead to adequate biological activity against, for example, mosquitoes. Thus, textile products can be provided that meet the strict German TL 8305-0331 standard both after production and after 100 washes.

[0068] In what follows, the invention is described by way of non-limiting examples illustrating the invention, and which are not intended to and should not be interpreted as limiting the scope of the invention.

EXAMPLES 1-3

[0069] A fabric was composed of a first yarn $G_{1, vb}$ with a composition of 47.5 wt% flame-resistant viscose, 34 wt% meta-aramid, 9 wt% polyamide-6,6, 8.4 wt% para-aramid and 1 wt% antistatic fibre. The second yarn $G_{2, vb}$ is a co-para-aramid fibre sold under the trademark 'Technora' by Teijin.

[0070] A rip yarn R_{vb} was produced by twisting the first yarn $G_{1, vb}$ and the second yarn $G_{2, vb}$. The resulting composition of the rip yarn R_{vb} consisted of 22.5 wt% flame-resistant viscose, 16 wt% meta-aramid, 4 wt% polyamide-6,6, 4 wt% para-aramid, 0.5 wt% antistatic fibre and 53 wt% co-para-aramid. The rip yarn R_{vb} has a yarn count of 52/2 Nm.

[0071] A base yarn B_{vb} was produced by twisting two first yarns $2 \times G_{1, vb}$. The base yarn B_{vb} has the same composition as the first yarn G_1 and a yarn count of 56/2 Nm.

[0072] A fabric was woven according to the linen or plain weave, with a pattern repeat of 4 base yarn B_{vb} per rip yarn R_{vb} . The ratio between the warp yarns and the weft yarns was 6/5. For example 3 (VB3) this amounts to 24 warp yarns per centimetre with 20 wefts per centimetre.

Example 1 (VB1) was woven with 19 wefts per centimetre.
 Example 2 (VB2) was woven with 19.5 wefts per centimetre.
 Example 3 (VB3) was woven with 20 wefts per centimetre, and therefore 24 warp yarns per centimetre.

[0073] These fabrics were each tested. The test results are shown in Table 1. The dimensional stability was measured according to ISO 5077:2008 after washing according to the ISO 6330:2012 standard.

Table 1: Test results of Examples 1-3

Subject	Test methodology	VB1	VB2	VB3
Flame retardancy	ISO 15025:2016	Good	Good	Good
Weight of the fabric	ISO 3801:1977	186 g/m ²	191 g/m ²	186 g/m ²
Abrasion resistance	ISO 12947/2 1998	> 100.000	> 100.000	250,000
Permeability (to air)	ISO 9237-2 1995	175 mm/s	155 mm/s	180 mm/s
Dimensional stability in the warp direction	ISO 5077:2008	-1%	-0.5%	0%
Dimensional stability in the weft direction	ISO 5077:2008	0%	0%	0%
Tensile strength in the warp direction	ISO 13934-1:2013	990 N	970 N	990 N
Tensile strength in the weft direction	ISO 13934-1:2013	790 N	820 N	770 N
Tear strength after weaving in the warp direction	ISO 13937-3:2000	140 N	110 N	110 N
Tear strength after weaving in the weft direction	ISO 13937-3:2000	110 N	110 N	100 N
Tear strength after washing in the warp direction	ISO 13937-3:2000	70 N	68 N	69 N
Tear strength after washing in the weft direction	ISO 13937-3:2000	62 N	58 N	80 N
The fabric becoming fluffy	ISO 12945/2:2000	4-5	4-5	4-5
Colour-fastness (dry)	ISO 105	4-5	4-5	4-5
Colour-fastness (wet)	ISO 105	4	4	4

Claims

- Fabric comprising a series of base yarns B and a series of rip yarns R, wherein the fabric consists of a plain weave or broken twill with rip, wherein the fabric comprises a ratio of 3-5 base yarns B per rip yarn R, the fabric comprising:
 - base yarn B comprising 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, and
 - rip yarn R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre.
- Fabric according to claim 1, wherein the rip yarns R are composed of:
 - a first yarn G_1 , wherein the first yarn G_1 comprises 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre, and 5-20 by weight of para-aramid fibre, and
 - a second yarn G_2 , wherein the second yarn G_2 comprises at least 80 wt% of para-aramid fibre, the first yarn G_1 and the second yarn G_2 being twisted into rip yarns R.
- Fabric according to claim 2, wherein the first yarn G_1 has the same composition as the base yarns B.
- A fabric according to any of the preceding claims 2-3, wherein the base yarns B are composed of two twisted first yarns $2 \times G_1$.
- Fabric according to any of the preceding claims 2-4, wherein the first yarn G_1 further comprises 5-10 wt% of amide fibre, preferably a fibre comprising polyamide 6,6.

6. Fabric according to any of the preceding claims 1-6, wherein the rip yarn R comprises a thickness of 20-35 Nm, preferably a thickness of 25-30 Nm.

7. Fabric according to any of the preceding claims 1-7, wherein the base yarn B comprises a thickness of 20-35 Nm, preferably a thickness of 25-30 Nm.

8. Fabric according to any of the preceding claims 1-8, wherein the fabric has between 18 and 22 wefts per centimetre, preferably between 19 and 21 wefts per centimetre.

9. Fabric according to any of the preceding claims 1-9, wherein the fabric comprises a weight between 175-195 g/m².

10. Fabric according to any of the preceding claims 1-10, wherein the fabric has an air permeability higher than 170 mm/s, preferably higher than 190 mm/s, measured according to ISO 9237-2.

11. Fabric according to any of the preceding claims 1-11, wherein the fabric is printed.

12. Fabric according to any of the preceding claims 1-12, wherein the fabric achieves a score of at least 4 on colour fastness after rubbing in dry and wet conditions measured according to ISO 105.

13. Protective clothing comprising a fabric according to claims 1-13.

14. Use of a fabric according to any of the preceding claims 1-13 for camouflage clothing.

15. Method for producing a fabric, comprising the steps of:

- providing a series of rip yarns R comprising 45-65 wt% of para-aramid fibre, 20-30 wt% of viscose fibre, 15-25 wt% of meta-aramid fibre,

- providing a series of base yarns B, which base yarns B comprise 40-70 wt% of viscose fibre, 25-40 wt% of meta-aramid fibre and 5-20 wt% of para-aramid fibre, in a ratio of 3-5 base yarns B per rip yarn R, and

- weaving the base yarns B and the rip yarn R according to a plain weave or broken twill weave with rip.



EUROPEAN SEARCH REPORT

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Place of search Munich		Date of completion of the search 17 April 2020	Examiner Louter, Petrus
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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