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(54) **WATER-REPELLENT WOVEN OR KNITTED FABRIC, AND METHOD FOR PRODUCING SAME**
WASSERABWEISENDE WEB- ODER STRICKWARE UND VERFAHREN ZUR HERSTELLUNG
DAVON

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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a water-repellent woven or knitted fabric and a method of producing the same.

BACKGROUND ART

10 **[0002]** Conventionally, woven or knitted fabrics with water repellency have been demanded in such fields as uniform clothing and sport clothing, and many water-repellent woven or knitted fabrics have been proposed to date. As woven or knitted fabrics with added value, those improved in water repellency and obtainable at a lower cost have been demanded these days. For example, JP-A-2015 98661 suggests a technique to provide the lotus effect, which is an effect by which water droplets are held on a surface at points, by forming fine irregularities (protrusions) on the surface of a woven or knitted fabric and also to improve water repellency of the woven or knitted fabric by forming an air-holding layer. This technique is capable of providing an excellent water repellency to a woven or knitted fabric by using a conventionally known, inexpensive fluorine-based water repellent, for example, without making any particular change in the structure of the woven or knitted fabric.

15 **[0003]** JP-A-2010-133052 and JP-A-2009 287128 describe a fabric having a composite polyester yarn providing water-repellent performance to the fabric. JP-A-H04 214468 describes a high density knit fabric comprising a composite multifilament yarn of polyester and polyamide providing durable water-repellency to the fabric.

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

25 **[0004]** Woven or knitted fabrics for sportswear and uniforms are required to have not only water repellency but also excellent lightweight properties to make the resulting clothing comfortable or pleasant to wear. Lightweight properties are attained by the use of a polyester fiber with a small total fineness. If the amount of such a polyester fiber with a small total fineness is increased for the purpose of weight reduction in the technique of JP-A-2015 98661, however, the volume of a polyester fiber with a relatively great total fineness present on the sheath side decreases accordingly and therefore fine protrusions are not maintained, leading to the woven or knitted fabric to have a flat surface and therefore to have an insufficient water repellency and poor anti-drape and stiffness. The present invention has an object to provide a water-repellent woven or knitted fabric that is excellent in lightweight properties, sufficient in anti-drape and stiffness, and remarkably excellent in water repellency attributed to the lotus effect.

MEANS FOR SOLVING THE PROBLEM

35 **[0005]** The inventors of the present invention have conducted intensive research and, as a result, have found the following: by using two types of constituent polyester fibers with different fineness, where one of the two is shrinkable upon hot-water treatment, to form an entangled combined-filament yarn (a heat-shrinkable entangled combined-filament yarn) and to produce a woven or knitted fabric containing the resulting yarn, and then subjecting the resulting woven or knitted fabric to hot-water shrinkage treatment, it is possible to form sufficient protrusions of the constituent fibers, such protrusions tend to be maintained, and the woven or knitted fabric has a reduced level of stretchability and a reduced amount of space; and after subjected to water repellent treatment, the woven or knitted fabric acquires an excellent water repellency and excellent anti-drape and stiffness even when the woven or knitted fabric is made using a polyester fiber with a small fineness.

40 **[0006]** More specifically, the inventors of the present invention have found that the water-repellent woven or knitted fabric obtained by the technique described above has the following characteristics: containing an entangled combined-filament yarn having properties (i) to (iv) described below; having a water repellent agent adhering to the surface; and having an elongation percentage (a constant load method, with a load of 14.7 N) measured according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric.

45 (i) The entangled combined-filament yarn is composed of polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a total fineness of 30 to 100 dtex.

(ii) The entangled combined-filament yarn has a ratio (A/B) of the monofilament fineness of polyester fiber A to the monofilament fineness of polyester fiber B within the range from 1/20 to 1/4.

(iii) The entangled combined-filament yarn has a mass ratio (A/B) of polyester fiber A to polyester fiber B within the range from 20/80 to 80/20.

(iv) The entangled combined-filament yarn has protrusions made of polyester fiber A on a surface portion.

[0007] Further studies have been conducted based on these findings and thus the present invention has now been completed. More specifically, the present invention provides inventions of the following embodiments.

Item 1. A water-repellent woven or knitted fabric containing an entangled combined-filament yarn and having a water repellent agent adhering to a surface of the water-repellent woven or knitted fabric, the entangled combined-filament yarn being composed of polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a total fineness of 30 to 100 dtex, the entangled combined-filament yarn having a ratio (A/B) of the monofilament fineness of polyester fiber A to the monofilament fineness of polyester fiber B within a range from 1/20 to 1/4, the entangled combined-filament yarn having a mass ratio (A/B) of polyester fiber A to polyester fiber B within a range from 20/80 to 80/20, the entangled combined-filament yarn having protrusions made of polyester fiber A on a surface portion, the water-repellent woven or knitted fabric having an elongation percentage measured with a constant load method with a load of 14.7 N according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric.

Item 2. The water-repellent woven or knitted fabric according to Item 1, wherein the number of entanglements formed by the entangled combined-filament yarn is within a range from 90/m to 300/m.

Item 3. The water-repellent woven or knitted fabric according to Item 1 or 2, wherein the water-repellent woven or knitted fabric has a mass per unit area of not higher than 200 g/m².

Item 4. The water-repellent woven or knitted fabric according to any one of Items 1 to 3, wherein the water-repellent woven or knitted fabric has a cover factor (CF) within a range from 1500 to 3000 and a water-droplet-moving angle not greater than 40 degrees.

Item 5. A method of producing the water-repellent woven or knitted fabric as claimed in any one of Items 1 to 4, the method including: a step involving preparing a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 18 to 50%; a step involving obtaining a grey woven or knitted fabric by weaving or knitting with the heat-shrinkable entangled combined-filament yarn; a step involving subjecting the grey woven or knitted fabric to hot-water shrinkage treatment to obtain a low-stretchable woven or knitted fabric; and a step involving subjecting the low-stretchable woven or knitted fabric to water repellent treatment to obtain a water-repellent woven or knitted fabric, wherein the step involving preparing a heat-shrinkable entangled combined-filament yarn comprises:

(1) a drawing step involving drawing highly-oriented undrawn polyester yarn B having a monofilament fineness of 1.0 to 10.0 dtex, a total fineness of 30 to 200 dtex, a degree of elongation of 80 to 150%, and a boiling water shrinkage rate of not lower than 20% with a draw ratio of 1.3 to 1.7 to obtain drawn polyester yarn B; or a step involving preparing drawn polyester yarn B having a monofilament fineness of 0.6 to 4.8 dtex, a total fineness of 18 to 96 dtex, a degree of elongation of 15 to 60%, and a boiling water shrinkage rate of not lower than 20%;

(2) a false-twisting step involving false-twisting highly-oriented undrawn polyester yarn A having a monofilament fineness of 0.20 to 1.44 dtex, a total fineness of 30 to 160 dtex, and a degree of elongation of 80 to 150% under conditions of a processing speed of 100 to 700 m/minute and a draw ratio of 1.1 to 1.6 to obtain false-twisted polyester yarn A; and

(3) a combining-and-entangling step involving conducting combined-filament entanglement of false-twisted polyester yarn A and drawn polyester yarn B with the use of a fluid nozzle under conditions of an air pressure of 0.1 to 1.0 Mpa and the difference in an overfeeding rate between drawn polyester yarn B and false-twisted polyester yarn A of 0 to 10.0%.

Item 6. The method of producing a water-repellent woven or knitted fabric according to Item 5, wherein a thickness of the water-repellent woven or knitted fabric is 1.01 to 2.00 times a thickness of the grey woven or knitted fabric.

Item 7. A water-repellent woven or knitted fabric intermediate, the water-repellent woven or knitted fabric intermediate consisting of a low-stretchable woven or knitted fabric containing an entangled combined-filament yarn, the entangled combined-filament yarn being composed of polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a total fineness of 30 to 100 dtex,

the entangled combined-filament yarn having a ratio (A/B) of the monofilament fineness of polyester fiber A to the monofilament fineness of polyester fiber B within a range from 1/20 to 1/4,

the entangled combined-filament yarn having a mass ratio (A/B) of polyester fiber A to polyester fiber B within a range from 20/80 to 80/20,
 the entangled combined-filament yarn having protrusions made of polyester fiber A on a surface portion,
 the water-repellent woven or knitted fabric intermediate having an elongation percentage measured with a constant
 load method with a load of 14.7 N according to JIS L 1096:2010 of not higher than 3% in the case in which the
 water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which
 the water-repellent woven or knitted fabric is a water-repellent knitted fabric.

ADVANTAGES OF THE INVENTION

[0008] The woven or knitted fabric of the present invention tends to have fine protrusions formed and maintained on the surface and has a reduced amount of space on the surface even when the woven or knitted fabric contains a polyester fiber with a small fineness for the purpose of enhanced lightweight properties. Water repellent treatment of this woven or knitted fabric allows surface tension of a water droplet in contact with a protrusion to be sufficiently exhibited and thereby allows the woven or knitted fabric to have excellent water-repellent properties (more specifically called the lotus effect, which refers to an effect by which a water droplet falls from a woven or knitted fabric when the fabric is tilted). The present invention also makes it possible to obtain a woven or knitted fabric that has an excellent, not-too-soft texture with excellent anti-drape and stiffness even when a polyester fiber with a small fineness is used. The present invention also makes it possible to provide a method of producing a woven or knitted fabric with such an excellent water repellency and excellent anti-drape and stiffness.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

Fig. 1 is an optical microscopic photograph of a cross section of a water-repellent woven or knitted fabric of the present invention.

Fig. 2 is a schematic view illustrating a heat-shrinkable entangled combined-filament yarn preparation step in a method of producing a water-repellent woven or knitted fabric of the present invention.

Fig. 3 is an optical microscopic photograph of a cross section of a water-repellent woven or knitted fabric obtained in Comparative Example 1.

EMBODIMENTS OF THE INVENTION

[0010] A water-repellent woven or knitted fabric of the present invention contains an entangled combined-filament yarn with a specific configuration, has a water repellent agent adhering to the surface, and has an elongation percentage (a constant load method, with a load of 14.7 N) measured according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric. Below, the present invention will be described in detail.

[Entangled combined-filament yarn]

[0011] The entangled combined-filament yarn used in the present invention is composed of polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a total fineness of 30 to 100 dtex. The entangled combined-filament yarn has a mass ratio (A/B) of polyester fiber A to polyester fiber B within a range from 20/80 to 80/20 and has protrusions (protruding portions) made of polyester fiber A formed on a surface portion of the entangled combined-filament yarn.

[0012] In the case in which the monofilament fineness of each of polyester fiber A and polyester fiber B is within the specific range described above, it is possible to make these two polyester fibers entangled to each other to a sufficient extent. The resulting entanglement allows easy formation of protrusions made of polyester fiber A, which is relatively thin, on a surface portion of the entangled combined-filament yarn and as a result, the surface of the water-repellent woven or knitted fabric of the present invention attains the so-called lotus effect. A protrusion made of polyester fiber A in the present invention refers to a portion on a surface portion of the entangled combined-filament yarn in which polyester fiber A forms a loop or a slack, for example, and as a result, polyester fiber A protrudes outwardly.

[0013] When a water droplet is placed on a protrusion of the entangled combined-filament yarn, the water droplet tends not to penetrate the entangled combined-filament yarn. In this way, the protrusion makes it possible for the water-repellent woven or knitted fabric of the present invention to attain the so-called lotus effect and thereby exhibit an excellent

water repellency. As described below, the entangled combined-filament yarn is made of two types of polyester fibers A and B each having a specific monofilament fineness combined in a specific mass ratio, and a surface portion of the entangled combined-filament yarn has a portion in which polyester fiber A, which is relatively thin, is gently entangled. This portion with the entangled thin fiber forms a layer (air-holding layer) that tends to hold air. Through this portion with entangled polyester fiber A, the protrusion protrudes. More specifically, thin polyester fiber A is gently entangled and thereby forms this air-holding layer under the protrusion of polyester fiber A (namely, to the side of the entangled combined-filament yarn) and as a result, moisture tends not to penetrate the entangled combined-filament yarn. Further under the air-holding layer of the entangled combined-filament yarn, polyester fiber A and polyester fiber B are entangled to each other.

[0014] In the case in which each of polyester fiber A and polyester fiber B has its total fineness within the specific range described above, the resulting water-repellent woven or knitted fabric may have an excellent water repellency, excellent lightweight properties, and excellent anti-drape and stiffness. Here, when the fineness of a constituent fiber is simply decreased, the volume of the resulting woven or knitted fabric decreases and protrusions made of polyester fiber A tend not to be maintained, making the resulting woven or knitted fabric poor in water repellency and poor in anti-drape and stiffness. The water-repellent woven or knitted fabric of the present invention, on the other hand, contains an entangled combined-filament yarn that contains polyester fiber B made by using a highly hot-water shrinkable constituent fiber and that is subjected to heat shrinkage treatment. Therefore, polyester fiber B is sufficiently heat-shrunk and tends to maintain protrusions made of protruding polyester fiber A to a noticeable extent. As a result, even when a polyester fiber with a small fineness is used (particularly when polyester fiber A with a sufficiently small fineness is used), the protrusions are maintained. Furthermore, the resulting woven or knitted fabric has a reduced level of stretchability and thereby has low stretch properties, in other words, tends not to stretch. Therefore, the woven or knitted fabric tends not to have a flat structure and has a reduced amount of space between constituent fibers. As a result, it is possible to obtain a woven or knitted fabric that is remarkably excellent in water repellency. Furthermore, because polyester fiber B is sufficiently heat-shrunk, the resulting woven or knitted fabric is not too soft and is excellent in anti-drape and stiffness.

[0015] From the viewpoint that the entangled combined-filament yarn is capable of giving an excellent water repellency to the resulting woven or knitted fabric, the monofilament fineness of polyester fiber A is preferably about 0.2 to about 0.8 dtex, more preferably about 0.2 to about 0.6 dtex, further preferably about 0.2 to about 0.5 dtex, particularly preferably about 0.2 to about 0.5 dtex. In the case in which the monofilament fineness of polyester fiber A is smaller than 0.2 dtex, the fiber is too thin to attain effective opening and also does not effectively become entangled with polyester fiber B, leading to a tendency toward poor entanglement. In the case in which the monofilament fineness of polyester fiber A is greater than 0.9 dtex, the fiber is too rigid to form an excellent combined filament with polyester fiber B, leading to a tendency toward poor entanglement. In the case in which polyester fiber A is thick, the area of contact between a water droplet and the resulting woven or knitted fabric is large and the fiber is rigid, whereby an air-holding layer as described above tends not to be formed and as a result, a desired level of water repellency tends not to be attained.

[0016] The total fineness of polyester fiber A is 30 to 100 dtex, preferably 30 to 85 dtex, more preferably 30 to 80 dtex. In the case in which the total fineness is not smaller than 30 dtex, the fiber becomes entangled with polyester fiber B to a sufficient extent and an excellent entanglement is attained, whereby protrusions and an air-holding layer tend to be maintained. In the case in which the total fineness is not greater than 100 dtex, excellent lightweight properties are attained.

[0017] In the case in which the monofilament fineness of polyester fiber B is smaller than 1.0 dtex, it is difficult to maintain fine protrusions as described above made of polyester fiber A on a surface portion of the entangled combined-filament yarn, and an air-holding layer as described above tends not to be formed. In the case in which the monofilament fineness of polyester fiber A is substantially the same as the monofilament fineness of polyester fiber B, the resulting water-repellent woven or knitted fabric of the present invention containing the entangled combined-filament yarn is too soft and tends to have poor anti-drape and stiffness. In the case in which the monofilament fineness of polyester fiber B is greater than 5.0 dtex, the resulting woven or knitted fabric is hard in texture even when the fiber is formed into a combined filament with polyester fiber A that has a monofilament fineness within the range described above. Such a woven or knitted fabric is unpreferable as a woven or knitted fabric for use in clothing, for example. In the case in which the monofilament fineness of polyester fiber B is greater than 5.0 dtex, the entanglement is poor and fine protrusions as described above tend not to be formed on the surface of the resulting woven or knitted fabric, whereby it is difficult to give an excellent water repellency to the resulting woven or knitted fabric. From the viewpoint that an excellent water repellency is attained and excellent anti-drape and stiffness are effectively attained, the monofilament fineness of polyester fiber B is preferably about 1.5 to about 4.0 dtex, more preferably about 2.0 to about 3.5 dtex.

[0018] The total fineness of polyester fiber B is 30 to 100 dtex, preferably 32 to 90 dtex, further preferably 40 to 90 dtex, more preferably 40 to 75 dtex. In the case in which the total fineness is not smaller than 30 dtex, protrusions and an air-holding layer tend to be formed and maintained. In the case in which the total fineness is not greater than 100 dtex, excellent lightweight properties are attained.

[0019] The ratio (A/B) of the monofilament fineness of polyester fiber A to the monofilament fineness of polyester fiber B needs to be set to the range from 1/20 to 1/4, preferably 1/20 to 1/5, further preferably 1/15 to 1/6, more preferably

1/10 to 1/6. Even when the fineness of polyester fiber A is small enough to ensure the lightweight properties of the water-repellent woven or knitted fabric of the present invention, polyester fiber B if it has the above characteristics allows protrusions to tend to be formed and maintained on the resulting combined filament and ensures a reduced amount of space, making the water-repellent woven or knitted fabric of the present invention remarkably excellent in water repellency.

[0020] The degree of false-twisting crimping, more specifically a crimping rate, in the entangled combined-filament yarn in the present invention is preferably low and, for example, more preferably not higher than 10%, particularly preferably 0%. This is because the entangled combined-filament yarn substantially does not have a crimping rate, for such reasons as that the entangled combined-filament yarn is capable of having protrusions as described above formed or maintained on a surface portion by heat shrinkage of polyester fiber B and the entangled combined-filament yarn shrinks in the longitudinal direction in response to heat. In the case in which the crimping rate of the entangled combined-filament yarn is higher than 10%, heat-shrinkage treatment does not proceed sufficiently and therefore a desired level of water repellency and excellent anti-drape and stiffness of the resulting woven or knitted fabric tend not to be attained sometimes.

[0021] The crimping rate of the entangled combined-filament yarn is measured by the following method, for example. A sizing reel having a frame circumference length of 1.125 m is used to wind the entangled combined-filament yarn five rounds to form a skein. The resulting skein is hung free on a support at room temperature for a whole day and night. Then, the skein is placed in boiling water with a load of 0.000147 cN/dtex being applied thereto, followed by wet heat treatment for 30 minutes. The skein is then taken out of the boiling water and moisture is gently removed with a piece of filter paper, followed by being left free at room temperature for 30 minutes. Then, the skein is applied with a load of 0.000147 cN/dtex and 0.00177 cN/dtex (light load), followed by measurement of length X. Subsequently, the light load is replaced with a load (heavy load) of 0.044 cN/dtex while a load of 0.000147 cN/dtex is still being applied, and length Y is measured. Calculation follows using the following expression: crimping rate (%) = $(Y - X)/Y \times 100$. This measurement of the crimping rate is carried out for five pieces of the entangled combined-filament yarn and the average value is regarded as the crimping rate of the entangled combined-filament yarn.

[0022] The mass ratio (A/B) of polyester fiber A to polyester fiber B is within the range from 20/80 to 80/20. In the case in which the mass ratio (combination proportion) of polyester fiber A is lower than 20%, the proportion of polyester fiber A in the entangled combined-filament yarn is too small and therefore it is difficult for protrusions as described above to be formed on a surface portion of the entangled combined-filament yarn and it is also difficult to give an excellent water repellency to the resulting woven or knitted fabric. In the case in which the combination proportion of polyester fiber A is higher than 80%, the proportion of polyester fiber B is too small and therefore it is difficult for protrusions as described above to be maintained on a surface portion. In this case, fine protrusions tend to collapse and it is difficult to give an excellent water repellency to the resulting woven or knitted fabric. The mass ratio (A/B) of polyester fiber A to polyester fiber B is preferably about 30/70 to about 70/30.

[0023] The entangled combined-filament yarn is a combined-filament yarn that is entangled itself, and the number of entanglements is preferably about 90/m to about 300/m, more preferably 130/m to 300/m, further preferably 200/m to 300/m. In the case in which the number of entanglements is smaller than 90/m, the entanglements come loose easily and sometimes it is difficult for fine protrusions as described above to be formed on a surface portion of the entangled combined-filament yarn. In the case in which the entanglements come loose easily, wear that is naturally caused by a guide in production of the woven or knitted fabric induces misalignment inside a thread, sometimes making a drawback of the woven or knitted fabric likely to appear. In the case in which the number of entanglements is greater than 300/m, polyester fiber A and polyester fiber B become entangled to each other excessively and protrusions as described above tend not to be formed, whereby an excellent water repellency of the resulting woven or knitted fabric tends not to be attained. The number of entanglements of the entangled combined-filament yarn in the present invention is measured by a hook method specified in JIS L1013 8.15.

[0024] In the case in which an appropriate additive is added to at least one of polyester fiber A and polyester fiber B in the entangled combined-filament yarn used in the present invention, the water-repellent woven or knitted fabric of the present invention may acquire an additional function. Usually, the higher the amount (absolute amount) of the additive is, the more the additional function given by the additive is enhanced. A greater amount of an additive may be added to polyester fiber B having a greater monofilament fineness than to polyester fiber A and therefore it is preferable that the additive be added to polyester fiber B. Examples of the additive include a sunlight blocker and an infrared absorber. One of these additives may be used alone, or two or more of these additives may be used in combination.

[0025] In the case in which the entangled combined-filament yarn used in the present invention contains a sunlight blocker, a sunlight blocking effect is attained and whereby the resulting water-repellent woven or knitted fabric may attain a cool feel. In the case in which the entangled combined-filament yarn contains a sunlight blocker, it is preferable that the sunlight blocker be contained in polyester fiber B from the viewpoint described above. The sunlight blocker used in the present invention is a substance that prevents transmission of a visible ray and an infrared ray contained in sunlight and that needs to be dispersible in polyester. From the viewpoint that an excellent sunlight blocking capability is attained

and an excellent cool feel of the resulting water-repellent woven or knitted fabric is attained, preferable examples of the sunlight blocker include titanium oxide, potassium titanate, zinc oxide, and indium oxide. One of these sunlight blockers may be used alone, or two or more of these sunlight blockers may be used in combination.

[0026] In the case in which polyester fiber A and/or polyester fiber B contains the sunlight blocker, the content thereof is not particularly limited and is about 3 to about 10 mass%, for example, preferably about 3 to about 7 mass%. In the case in which this requirement for the content is satisfied, a desired level of cool feel may be attained with a decrease in spinning properties being inhibited. Polyester fiber A or polyester fiber B may have a cross section in which the core portion and the sheath portion form concentric circles and the amount of the sunlight blocker contained in the core portion may be different from the amount of the sunlight blocker contained in the sheath portion. For example, it is preferable that the amount of the sunlight blocker contained in the sheath portion be not higher than 0.8 mass% and the amount of the sunlight blocker contained in the whole fiber be about 3 to about 10 mass%. In the case in which the amount of the sunlight blocker contained in the sheath portion is low, wear caused by a guide during production tends not to be influential and yarn breakage or fuzz formation tends not to occur.

[0027] In the case in which the entangled combined-filament yarn used in the present invention contains an infrared absorber, the resulting water-repellent woven or knitted fabric may have thermal insulating properties. In the case in which the entangled combined-filament yarn contains an infrared absorber, it is preferable that the infrared absorber be contained in polyester fiber B from the viewpoint described above. The infrared absorber used in the present invention is a substance that is capable of absorbing infrared light and converting it into heat, and needs to be dispersible in polyester. From the viewpoint that an excellent infrared absorbing capability is attained and excellent thermal insulating properties of the resulting water-repellent woven or knitted fabric are attained, preferable examples of the infrared absorber include zirconium carbide, silicon carbide, and antimony-doped indium oxide. One of these infrared absorbers may be used alone, or two or more of these infrared absorbers may be used in combination.

[0028] In the case in which polyester fiber A and/or polyester fiber B contains the infrared absorber, the content thereof is not particularly limited and is about 0.5 to about 5 mass%, for example. In the case in which this requirement for the content is satisfied, a desired level of thermal insulating properties may be attained with a decrease in spinning properties being inhibited. Polyester fiber A or polyester fiber B may have a cross section in which the core portion and the sheath portion form concentric circles and the amount of the infrared absorber contained in the core portion may be different from the amount of the infrared absorber contained in the sheath portion. For example, it is preferable that the amount of the infrared absorber contained in the core portion be about 5 to about 25 mass%, more preferably about 7 to about 17 mass% and the amount of the infrared absorber contained in the whole fiber be about 0.5 to about 5 mass%. In the case in which the amount of the infrared absorber contained in the sheath portion is low, wear caused by a guide during production tends not to be influential and yarn breakage or fuzz formation tends not to occur.

[0029] For giving a design capability to the water-repellent woven or knitted fabric of the present invention, a cation-dyeable polyester may be used as polyester fiber A and/or polyester fiber B. In the case in which a cation-dyeable polyester is used and a cation dye is used in the dyeing process, a melange-toned texture may be attained.

[0030] The cation-dyeable polyester is not particularly limited as long as it is dyeable with a cation dye, and is preferably a polyester that is a copolymer of an ethylene terephthalate unit with 5-sulfoisophthalic acid in an amount of about 0.5 to about 5.0 mol% relative to the total amount of all acid components.

[Water repellent agent]

[0031] The water-repellent woven or knitted fabric of the present invention has a water repellent agent adhering to at least one surface of the woven or knitted fabric. In the case in which the water-repellent woven or knitted fabric of the present invention is overlaid with a moisture-permeable waterproof layer described below, the water repellent agent needs to be adhered to a side of the fabric opposite to a side to which the moisture-permeable waterproof layer is overlaid. In the case in which the woven or knitted fabric is not overlaid with a moisture-permeable waterproof layer described below, the water repellent agent needs to be adhered to one side or both sides of the woven or knitted fabric.

[0032] The water repellent agent used in the present invention is not particularly limited but is preferably a fluorine-based water repellent in terms of workability, cost, and the like. More specifically, a preferable fluorine-based water repellent consists of a fluorine-based compound having a polyfluoroalkyl group (Rf group) in the chemical structure. The Rf group refers to a group obtained by substituting two or more hydrogen atoms of an alkyl group with fluorine atoms. The number of carbon atoms in the Rf group is preferably 2 to 20, more preferably 2 to 8, further preferably 1 to 6. The Rf group may have either a linear structure or a branched structure. In the case in which the Rf group has a branched structure, in particular, it is preferable that the Rf group has the branched part in a terminal portion thereof and be a short chain having about 1 to about 8 carbon atoms, more preferably 1 to 6 carbon atoms. A preferable Rf group is a group (a perfluoroalkyl group) obtained by substituting all the hydrogen atoms in an alkyl group with fluorine atoms.

[0033] A preferable fluorine-based compound is a copolymer obtained by polymerizing, by a known polymerization method, a polymer containing the perfluoroalkyl group described above with another polymerizable monomer that is

polymerizable with this polymer. Examples of this another polymerizable monomer include acrylic acid, methacrylic acid, styrene, and vinyl chloride. When needed, an acrylic-based compound, a vinyl-acetate-based compound, a melamine-based compound, and the like may be appropriately used as a mixture.

[0034] The fluorine-based water repellent may be a commercially available product, and examples thereof include "AsahiGuard (trade name)" manufactured by Asahi Glass Co., Ltd. and "NK Guard (trade name)" manufactured by Nicca Chemical Co., Ltd. Considering environmental protection, a particularly preferable fluorine-based water repellent is a fluorine-based water repellent containing no perfluoroalkylcarboxylic acid. It is preferable that the fluorine-based water repellent be used in a form of aqueous emulsion.

[0035] Considering the environment, the water repellent agent used in the present invention may be a water repellent agent containing no fluorine (more specifically, a non-fluorine water repellent). Examples of the non-fluorine water repellent include hydrocarbon-based non-fluorine water repellents, silicone-based non-fluorine water repellents, and wax-based non-fluorine water repellents. The non-fluorine water repellent may be a commercially available product, and examples thereof include the following: as a hydrocarbon-based non-fluorine water repellent, "Neoseed (trade name)" manufactured by Nicca Chemical Co., Ltd. and "Palladium ECO (trade name)" manufactured by Ohara Paragium Chemical Co., Ltd.; as a silicone-based non-fluorine water repellent, "Drypon 600E (trade name)" manufactured by Nicca Chemical Co., Ltd. and "Polon (trade name)" manufactured by Shin-Etsu Chemical Co., Ltd.; and as a wax-based non-fluorine water repellent, "TH-44 (trade name)" manufactured by Nicca Chemical Co., Ltd. and "Neolax (trade name)" manufactured by Takamatsu Oil & Fat Co., Ltd. A hydrocarbon-based non-fluorine water repellent is particularly preferable because a combination of it with another agent allows an easy enhancement of washing durability.

[0036] The amount of the water repellent agent to make adhered to the woven or knitted fabric may be determined as appropriate depending on the type of the water repellent agent to use and the desired level of water repellency to attain, for example. The solid content of the water repellent agent is 0.05 to 10 g/m², for example, and preferably 0.1 to 7 g/m².

[Structure and properties of water-repellent woven or knitted fabric]

[0037] The water-repellent woven or knitted fabric of the present invention needs to contain the entangled combined-filament yarn as at least part of a constituent warp and/or a constituent weft. From the viewpoint that an excellent water repellency and excellent anti-drape and stiffness are attained, the amount of the entangled combined-filament yarn used in the woven or knitted fabric is not lower than 20 mass%, preferably not lower than 25 mass%, more preferably not lower than 35 mass%, further preferably not lower than 50 mass%, further more preferably not lower than 70 mass%, particularly preferably not lower than 80 mass%, not lower than 90%, not lower than 95 mass%, or 100 mass%.

[0038] The water-repellent woven or knitted fabric of the present invention has a remarkably excellent water repellency attributed to the presence of protrusions formed on a surface portion of the entangled combined-filament yarn, has this water repellency further enhanced because of the presence of the air-holding layer as described above formed on the entangled combined-filament yarn, and has a reduced amount of space between constituent fibers and less penetration of water droplets. For these reasons, use of a conventionally known, inexpensive fluorine-based water repellent and the like may make it possible to attain an excellent water repellency, without making any particular change in the structure of the woven or knitted fabric. More specifically, the water-repellent woven or knitted fabric of the present invention is capable of supporting a big water droplet as well as a small water droplet on its protrusions, and is also capable of effectively inhibiting a water droplet from penetrating the water-repellent woven or knitted fabric because of the presence of the air-holding layer and the reduced amount of space. For these reasons, water repellency is remarkably improved to the same level as that of the so-called lotus effect.

[0039] Examples of an index of the level of fineness of protrusions formed on a surface portion of the entangled combined-filament yarn in the water-repellent woven or knitted fabric of the present invention include a mean deviation (SMD) of the surface roughness of the woven or knitted fabric measured according to the KES-F system. The mean deviation (SMD) of the surface roughness of the water-repellent woven or knitted fabric of the present invention measured according to the KES-F system is preferably 1.5 to 5.0 μm. In the case in which the mean deviation (SMD) is lower than 1.5 μm, protrusions of the entangled combined-filament yarn are too fine and they form a near flat surface. In this case, the area of contact between a water droplet and the surface of the resulting woven or knitted fabric is large and therefore a sufficient level of surface tension tends not to be exerted against the water droplet. As a result, the woven or knitted fabric tends not to have an excellent water repellency. In the case in which the mean deviation (SMD) is higher than 5.0 μm, protrusions of the entangled combined-filament yarn are too big and sometimes a water droplet tends to fall into space between protrusions. As a result, a water droplet tends to penetrate the woven or knitted fabric and a desired level of water repellency tends not to be attained sometimes. The mean deviation (SMD) of the water-repellent woven or knitted fabric of the present invention may be set within a predetermined range by setting the amount of the entangled combined-filament yarn in the woven or knitted fabric to the above-described range.

[0040] In the present invention, even when polyester fiber A and polyester fiber B both with small fineness are used

for improving lightweight properties, protrusions of the entangled combined-filament yarn may be easily formed and maintained because polyester fiber B has been hot-water shrunk and whereby a value of SMD not lower than 1.5 may be attained.

[0041] In the present invention, the mean deviation (SMD) of the surface roughness of the woven or knitted fabric measured according to the KES-F system is determined with an automated surface tester under the following measurement conditions.

(1) A water-repellent woven or knitted fabric to be measured is cut to obtain a 20-cm-square specimen, and the resulting specimen is applied with a tension of 400 g and set in the automated surface tester.

(2) A load of 50 g including the weight of a metal friction block is applied to the specimen in a vertical direction. While the specimen is in contact with the friction block with a force of 10 g attributed to a contact pressure exerted by a spring, the specimen is moved 30 mm back-and-forth, during which changes in the surface roughness of the specimen are measured.

(3) This measurement is repeated three times each in the two directions WARP and WEFT, and the average is defined as mean deviation (SMD).

[0042] In the present invention, from the viewpoint that an excellent water repellency is attained, the woven fabric preferably has a cover factor (CF) of 1500 to 3000, more preferably 2200 to 2800. In the case in which the CF is lower than 1500, the resulting woven fabric has rough intersections and has an increased amount of space. As a result, a water droplet tends to fall into the space and therefore improvement in water repellency may not be attained. In the case in which the CF is higher than 3000, restraint attributed to intersections is strong and whereby tear tenacity and breaking tenacity of the resulting woven fabric may decrease.

[0043] The cover factor (CF) of the woven or knitted fabric refers to a numerical value of the roughness or fineness thereof. The cover factor (CF) of a woven fabric is calculated by the following expression. In the expression, D represents the total fineness of the warp and E represents the total fineness of the weft.

$$CF = D^{1/2} \times (\text{warp density (warps/2.54 cm)}) + E^{1/2} \times (\text{weft density (wefts/2.54 cm)})$$

[0044] The surface density of the water-repellent woven or knitted fabric when the water-repellent woven or knitted fabric is a water-repellent knitted fabric is preferably 55 to 150 courses/2.54 cm and 45 to 100 wales/2.54 cm, more preferably 50 to 100 courses/2.54 cm and 45 to 85 wales/2.54 cm. In the case in which the course density or the wale density is lower than the corresponding range, the resulting knitted fabric has rough intersections and the amount of space in the knitted fabric tends to be high, leading to a tendency that a water droplet falls into the space and whereby a sufficient level of improvement in water repellency may not be attained. In the case in which the course density or the wale density is higher than the corresponding range, restraint attributed to intersections is strong and whereby tear tenacity and breaking tenacity of the resulting knitted fabric may decrease.

[0045] The water-repellent woven or knitted fabric of the present invention has an elongation percentage (a constant load method, with a load of 14.7 N) measured according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric. It is preferable that the elongation percentage is not higher than 2% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 110% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric. In the case in which the elongation percentage (stretchability) is within the range described above, it indicates that polyester fiber B in the entangled combined-filament yarn is sufficiently heat-shrunk and therefore the woven or knitted fabric is excellent in anti-drape and stiffness. Furthermore, in the case in which the elongation percentage (stretchability) is within the range described above, it indicates that polyester fiber B of the entangled combined-filament yarn is sufficiently hot-water shrunk, fine protrusions made of polyester fiber A as described above are sufficiently formed and maintained, and whereby the woven or knitted fabric is enhanced in water repellency. Furthermore, in the case in which the stretchability is within the range described above, it indicates that stretch properties are not too strong, the entangled combined-filament yarn is not excessively stretched and does not form a flat structure, the amount of space between constituent fibers is reduced, and whereby the woven or knitted fabric is even more excellent in water repellency. The water-repellent woven or knitted fabric of the present invention has a reduced level of stretchability as described above attributed to polyester fiber B having been subjected to heat-shrinkage treatment. To make the resulting texture not too hard, it is preferable that the lower limit to the stretchability be 0.5% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or about 100% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric. To make the elongation percentage of the water-repellent woven or knitted fabric of the

present invention fall within the range described above, it is preferable, for example, that the entangled combined-filament yarn containing polyester fiber B in the mass ratio described above be used in a proportion of not lower than 20 mass%. More specifically, the elongation percentage of the water-repellent woven or knitted fabric of the present invention is 0.5 to 3%, preferably 0.5 to 2.5% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric, and the elongation percentage of the water-repellent woven or knitted fabric of the present invention is 100 to 120%, preferably 100 to 110% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric.

[0046] The water-repellent woven or knitted fabric of the present invention contains a constituent fiber with a small fineness and is thereby excellent in lightweight properties. The mass per unit area of the water-repellent woven or knitted fabric of the present invention is not particularly limited and, for example, it is preferably not higher than 200 g/m², more preferably not higher than 150 g/m². The lower limit to the mass per unit area is not particularly limited and is 80 g/m², for example. More specifically, the mass per unit area of the water-repellent woven or knitted fabric of the present invention is preferably 80 to 200 g/m², more preferably 80 to 150 g/m².

[0047] The type of weave or knitting of the water-repellent woven or knitted fabric of the present invention is not particularly limited and may be any appropriate type of weave or knitting (in the case of a woven fabric, it may be plain weave, twill weave, satin weave, or, as needed, multilayer weave; and in the case of a knitted fabric, it may be circular plain knitting, smooth knitting, warp tricot knitting, or, as needed, multilayer knitting). Compared to a woven fabric, a knitted fabric has suitably-maintained irregularities on the fabric surface and therefore is remarkably excellent in water droplet mobility attributed to synergy with protrusions of the entangled combined-filament yarn.

[0048] The water-repellent woven or knitted fabric of the present invention has an excellent water repellency. More specifically, a surface of the water-repellent woven or knitted fabric to which a water repellent agent is adhered has a water-droplet-moving angle of preferably not greater than 40 degrees, further preferably not greater than 35 degrees, more preferably not greater than 30 degrees. Even more specifically, the water-droplet-moving angle is preferably 5 to 40 degrees, further preferably 5 to 35 degrees, more preferably 5 to 30 degrees. The water-droplet-moving angle serves as an index for use in evaluation of water repellency such as the lotus effect. Having an excellent water repellency in the present invention is equivalent to having the lotus effect to an excellent extent. The water-droplet-moving angle refers to the angle at which a water droplet starts to move after the water droplet in a volume of 0.02 mL is gently placed on a flat sample (woven or knitted fabric) fixed onto a flat plate and then the flat plate is gently tilted. In the case in which the resulting woven or knitted fabric has a water-droplet-moving angle greater than 40 degrees, it is sometimes difficult to shake off a water droplet, such as a rain water droplet, intact in shape from a product obtained by sewing the woven or knitted fabric. For example, in the case in which the water-repellent woven or knitted fabric of the present invention contains not lower than 50 mass% of the entangled combined-filament yarn described above and has a cover factor (CF) being set within the range described above, the water-droplet-moving angle may be easily set to be not higher than 40 degrees.

[0049] Fig. 1 is a photograph taken with an optical microscope, of a section extending in a thickness direction of the water-repellent woven or knitted fabric of the present invention obtained in Example 1 (magnification: 100 times). From Fig. 1, it is understandable that polyester fiber B is heat-shrunk, the woven or knitted fabric is pressed and densely packed, and protrusions made of polyester fiber A are maintained. Because of this structure, even when a constituent fiber with a small fineness is used for enhancing lightweight properties and particularly when the fineness of polyester fiber A is smaller than the fineness of polyester fiber B, protrusions are sufficiently maintained, the surface of the woven or knitted fabric is not flat, the amount of space between constituent fibers is reduced, and a remarkably excellent water repellency is attained.

[0050] The water-repellent woven or knitted fabric of the present invention may be overlaid with a moisture-permeable waterproof layer on one side and thereby made into a multilayer fabric. The presence of this moisture-permeable waterproof layer yields a combination of moisture permeability and waterproof properties. In the case in which the water-repellent woven or knitted fabric of the present invention has a water repellent agent adhered to only one surface thereof, the moisture-permeable moisture-proof layer needs to be provided on a side with no water repellent agent adhered thereto.

[0051] A constituent resin of the moisture-permeable waterproof layer is not particularly limited and examples thereof include resins predominantly composed of polyurethane resin. There may be an adhesive layer interposed between the water-repellent woven or knitted fabric and the moisture-permeable waterproof layer. The moisture-permeable waterproof layer may be overlaid with another fiber fabric.

[Other processing]

[0052] The water-repellent woven or knitted fabric of the present invention may be subjected to post-weaving or post-knitting processing, as needed, such as antimicrobial processing, dyeing processing, water absorption processing only on the back side, UV-cut processing, thermal storage processing, bacteriostatic processing, antimicrobial deodorant processing, odor control processing, antifouling processing, mosquito-repelling processing, calender processing, and

print processing. It is preferable that any of these processings be carried out under conditions that protrusions do not collapse to an extent where an effect of the present invention is lost.

[Applications of water-repellent woven or knitted fabric]

[0053] The water-repellent woven or knitted fabric of the present invention is excellent in water repellency and light-weight properties with appropriate levels of anti-drape and stiffness, and therefore is suitably used in such applications as uniform clothing, sport clothing, casual clothing, and outdoor products.

[Method of producing water-repellent woven or knitted fabric]

[0054] A method of producing the water-repellent woven or knitted fabric of the present invention includes the following steps in this order: a step (heat-shrinkable entangled combined-filament yarn preparation step) involving preparing a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 18 to 50%; a step (grey woven or knitted fabric production step) involving weaving or knitting a grey woven or knitted fabric with the heat-shrinkable entangled combined-filament yarn; a step (hot-water shrinkage treatment step) involving subjecting the grey woven or knitted fabric to hot-water shrinkage treatment to obtain a low-stretchable woven or knitted fabric; and a step (water-repellent treatment step) involving subjecting the low-stretchable woven or knitted fabric to water repellent treatment to obtain the water-repellent woven or knitted fabric of the present invention.

[0055] In the case in which the water-repellent woven or knitted fabric of the present invention is overlaid with a moisture-permeable waterproof layer, the above method further includes a step (moisture-permeable waterproof layer overlaying step) involving depositing a moisture-permeable waterproof layer on one side of the water-repellent woven or knitted fabric after the water-repellent treatment step.

[0056] Next, each step of the method of producing a water-repellent woven or knitted fabric of the present invention is more specifically described.

(Heat-shrinkable entangled combined-filament yarn preparation step)

[0057] In the heat-shrinkable entangled combined-filament yarn preparation step, a heat-shrinkable entangled combined-filament yarn having a degree of elongation of 18 to 50% needs to be prepared. The degree of elongation of the heat-shrinkable entangled combined-filament yarn thus prepared is preferably 18 to 45%, further preferably 18 to 40%. The degree of elongation of the heat-shrinkable entangled combined-filament yarn is determined by a tensile test carried out with a tensile tester with constant speed strain control according to JIS L1013 8.5.1 under conditions of a sample length of 200 mm and a strain speed of 200 mm/min. The degree of elongation of each of highly-oriented undrawn polyester yarn A and highly-oriented undrawn polyester yarn B described below is measured by the same method.

[0058] A specific embodiment of the heat-shrinkable entangled combined-filament yarn preparation step is not particularly limited and examples thereof include an embodiment that includes the following steps:

(1) a drawing step involving drawing highly-oriented undrawn polyester yarn B having a monofilament fineness of 1.0 to 10.0 dtex, a total fineness of 30 to 200 dtex, a boiling water shrinkage rate of not lower than 20%, and a degree of elongation of 80 to 150% with a draw ratio of 1.3 to 1.7 to obtain drawn polyester yarn B;

(2) a false-twisting step involving false-twisting highly-oriented undrawn polyester yarn A having a monofilament fineness of 0.2 to 1.44 dtex, a total fineness of 30 to 160 dtex, and a degree of elongation of 80 to 150% under conditions of a processing speed of 100 to 700 m/minute and a draw ratio of 1.1 to 1.6 to obtain false-twisted polyester yarn A; and

(3) a combining-and-entangling step involving conducting combined-filament entanglement of drawn polyester yarn B drawn in the drawing step and false-twisted polyester yarn A false-twisted in the false-twisting step with the use of a fluid nozzle under conditions of an air pressure of 0.1 to 1.0 Mpa and a difference in the overfeeding rate between drawn polyester yarn B and false-twisted polyester yarn A of 0 to 10.0%.

[0059] The heat-shrinkable entangled combined-filament yarn prepared in the heat-shrinkable entangled combined-filament yarn preparation step is a yarn that can be subjected to the grey woven or knitted fabric production step, the hot-water shrinkage treatment step, and the water-repellent treatment step to become the entangled combined-filament yarn contained in the water-repellent woven or knitted fabric of the present invention.

In the heat-shrinkable entangled combined-filament yarn preparation step, the drawing step involving drawing a specific highly-oriented undrawn polyester yarn B (which is to become polyester fiber B, a constituent fiber of the entangled combined-filament yarn) with a specific draw ratio to form drawn polyester yarn B is carried out. By this drawing step, the degree of elongation of drawn polyester yarn B becomes substantially the same as or slightly lower than the degree

of elongation of highly-oriented undrawn polyester yarn A (which is to become polyester fiber A, a constituent fiber of the entangled combined-filament yarn). Then, the false-twisting step involving false-twisting highly-oriented undrawn polyester yarn A to obtain false-twisted polyester yarn A is carried out. By this false-twisting step, highly-oriented undrawn polyester yarn A is opened and thereby tends to become entangled with drawn polyester yarn B. Then, the combining-
 5 and-entangling step involving combining drawn polyester yarn B drawn in the drawing step with false-twisted polyester yarn A that is also to be a constituent of the resulting combined filament is carried out, and thus a heat-shrinkable entangled combined-filament yarn is obtained. It is preferable that the overfeeding rates of the two yarns be adjusted so that the proportion of false-twisted polyester yarn A on the outer side (surface side) of the heat-shrinkable entangled combined-filament yarn is great.

10 **[0060]** In the water-repellent woven or knitted fabric of the present invention obtained after the grey woven or knitted fabric production step, the hot-water shrinkage treatment step, and the water-repellent treatment step, polyester fiber A described above as a constituent of the entangled combined-filament yarn is derived from highly-oriented undrawn polyester yarn A and polyester fiber B described above as a constituent of the entangled combined-filament yarn is derived from highly-oriented undrawn polyester yarn B.

15 **[0061]** The highly-oriented undrawn polyester yarn refers to a multifilament yarn produced by spinning and winding a polyester polymer at a speed of about 2000 to about 4000 m/minute. As the polyester polymer, polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, or the like may be used alone or a plurality of these may be used in combination. The polyester polymer may be a polyester copolymer. Examples of a copolymer component include copolymer components, including aromatic dicarboxylic acids, such as isophthalic acid, 5-alkali isophthalic acid, and
 20 3,3'-diphenyldicarboxylic acid; aliphatic dicarboxylic acids, such as adipic acid, sebacic acid, and succinic acid; aliphatic and alicyclic diols, such as diethylene glycol, 1,4-butanediol, and 1,4-cyclohexanediol; and P-hydroxybenzoic acid. When needed, the polyester polymer may contain a modifier, such as a matting agent, a stabilizer, a flame retardant, and a colorant. The highly-oriented undrawn polyester yarn is composed of a bundle of a plurality of highly-oriented undrawn fibers. In the case in which each fiber has a cross section in which the core portion and the sheath portion form concentric
 25 circles, for example, it is preferable that the polyester polymer of the core portion be the same as the polyester polymer of the sheath portion in consideration of the compatibility between the polymer of the core portion and the polymer of the sheath portion.

[0062] Highly-oriented undrawn polyester yarn A needs to have a monofilament fineness of 0.2 to 1.44 dtex, a total fineness of 30 to 160 dtex, and a degree of elongation of 80 to 150%, preferably a monofilament fineness of 0.2 to 0.9
 30 dtex, a total fineness of 30 to 130 dtex, and a degree of elongation of 85 to 140%, more preferably a monofilament fineness of 0.22 to 0.9 dtex, a total fineness of 30 to 100 dtex, and a degree of elongation of 85 to 130%, particularly preferably a monofilament fineness of 0.22 to 0.85 dtex and a total fineness of 33 to 100 dtex. In the case in which the monofilament fineness of highly-oriented undrawn polyester yarn A is smaller than 0.2 dtex, the monofilament is too thin to attain effective opening and it is difficult to make highly-oriented undrawn polyester yarn A sufficiently combined with
 35 highly-oriented undrawn polyester yarn B described below, leading to a tendency toward poor entanglement. This phenomenon is unpreferable because as a result of this phenomenon, protrusions tend not to be formed on a surface portion of the entangled combined-filament yarn of the water-repellent woven or knitted fabric of the present invention and yarn breakage and fuzz formation tend to occur. In the case in which the monofilament fineness of highly-oriented undrawn polyester yarn A is greater than 1.44 dtex, big space tends to form within a constituent thread and it is difficult to make
 40 highly-oriented undrawn polyester yarn A sufficiently combined with highly-oriented undrawn polyester yarn B, leading to a tendency toward poor entanglement and then difficult protrusion formation.

[0063] It is preferable that the boiling water shrinkage rate of highly-oriented undrawn polyester yarn A be lower than that of highly-oriented undrawn polyester yarn B, for instance 15 to 35%, preferably 15 to 30%, further preferably not lower than 15% and lower than 20%. The boiling water shrinkage rate of highly-oriented undrawn polyester yarn A refers
 45 to a skein dimensional change rate. This skein dimensional change rate is measured by "skein dimensional change rate (Method A)" specified in JIS L1013 8.18.1 under conditions including immersion in hot water at 100°C for 30 minutes. The boiling water shrinkage rate of highly-oriented undrawn polyester yarn B described below is measured by the same method.

[0064] In the case in which the total fineness of highly-oriented undrawn polyester yarn A is not smaller than 30 dtex, entanglement thereof with highly-oriented undrawn polyester yarn B becomes excellent and protrusions and an air-
 50 holding layer tend to be maintained. In the case in which the total fineness is not greater than 160 dtex, a water-repellent woven or knitted fabric excellent in lightweight properties may be obtained.

[0065] In the case in which the degree of elongation of highly-oriented undrawn polyester yarn A is lower than 80%, many yarn breakages may occur in the false-twisting step described below. Stably supplying a highly-oriented undrawn
 55 yarn with a degree of elongation higher than 150% is difficult because yarn breakage, quality loss, and the like occur during production.

[0066] Highly-oriented undrawn polyester yarn B needs to have a monofilament fineness of 1.0 to 10.0 dtex, a total fineness of 30 to 200 dtex, a boiling water shrinkage rate of not lower than 20%, and a degree of elongation of 80 to

150%, preferably a monofilament fineness of 1.0 to 5.0 dtex, a total fineness of 30 to 100 dtex, a boiling water shrinkage rate of 20 to 50%, and a degree of elongation of 85 to 150%, more preferably a monofilament fineness of 1.5 to 5.0 dtex, a total fineness of 30 to 90 dtex, a boiling water shrinkage rate of 20 to 40%, and a degree of elongation of 90 to 150%. In the case in which the monofilament fineness of highly-oriented undrawn polyester yarn B is smaller than 1.0 dtex, protrusions made of polyester fiber A of the entangled combined-filament yarn of the resulting water-repellent woven or knitted fabric may not be maintained strongly enough and tend to collapse, the thread is too thin, and the texture of the resulting woven or knitted fabric is poor in anti-drape and stiffness. In the case in which the monofilament fineness is greater than 10.0 dtex, entanglement is poor, and the texture of the woven or knitted fabric is hard because of lack of an appropriate level of fluffiness, whereby such a monofilament fineness is unpreferable.

[0067] In the case in which the total fineness of highly-oriented undrawn polyester yarn B is not smaller than 30 dtex, protrusions and an air-holding layer tend to be maintained. In the case in which the total fineness is not greater than 200 dtex, a woven or knitted fabric excellent in lightweight properties may be obtained.

[0068] In the case in which the boiling water shrinkage rate of highly-oriented undrawn polyester yarn B is not lower than 20%, stretchability and SMD fall within the ranges described above after the hot-water shrinkage treatment step described below, and a woven or knitted fabric remarkably excellent in water repellency may be obtained. In addition, the water-repellent woven or knitted fabric has excellent anti-drape and stiffness and the texture thereof is not too hard. Therefore, such a boiling water shrinkage rate is preferable. The boiling water shrinkage rate of highly-oriented undrawn polyester yarn B refers to a skein dimensional change rate. This skein dimensional change rate is measured by "skein dimensional change rate (Method A)" specified in JIS L1013 8.18.1 under conditions including immersion in hot water at 100°C for 30 minutes.

[0069] In the case in which the degree of elongation of highly-oriented undrawn polyester yarn B is lower than 80%, many yarn breakages may occur in the drawing step described below. In the case in which the degree of elongation is higher than 150%, the degree of elongation of the entangled combined-filament yarn is too high and therefore such a degree of elongation is unpreferable from the viewpoint of attaining consistent quality.

[0070] Next, the heat-shrinkable entangled combined-filament yarn preparation step is described in detail referring to a schematic view of Fig. 2. First, each of packages YA and YB containing highly-oriented undrawn polyester yarns A and B are set on a creel. Then, highly-oriented undrawn polyester yarn B is fed to first feeding roller 1. Then, highly-oriented undrawn polyester yarn B is drawn between first feeding roller 1 and first take-up roller 3 with heat applied thereto with heater 2. This step is the drawing step.

[0071] In the drawing step, the draw ratio needs to be set at 1.3 to 1.7, preferably about 1.35 to about 1.7, more preferably about 1.4 to about 1.7. By this setting, the degree of elongation of highly-oriented undrawn polyester yarn A and the degree of elongation of drawn polyester yarn B become substantially the same. The draw ratio in the drawing step refers to the ratio of the surface speed of first take-up roller 3 to the surface speed of first feeding roller 1 (draw ratio = (surface speed of first take-up roller 3)/(surface speed of first feeding roller 1)). Drawing highly-oriented undrawn polyester yarn B allows fine adjustments to attain a more preferable monofilament fineness and also allows fine adjustments to attain a more preferable combination proportion between highly-oriented undrawn polyester yarn A and drawn polyester yarn B. Drawing highly-oriented undrawn polyester yarn B is carried out while heat is being applied thereto with a heater or the like. By this heating process with a heater, drawn yarn B with stable physical properties is obtained.

[0072] In the case in which the draw ratio of highly-oriented undrawn polyester yarn B is lower than 1.3, the degree of elongation of the entire entangled combined-filament yarn is high and due to the tension naturally applied during post-weaving or post-knitting processing (for example, a series of processing including dyeing processing), physical properties of the entangled combined-filament yarn tend to vary, potentially leading to troubles in terms of grade and quality of the resulting woven or knitted fabric. In the case in which the draw ratio factor is higher than 1.7, many yarn breakages tend to occur.

[0073] Instead of the drawing step to be carried out, drawn polyester yarn B having a monofilament fineness of 0.6 to 4.8 dtex, a total fineness of 18 to 96 dtex, a degree of elongation of 15 to 60%, and a boiling water shrinkage rate of not lower than 20% may be prepared in a form of a commercially available product or the like and this drawn polyester yarn B may be subjected to the combining-and-entangling step. It is preferable that this drawn polyester yarn B thus prepared have a monofilament fineness of 0.8 to 3.8 dtex, a total fineness of 26 to 76 dtex, a degree of elongation of 16 to 40%, and a boiling water shrinkage rate of 20 to 45%.

[0074] Then, the false-twisting step involving false-twisting highly-oriented undrawn polyester yarn A under predetermined conditions is carried out. More specifically, highly-oriented undrawn polyester yarn A is false-twisted under conditions of a processing speed of 100 to 700 m/minute and a draw ratio of 1.1 to 1.6. More specifically, as shown in Fig. 2, highly-oriented undrawn polyester yarn A is fed to second feeding roller 4, then to heater 5, and then to false-twisting apparatus 6 and then pulled through second take-up roller 7. Thus, false-twisted polyester yarn A is obtained. The area between second feeding roller 4 and second take-up roller 7 in Fig. 2 forms a complex false-twisting area. More specifically, the area between second feeding roller 4 and false-twisting apparatus 6 forms twisting area T1 and the area between false-twisting apparatus 6 and second take-up roller 7 forms loosening area T2.

[0075] The processing speed in the false-twisting step refers to the speed of thread pulled through second take-up roller 7, more specifically, the surface speed of second take-up roller 7.

[0076] Typically, the mode of false-twisting is broadly classified into a spindle mode and a friction mode. Either mode may be adopted in the present invention. Typically, false-twisting apparatus 6 of spindle mode is a pin-type one and that of friction mode is a disc-type one.

[0077] In the false-twisting step, the processing speed needs to be 100 to 700 m/minute, where preferable conditions of false-twisting for the spindle mode are slightly different from those for the friction mode. For example, the processing speed is preferably about 100 to about 200 m/minute for the spindle mode and preferably about 200 to about 700 m/minute for the friction mode. The temperature of the heater is preferably about 150 to about 200°C for the spindle mode, and for the friction mode, the temperature is preferably about 170 to about 200°C in the case in which a contact heater is used and preferably about 200 to about 300°C in the case in which a point-contact heater is used. In the case in which the temperature of the heater is lower than the above range, either mode described above tends not to attain a sufficient level of crimping. In the case in which the temperature of the heater is higher than the above range, either mode described above tends to cause fusion between fibers and whereby it is difficult to sufficiently open fibers, making it difficult to combine these fibers in a later process.

[0078] The mechanism of twisting and loosening for the spindle mode is slightly different from that for the friction mode.

[0079] In the spindle mode, rotation of a spindle causes rotation of pin-type false-twisting apparatus 6, causing twisting of threads. The degree of twisting, more specifically the false-twisting coefficient, during this process is preferably 20000 to 34000, more preferably 22000 to 30000. The false-twisting coefficient is calculated by the following expression: $K = T \times D^{1/2}$. In the expression, K represents the false-twisting coefficient, T represents the number of false-twisting (T/M), and D represents the total fineness of complex false-twisted yarn (dtex). The number of false-twisting is calculated as follows: $T = (\text{spindle rotational speed (rpm)}) / (\text{surface speed of second take-up roller 7 (m/minute)})$. In the case in which the false-twisting coefficient is lower than 20000, the level of crimping is poor and false-twisted yarn A tends not to have a sufficient level of crimps. As a result, fine protrusions described above tend not to be formed on a surface portion of the entangled combined-filament yarn contained in the water-repellent woven or knitted fabric of the present invention. In the case in which the false-twisting coefficient is higher than 34000, crimps are too dense in shape and whereby an air-holding layer as described above tends not to be formed on a surface portion of the entangled combined-filament yarn.

[0080] In the friction mode, the degree of twisting is typically regulated by adjustment of a K value and the number of discs, instead of adjustment of the false-twisting coefficient. This difference is attributed to the difference in the mechanism of twisting and loosening between the two modes. The K value represents the ratio ($F2/F1$) of loosening tension ($F2$) to twisting tension ($F1$). $F2$ represents thread tension measured right after passage through a disc, and $F1$ represents thread tension immediately before feeding to a disc. In the friction mode, disc rotation causes twisting. Therefore, the degree of twisting is determined by the disc speed and the number of discs. Direct control of a disc speed is not regarded as a very efficient technique in terms of process control. From the viewpoint that a K value changes as a disc speed changes, controlling a K value is typically regarded as an efficient technique.

[0081] Typically in the friction mode, a disc used is a polyurethane disc. The number of discs is typically and preferably 5 to 7, and the thickness of a disc is preferably 5 to 10 mm. The K value is preferably 0.6 to 1.2. In the case in which the K value is lower than 0.6, the number of yarn breakages increases and the resulting false-twisted yarn may have a great level of fuzz. In the case in which the K value is higher than 1.2, surging tends to occur. Surging refers to a state of twisting that is once formed and then remains unloosened in a loosening area.

[0082] In the false-twisting step, the draw ratio needs to be 1.1 to 1.6, preferably about 1.1 to about 1.55, more preferably about 1.15 to about 1.5. The draw ratio in the false-twisting step refers to the ratio of the surface speed of second take-up roller 7 to the surface speed of second feeding roller 4 (draw ratio) = (surface speed of second take-up roller 7)/(surface speed of second feeding roller 4)). In the case in which the draw ratio is lower than 1.1, consistent quality of false-twisted polyester yarn A is difficult to be ensured. In the case in which the draw ratio is higher than 1.6, many occasions of fuzz formation and yarn breakage occur in the false-twisting step and therefore such a draw ratio is unpreferable.

[0083] After the false-twisting step is carried out, false-twisted polyester yarn A together with drawn polyester yarn B is fed to fluid nozzle 8 and subjected to the combining-and-entangling step under conditions of an air pressure of 0.1 to 1.0 Mpa applied with fluid nozzle 8 and a difference in the overfeeding rate between drawn polyester yarn B and false-twisted polyester yarn A of 0 to 10.0%. Thus, a heat-shrinkable entangled combined-filament yarn is obtained. The length of false-twisted polyester yarn A of the heat-shrinkable entangled combined-filament yarn is preferably about 10% or less greater, more preferably about 4 to about 8% greater than the length of drawn polyester yarn B. In the case in which false-twisted polyester yarn A is more than 10% longer than drawn polyester yarn B, the bulkiness of the heat-shrinkable entangled combined-filament yarn is high and therefore protrusions formed on the surface of the water-repellent woven or knitted fabric of the present invention is excessively large, leading to a decrease in water repellency. Such a case is unpreferable.

[0084] The fluid nozzle used in the combining-and-entangling step is not particularly limited and is typically and pref-

erably a Taslan nozzle or an interlacing nozzle. In this procedure, the overfeeding rate is preferably 1 to 5% in the case in which a constant-speed filament combining method is adopted where the feeding speed is constant (difference in the overfeeding rate is 0%). In the case in which the so-called core/sheath filament combining method is adopted where the feeding speed changes, preferable conditions include a difference in the overfeeding rate between false-twisted polyester yarn A and drawn polyester yarn B of 1 to 7%, an overfeeding rate of drawn polyester yarn B (core) of 0.5 to 3.0%, and an overfeeding rate of false-twisted polyester yarn A (sheath) of 4.0 to 9.5%. The overfeeding rate is calculated by the following expression: (overfeeding rate) = $(V1 - V2)/V2 \times 100 (\%)$, where the thread speed immediately before feeding to the fluid nozzle is represented as V1 and the thread speed right after the passage through the fluid nozzle is represented as V2. In the case of Fig. 2, calculation is carried out by the following expression: (overfeeding rate) = $((\text{surface speed of first take-up roller 3}) - (\text{surface speed of third take-up roller 9})) / (\text{surface speed of third take-up roller 9}) \times 100 (\%)$ or (overfeeding rate) = $((\text{surface speed of second take-up roller 7}) - (\text{surface speed of third take-up roller 9})) / (\text{surface speed of third take-up roller 9}) \times 100 (\%)$. In the case in which filament combining and entanglement is carried out under such conditions, an air-holding layer as described above having protrusions made of polyester fiber A is formed. In the case in which the conditions of filament combining and entanglement do not satisfy the above range, protrusions of an appropriate size made of polyester fiber A of the water-repellent woven or knitted fabric of the present invention are not formed and an air-holding layer as described above tends not to be formed on a surface portion of the entangled combined-filament yarn.

[0085] The heat-shrinkable entangled combined-filament yarn passes through third take-up roller 9 and is then wound around winding roller 10 into package 11. As a guide, when the number of entanglements of the entangled combined-filament yarn contained in the water-repellent woven or knitted fabric of the present invention is within the range from about 90 to about 300/m, it may be regarded that an appropriate level of filament combining and entanglement is attained.

[0086] It is typically the case that the thicker a fiber is, the more rigid the fiber is; and the thinner a fiber is, the more flexible the fiber is. The present invention uses such finer properties and deposits relatively thin false-twisted polyester yarn A in a big space formed between relatively thick drawn polyester yarns B in the false-twisting step and the combining-and-entangling step. Thus, the resulting woven or knitted fabric may have polyester fiber A protrude on a surface portion of the entangled combined-filament yarn.

(Grey woven or knitted fabric production step)

[0087] In the grey woven or knitted fabric production step, a grey woven or knitted fabric is obtained by weaving or knitting with the heat-shrinkable entangled combined-filament yarn described above. The weaving or knitting needs to be carried out with a known loom or knitting machine. The preparation step carried out prior to the weaving or knitting also needs to be carried out with a known equipment.

(Hot-water shrinkage treatment step)

[0088] In the hot-water shrinkage treatment step, the grey woven or knitted fabric is immersed in hot water for a predetermined period of time to make drawn polyester yarn B sufficiently heat-shrunk and thus a low-stretchable woven or knitted fabric is obtained. The hot-water shrinkage treatment may be carried out at about 80 to about 135°C for about 10 to about 30 minutes, for example. By using drawn polyester yarn B made of highly-oriented drawn polyester yarn B with a specific range of a boiling-water shrinkage rate and carrying out the hot-water shrinkage treatment, drawn polyester yarn B may be sufficiently heat-shrunk, protrusions may be sufficiently maintained, and whereby a woven or knitted fabric with a reduced level of stretchability may be obtained. The hot-water shrinkage treatment step may be carried out during refining processing and dyeing processing. More specifically, the hot-water shrinkage treatment step may be carried out under conditions of about 80 to about 120°C for about 10 to about 30 minutes as refining treatment and/or about 100 to about 135°C for about 10 to about 30 minutes as dyeing treatment, more preferably under conditions of about 80 to about 100°C for about 10 to about 30 minutes as refining treatment and/or about 120 to about 135°C for about 10 to about 30 minutes as dyeing treatment. Refining and dyeing may be carried out at once.

[0089] An example is shown below. First, the grey woven or knitted fabric is refined. The refining needs to be carried out at a temperature of 80 to 130°C either in a continuous mode or a batch mode. Typically, the refining is preferably carried out at not higher than 100°C in a batch mode, particularly preferably with a high-pressure fluid dyeing machine equipped with a jet nozzle. After the refining, presetting may be carried out as needed. Typically in the presetting, a pin tenter is used and hot-air treatment is carried out at 170°C to 200°C for 30 to 120 seconds. Subsequently, dyeing processing is carried out according to a conventional procedure. In the case in which a cation-dyeable polyester is used as a constituent material, a cation dye needs to be used in the dyeing processing. Final setting may be carried out as needed.

[0090] In the production method of the present invention, the thickness of the water-repellent woven or knitted fabric is preferably 1.01 to 2.00 times greater, more preferably 1.20 to 1.80 times greater than the thickness of the grey woven

or knitted fabric (obtained in the grey woven or knitted fabric production step). In the case in which this value is not smaller than 1.01 times, it means that polyester fiber B is sufficiently heat-shrunk, protrusions made of polyester fiber A of the entangled combined-filament yarn are sufficiently maintained, and the woven or knitted fabric has an excellent water repellency and excellent anti-drape and stiffness. In the case in which this value is not greater than 2.00 times,

[0091] The resulting low-stretchable woven or knitted fabric is subjected to the water-repellent treatment step described below and whereby the water-repellent woven or knitted fabric of the present invention is obtained. Therefore, the low-stretchable woven or knitted fabric may be used as a water-repellent woven or knitted fabric intermediate.

(Water-repellent treatment step)

[0092] In the water-repellent treatment step, the low-stretchable woven or knitted fabric is subjected to water repellent treatment. For example, an aqueous solution containing a water repellent agent needs to be prepared first and then the resulting aqueous solution needs to be applied to the low-stretchable woven or knitted fabric by a method such as a padding method, a spraying method, a kiss-roll coating method, or a slit coating method, followed by hot-air treatment at 105 to 190°C for 30 to 150 seconds. The aqueous solution may additionally contain a crosslinking agent, a softening agent, an antistatic agent, and/or the like, as needed. The water-repellent woven or knitted fabric of the present invention obtained after this water repellent treatment may be subjected to calender processing, for example.

((Moisture-permeable waterproof layer)-(fiber fabric) overlaying step)

[0093] In the case in which the water-repellent woven or knitted fabric of the present invention is overlaid with a moisture-permeable waterproof layer, the moisture-permeable waterproof layer needs to be deposited by a known technique. In the case in which the moisture-permeable waterproof layer is overlaid with a fiber fabric, the fiber fabric needs to be deposited by a known technique.

[Other processing]

[0094] In the case in which the water-repellent woven or knitted fabric of the present invention is subjected to antimicrobial processing, dyeing processing, water-repelling processing and water-absorbing-lining processing, UV-cut processing, thermal storage processing, bacteriostatic processing, antimicrobial deodorant processing, odor control processing, anti-adherent processing, mosquito-repelling processing, calender processing, and/or print processing, any of these processings needs to be carried out before or after the water-repellent treatment step or before or after the moisture-permeable waterproof layer overlaying step.

Examples

[0095] Next, the present invention is described more specifically referring to examples. The scope of the present invention is not limited to these examples.

[Measurement method and evaluation method]

[0096] In examples and comparative examples, the methods described below were used to measure and/or evaluate the following items: 1. the thickness of water-repellent woven or knitted fabric or of grey woven or knitted fabric, 2. the monofilament fineness and the total fineness of each of highly-oriented undrawn yarn, drawn yarn, and entangled combined-filament yarn, 3. the mass per unit area, 4. the degree of elongation of each of highly-oriented undrawn yarn and highly-oriented drawn yarn, 5. the number of entanglements of entangled combined-filament yarn, 6. the mean deviation (SMD) of surface roughness of woven or knitted fabric, 7. the water repellency (water-droplet-moving angle) of woven or knitted fabric, 8. the boiling water shrinkage rate, 9. the elongation percentage of water-repellent woven or knitted fabric, and 10. the texture (sensory evaluation).

1. Thickness of water-repellent woven or knitted fabric or of grey woven or knitted fabric

[0097] A water-repellent woven or knitted fabric or a grey woven or knitted fabric obtained was cut with a utility knife. Then, a cross section of the fabric was examined with an optical microscope ("Microscope VHX-900" manufactured by Keyence Corporation) under a magnification of 100 times for thickness measurement.

2. Monofilament fineness and total fineness of each of highly-oriented undrawn yarn, drawn yarn, and entangled combined-filament yarn

[0098] The monofilament fineness and the total fineness of a highly-oriented undrawn yarn and an entangled combined-filament yarn were measured as specified by JIS L1013 8.3.1. The specific measurement method is as follows.

[0099] A sample was wound into a small skein using a sizing reel with a frame circumference length of 1.125 m or a rewinder with equivalent performance under a load of $2.94 \text{ mN} \times (\text{numerical value in tex})$ at a speed of 120 times/minute. The mass of the resulting small skein having a yarn length of 900 m was measured for determining the apparent fineness thereof. The resulting apparent fineness was used together with an equilibrium moisture regain that had been separately measured, and thus a fineness (tex) based on corrected mass was calculated by an expression described below. The average value of five such measurements was rounded off to one decimal digit. To obtain the value of fineness in dtex, the fineness in tex needs to be divided by 10 (1 tex = 10 dtex).

[Expression 1]

$$F_o = D' \times \frac{100 + R_o}{100 + R_e}$$

Wherein

F_o : fineness (tex) based on corrected mass

D' : apparent fineness (tex)

R_o : official regain (%) specified in JIS L0105 4.1 (official regain)

R_e : equilibrium moisture regain (%)

R_o (official regain) in the expression was 0.4%, which is an official regain of a polyester-based synthetic fiber.

[0100] The value R_e (equilibrium moisture regain) in the expression was obtained by taking about 5 g from a sample at the moisture equilibrium, measuring the mass and the absolute dry mass, calculating the equilibrium moisture regain (%) by an expression described below, and rounding off the average value of two such measurements to one decimal digit. The moisture equilibrium refers to the following state: when the mass was measured in a test room in a standard state (the standard state refers to a temperature of $20 \pm 2^\circ\text{C}$ and a relative humidity of $65 \pm 4\%$) at an interval of 1 hour or longer, the difference between the mass measured before a certain interval and the mass measured after the certain interval reached 0.1% or smaller the mass measured after the certain interval.

[Expression 2]

$$R_e = \frac{m - m'}{m'} \times 100$$

Wherein

R_e : equilibrium moisture regain (%)

m : mass (g) of sample when it was taken

m' : absolute dry mass (g) of sample

3. Mass per unit area

[0101] The mass per unit area was measured according to JIS L1096:2010 8.3.2. The specific measurement method is as follows.

[0102] Two specimens each of about $200 \text{ mm} \times \text{about } 200 \text{ mm}$ were taken from a sample. The mass (g) of each specimen was measured in a standard state and the mass per 1 m^2 (g/m^2) was determined. The average value was calculated and rounded off to one decimal digit.

4. Degree of elongation of each of highly-oriented undrawn yarn and drawn yarn

[0103] The degree of elongation of a highly-oriented undrawn yarn was measured according to JIS L1013 8.5.1. The specific measurement method is as follows.

[0104] A tensile tester with constant speed strain control (autograph "AGS-5KNG" manufactured by Shimadzu Corporation) was used and set at a sample length of 200 mm, to which an initial load ($8.82 \text{ mN} \times (\text{numerical value in tex})$) was applied. A sample was attached to a grip of the tensile tester and then pulled at a strain speed of 200 mm/min. The elongation was calculated by the following mathematical expression. The average value of ten such measurements was calculated.

$$\text{Elongation (\%)} = (\text{elongation at maximum tenacity (mm)}) / (\text{sample length (mm)}) \times 100$$

5. Number of entanglements of entangled combined-filament yarn

[0105] A water-repellent woven or knitted fabric obtained was loosened to obtain an entangled combined-filament yarn, which was used as a sample. The number of entanglements (entanglements/m) of the entangled combined-filament yarn was measured according to a hook method specified in JIS L1013 8.15. The specific measurement method is as follows. The number of entanglements is also expressed as the entangled degree sometimes.

[0106] One end of the sample was attached to an upper grip of a hanger apparatus that had suitable performance. A weight ($2.94 \text{ mN} \times (\text{numerical value in tex})$) was attached and hung from the position about 70 cm below the grip so that the sample was hung in a vertical direction. The positions about 2 cm and about 52 cm below the grip were marked.

[0107] After removal of the load, a hook (a needle-shaped hook with a diameter of 0.5 mm to 1.0 mm with a smooth finish on the side surface) was inserted into the sample at the marked position 2 cm below the grip so that the bundle of yarns was divided downward into two portions. The length L (unit, mm) that the hook moved beyond the marked position 52 cm below the grip before the hook stopped due to an entanglement in the yarns was measured, and the resultant value was converted by the following expression into the number of entanglements per 1 m. The average value of 50 such measurements was calculated.

$$\text{Number of entanglements} = 1000/L$$

6. Mean deviation (SMD) of surface roughness of woven or knitted fabric

[0108] An automated surface tester ("KESFB4-AUTO-A" manufactured by Kato tech Co., Ltd.) was used to measure SMD. A 20-cm-square specimen was obtained and applied with a tension of 400 g. The resulting specimen was set on the tester. A vertical load of 50 g including the weight of a metal friction block was applied thereto, and the friction block was brought into contact with the specimen with a force of 10 g attributed to the contact pressure exerted by a spring. The specimen was then moved back and forth for a distance of 30 mm, during which the fluctuation in the surface roughness of the specimen was measured. The measurement was repeated three times in each of the two directions, namely the WARP direction and the WEFT direction, and the average value was defined as SMD. SMD indicates the fluctuation in the surface roughness in a way that the greater the SMD value is, the more irregularities the protrusions have formed.

7. Water repellency (water-droplet-moving angle) of woven or knitted fabric

[0109] A water-droplet-moving angle was an angle at which a water droplet started to move after the water droplet in a volume of 0.02 mL was gently placed on a flat sample (woven or knitted fabric) fixed onto a flat plate and then the flat plate was gently tilted.

8. Boiling water shrinkage rate

[0110] Measurement was carried out according to "skein dimensional change rate (Method A)" specified in JIS L1013 8.18.1. The specific measurement method is as follows.

[0111] A sizing reel with a frame circumference length of 1.125 m or a beaming machine with equivalent performance

was used, and an initial load of $2.94 \text{ mN} \times (\text{numerical value in tex})$ was applied to a sample. The sample was wound 20 times to form a small skein, to which a load 40 times heavier the initial load was applied, followed by measurement of the length of the skein. After removal of the load, the skein was immersed in hot water at 100°C for 30 minutes and then taken out of the hot water, followed by removal of moisture off the skein with a piece of blotting paper or cloth. The resulting skein was air dried while maintained in a horizontal state. Then, a load 40 times heavier the initial load was applied thereto again, followed by measurement of the length of the skein. The following expression was used to calculate the hot-water dimensional change rate (%), and the average value of five such measurements was rounded off to one decimal digit, which was defined as boiling water shrinkage rate.

[Expression 3]

$$\Delta L = \frac{L_1 - L_2}{L_1} \times 100$$

Wherein

ΔL : hot-water dimensional change rate (%)

L_1 : length before treatment (mm)

L_2 : length after treatment (mm)

9. Elongation percentage of water-repellent woven or knitted fabric

[0112] The elongation percentage of a water-repellent woven or knitted fabric was measured according to JIS L 1096:2010. The specific measurement method is as follows.

[0113] Three specimens in a longitudinal direction each measuring about $60 \text{ mm} \times \text{about } 300 \text{ mm}$ were obtained. From each end in the width direction of each specimen, substantially the same number of yarns were removed to make the width of the specimen 50 mm . A tensile tester was used. One end of the specimen was immobilized with an upper clamp, and the other end of the specimen was applied with an initial load (N) (integer) equivalent to the amount of gravity that the specimen received for its entire width and a length of 1 m . Then, the specimen was marked at 200-mm intervals. The initial load was removed, and a load of 14.7 N was gently applied. After 1 minute, the distance (mm) between marks was measured, followed by measurement of elongation percentage (%) by the following expression. The average value of three such measurements was calculated and rounded off to one decimal digit.

$$E_p = \frac{L_1 - L_0}{L_0} \times 100$$

Wherein

E_p : elongation percentage (%)

L_0 : initial length between marks (200 mm)

L_1 : length between marks after 1-minute application of load of 14.7 N (mm)

10. Texture (sensory evaluation)

[0114] The feel of a water-repellent woven or knitted fabric obtained was evaluated based on the following criteria.

○: excellent in anti-drape and stiffness

△: normal in anti-drape and stiffness

×: too soft and poor in anti-drape and stiffness, or too hard

[Production of water-repellent woven or knitted fabric]

(Example 1)

[0115] Highly-oriented undrawn polyester yarn A with a degree of elongation of 104% , a monofilament fineness of 0.54 dtex , a boiling water shrinkage rate of 19.3% , a total fineness of 45 dtex , and a filament count of 84 was prepared.

Separately, highly-oriented undrawn polyester yarn B with a degree of elongation of 118%, a monofilament fineness of 4.7 dtex, a total fineness of 56 dtex, a filament count of 12, and a boiling water shrinkage rate of 22.3% was prepared. The resulting highly-oriented undrawn polyester yarns A and B were subjected to a step involving producing a heat-shrinkable entangled combined-filament yarn shown in Fig. 2. False-twisting apparatus 5 used was a disc-type one. The conditions of complex false-twisting as well as filament combining and entangling were as follows. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 26.6% was obtained.

<Conditions of drawing>

[0116] Surface speed of first feeding roller 1: 284 m/minute
Temperature of heater 2 (non-contact heater): 245°C
Draw ratio of highly-oriented undrawn polyester yarn B: 1.6
Surface speed of first take-up roller 3: 455 m/minute

<Conditions of false-twisting>

[0117] Surface speed of second feeding roller 4: 367 m/minute
Temperature of heater 5 (contact heater): 160°C
Twisting direction: Z direction
Structure of false-twisting apparatus 6 (disc): 1-6-1
Thickness of false-twisting apparatus 6 (disc): 9 mm
K value: 1.0
Surface speed of second take-up roller 7: 477 m/minute
Draw ratio during false-twisting: 1.3

<Conditions of filament combining and entangling>

[0118] Surface speed of third take-up roller 9: 450 m/minute
Fluid nozzle 8: Taslan nozzle
Air pressure: 0.735 MPa
Overfeeding rate of false-twisted polyester yarn A: 6%
Overfeeding rate of drawn polyester yarn B: 1%

[0119] Then, the resulting heat-shrinkable entangled combined-filament yarn obtained above in an untwisted state was set as a warp and a weft to a water jet loom (manufactured by Tsudakoma Corporation), and a plain-weave grey fabric with a warp density of 156 counts/2.54 cm and a weft density of 114 counts/2.54 cm was woven.

[0120] The resulting grey woven fabric was refined with a BOIL OFF refiner (manufactured by Fukushin Kogyo Co., Ltd.) at 80°C. A dye liquid having a composition of the following formulation 1 was prepared, and the resulting dye liquid was used to dye the woven fabric at 135°C for 30 minutes. Then, a Shrink Surfer dryer (manufactured by Hirano Tecseed Co., Ltd.) was used to carry out drying at 140°C.

<Formulation 1>

[0121] Dye: 2% omf of disperse dye "Dianix Blue UN-SE (trade name)" manufactured by Dystar Japan Ltd.
Dispersant: 0.5 g/L of "Nicca Sunsolt SN-250E (trade name)" manufactured by Nicca Chemical Co., Ltd.

Acetic acid (98%) 0.1 mL/L

[0122] An aqueous solution having a composition of the following formulation 2 was prepared, which was applied to the woven fabric with a padding processor at a squeezing rate of 80%, followed by hot-air treatment at 120°C for 120 seconds. Final setting was carried out at 180°C for 30 seconds, and thus a water-repellent woven or knitted fabric (with a warp density of 197 counts/2.54 cm, a weft density of 144 counts/2.54 cm, and a cover factor (CF) of 2720) was obtained.

<Formulation 2>

[0123] Fluorine-based water repellent: 50 g/L of "NK Guard S-07 (trade name) (the Rf group contained six carbon atoms) with 20 mass% solid content" manufactured by Nicca Chemical Co., Ltd.
Crosslinking agent: 3 g/L of melamine resin "Beckamine M-3 (trade name)" manufactured by DIC Corporation

Catalyst: 3 g/L of "Catalyst ACX (trade name) with 35 mass% solid content" manufactured by DIC Corporation

(Example 2)

[0124] A mesh-type knitted fabric was made with a circular-knitting machine (model LPJ-H, 33 inches, 32 gauge) manufactured by Precision Fukuhara Works, Ltd. using the heat-shrinkable entangled combined-filament yarn obtained above in an untwisted state for the front side of the knitted fabric and a 56-dtex false-twisted processed polyester yarn with a filament count of 24 in an untwisted state for the back side of the knitted fabric. The resulting knitted fabric having a density of 45 courses/2.54 cm and 34 wales/2.54 cm was then treated in the same manner as in Example 1, more specifically subjected to refining, dyeing processing, and water repellent treatment. Thus, a water-repellent woven or knitted fabric of Example 2 (with a density of 78 courses/2.54 cm and 55 wales/2.54 cm) was obtained. The resulting water-repellent woven or knitted fabric had a combination proportion of the entangled combined-filament yarn of 39 mass%.

(Example 3)

[0125] A water-repellent woven or knitted fabric (with a warp density of 197 counts/2.54 cm, a weft density of 144 counts/2.54 cm, and a cover factor (CF) of 2720) was obtained under the conditions same as those in Example 1 except that water repellent treatment was carried out using an aqueous solution having a composition of the following formulation 3 instead of the aqueous solution having a composition of formulation 2.

<Formulation 3>

[0126] Hydrocarbon-based water repellent agent (non-fluorine water repellent): 100 g/L of "Neoseed NR-7080 (trade name) with 30 mass% solid content" manufactured by Nicca Chemical Co., Ltd.
Crosslinking agent: 7 g/L of melamine resin "Beckamine M-3 (trade name)" manufactured by DIC Corporation
Catalyst: 5 g/L of "Catalyst ACX (trade name) with 35 mass% solid content" manufactured by DIC Corporation

(Example 4)

[0127] A water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 140 counts/2.54 cm and a weft density of 103 counts/2.54 cm using the heat-shrinkable entangled combined-filament yarn obtained in Example 1 in an untwisted state as a warp and a weft. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric (with a warp density of 177 counts/2.54 cm, a weft density of 130 counts/2.54 cm, and a cover factor (CF) of 2449) was obtained.

(Example 5)

[0128] A step involving producing an entangled combined-filament yarn was carried out in the same manner as in Example 1 except that highly-oriented undrawn polyester yarn A with a degree of elongation of 105%, a monofilament fineness of 0.60 dtex, a boiling water shrinkage rate of 17.3%, a total fineness of 90 dtex, and a filament count of 150 was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 27.5% was obtained.

[0129] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 108 counts/2.54 cm and a weft density of 90 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric (with a warp density of 135 counts/2.54 cm, a weft density of 112 counts/2.54 cm, and a cover factor (CF) of 2470) was obtained.

(Example 6)

[0130] Highly-oriented undrawn polyester yarn A with a degree of elongation of 104%, a monofilament fineness of 0.54 dtex, a boiling water shrinkage rate of 19.3%, a total fineness of 45 dtex, and a filament count of 84 was prepared. Separately, highly-oriented drawn polyester yarn B with a degree of elongation of 29.9%, a monofilament fineness of 2.8 dtex, a total fineness of 66 dtex, a filament count of 24, and a boiling water shrinkage rate of 26.0% was prepared. The resulting highly-oriented undrawn polyester yarn A and highly-oriented drawn polyester yarn B were subjected to a step involving producing a heat-shrinkable entangled combined-filament yarn shown in Fig. 2 under the conditions

same as those in Example 1 except that none of first feeding roller 1, heater 2, or first take-up roller 3 was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 27.8% was obtained.

[0131] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 111 counts/2.54 cm and a weft density of 90 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric (with a warp density of 138 counts/2.54 cm, a weft density of 113 counts/2.54 cm, and a cover factor (CF) of 2452) was obtained.

(Example 7)

[0132] Highly-oriented undrawn polyester yarn A with a degree of elongation of 104%, a monofilament fineness of 0.54 dtex, a boiling water shrinkage rate of 19.3%, a total fineness of 45 dtex, and a filament count of 84 was prepared. Separately, highly-oriented drawn polyester yarn B with a degree of elongation of 25.9%, a monofilament fineness of 1.8 dtex, a total fineness of 33 dtex, a filament count of 18, and a boiling water shrinkage rate of 16.0% was prepared. The resulting highly-oriented undrawn polyester yarn A and highly-oriented drawn polyester yarn B were subjected to a step involving producing a heat-shrinkable entangled combined-filament yarn shown in Fig. 2 under the conditions same as those in Example 1 except that none of first feeding roller 1, heater 2, or first take-up roller 3 was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 24.3% was obtained. When highly-oriented undrawn polyester yarn A was false-twisted, the boiling water shrinkage rate thereof was 14.2%.

[0133] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 156 counts/2.54 cm and a weft density of 114 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric of Example 7 (with a warp density of 184 counts/2.54 cm, a weft density of 137 counts/2.54 cm, and a cover factor (CF) of 2561) was obtained.

(Example 8)

[0134] A step involving producing an entangled combined-filament yarn was carried out in the same manner as in Example 1 except that highly-oriented undrawn polyester yarn A with a degree of elongation of 116%, a monofilament fineness of 0.85 dtex, a boiling water shrinkage rate of 18.5%, a total fineness of 119 dtex, and a filament count of 144 was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 29.1% was obtained.

[0135] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 90 counts/2.54 cm and a weft density of 71 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric of Example 8 (with a warp density of 111 counts/2.54 cm, a weft density of 79 counts/2.54 cm, and a cover factor (CF) of 2105) was obtained.

(Example 9)

[0136] Highly-oriented undrawn polyester yarn A with a degree of elongation of 104%, a monofilament fineness of 0.54 dtex, a boiling water shrinkage rate of 19.3%, a total fineness of 45 dtex, and a filament count of 84 was prepared. Separately, drawn polyester yarn B with a degree of elongation of 27.8%, a monofilament fineness of 2.8 dtex, a total fineness of 33 dtex, a filament count of 12, and a boiling water shrinkage rate of 23.0% was prepared. The resulting highly-oriented undrawn polyester yarn A and highly-oriented drawn polyester yarn B were subjected to a step involving producing a heat-shrinkable entangled combined-filament yarn under the conditions same as those in Example 1 except that none of first feeding roller 1, heater 2, or first take-up roller 3 was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 20.5% was obtained.

[0137] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 156 counts/2.54 cm and a weft density of 114 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric of Example 9 (with a warp density of 197 counts/2.54 cm, a weft density of 144 counts/2.54 cm, and a cover factor (CF) of 2720) was obtained.

(Comparative Example 1)

[0138] A plain-weave grey fabric with a warp density of 141 counts/2.54 cm and a weft density of 112 counts/2.54 cm was woven using a 72-dtex false-twisted processed polyester yarn with a filament count of 150 in an untwisted state for a warp and a weft. Subsequently, dyeing processing and water repellent treatment were carried out in the same manner as in Example 1, and a woven fabric (with a warp density of 144 counts/2.54 cm, a weft density of 119 counts/2.54 cm, and a cover factor (CF) of 2290) was obtained.

(Comparative Example 2)

[0139] A circular-knitting machine (model LPJ-H, 33 inches, 28 gauge) manufactured by Precision Fukuhara Works, Ltd. was used to knit a mesh-type knitted fabric with a density of 38 courses/2.54 cm and 32 wales/2.54 cm using a 84-dtex false-twisted processed polyester yarn with a filament count of 72 in an untwisted state for the front side of the knitted fabric and a 84-dtex 36-f false-twisted processed polyester yarn in an untwisted state for the back side of the knitted fabric. Subsequently, dyeing processing and water repellent treatment were carried out in the same manner as in Example 1, and a knitted fabric (with a density of 54 courses/2.54 cm and 39 wales/2.54 cm) was obtained.

(Comparative Example 3)

[0140] A water repellent woven fabric of Comparative Example 3 was produced according to the description of Example 2 of Patent Document 1 (JP 2015-98661 A). The specific procedure is as follows. 336-f highly-oriented undrawn polyester yarn a (with a boiling water shrinkage rate of 19.5%) with a degree of elongation of 92%, a monofilament fineness of 0.54 dtex, and a total fineness of 180 dtex was prepared. Separately, 48-f highly-oriented undrawn polyester yarn b (with a boiling water shrinkage rate of 19.7%) with a degree of elongation 147%, a monofilament fineness of 2.7 dtex, and a total fineness of 130 dtex composed of a highly-oriented undrawn fiber was prepared. The 48-f highly-oriented undrawn polyester fiber had a fiber cross section in which the core portion and the sheath portion formed concentric circles with a mass ratio (core/sheath) of 75/25, contained titanium oxide as a sunlight blocker in an amount of 5 mass% in the core portion, 0.3 parts by mass in the sheath portion, and 3.825 mass% in the whole fiber. The resulting oriented undrawn polyester yarn a and highly-oriented undrawn polyester yarn b were subjected to complex false-twisting and filament combining and entanglement using a disc-type false-twisting apparatus. Thus, an entangled combined-filament yarn with a degree of elongation of 25.4% was obtained. More specifically, the entangled combined-filament yarn was obtained without false-twisting oriented undrawn polyester yarn a in an uncombined state and without using an oriented undrawn polyester yarn with a certain boiling water shrinkage rate.

[0141] The resulting entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a twill-weave grey fabric with a warp density of 78 counts/2.54 cm and a weft density of 50 counts/2.54 cm. The resulting grey woven fabric was refined with a BOIL OFF refiner (manufactured by Fukushin Kogyo Co., Ltd.) at 95°C and then relaxed with a continuous relaxer (manufactured by Wakayama Iron Works Ltd.). The resulting woven fabric was dried at 130°C, followed by presetting at 190°C for 30 seconds.

[0142] A dye liquid having a composition of formulation 1 was prepared, and the resulting dye liquid was used to dye the woven fabric at 130°C for 40 minutes. Then, a Shrink Surfer dryer (manufactured by Hirano Tecseed Co., Ltd.) was used to carry out drying at 130°C.

[0143] An aqueous solution having a composition of formulation 2 was prepared, which was applied to the woven fabric with a padding processor at a squeezing rate of 80%, followed by hot-air treatment at 120°C for 120 seconds. Final setting was carried out at 180°C for 30 seconds, followed by calender processing at 160°C. The resulting woven fabric had a warp density of 83 counts/2.54 cm, a weft density of 56 counts/2.54 cm, and a cover factor (CF) of 2176.

(Comparative Example 4)

[0144] Highly-oriented undrawn polyester yarn A with a degree of elongation of 104%, a monofilament fineness of 0.54 dtex, a total fineness of 45 dtex, and a filament count of 84 was prepared. Separately, highly-oriented undrawn polyester yarn B with a degree of elongation of 131%, a monofilament fineness of 3.3 dtex, a total fineness of 40 dtex, a filament count of 12, and a boiling water shrinkage rate of 5.1% was prepared. The resulting highly-oriented undrawn polyester yarns A and B were subjected to a step involving producing an entangled combined-filament yarn under the conditions same as those in Example 1, and an entangled combined-filament yarn with a degree of elongation of 28.8% was obtained.

[0145] The resulting entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp

density of 145 counts/2.54 cm and a weft density of 115 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric (with a warp density of 165 counts/2.54 cm, a weft density of 120 counts/2.54 cm, and a cover factor (CF) of 2157) was obtained.

(Comparative Example 5)

[0146] A step involving producing a heat-shrinkable entangled combined-filament yarn was carried out under the conditions same as those in Example 1 except that 300-f highly-oriented undrawn polyester yarn A with a degree of elongation of 92%, a monofilament fineness of 0.54 dtex, and a total fineness of 180 dtex was prepared. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 27.4% was obtained.

[0147] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 70 counts/2.54 cm and a weft density of 52 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, a water-repellent woven or knitted fabric of Comparative Example 5 (with a warp density of 81 counts/2.54 cm, a weft density of 60 counts/2.54 cm, and a cover factor (CF) of 1804) was obtained.

(Comparative Example 6)

[0148] A step involving producing an entangled combined-filament yarn was carried out in the same manner as in Example 1 except that drawn polyester yarn B with a degree of elongation of 28.7%, a monofilament fineness of 3.48 dtex, a total fineness of 167 dtex, a filament count of 48, and a boiling water shrinkage rate of 22.0% was used and none of first feeding roller 1, heater 2, or first take-up roller 3 was used in a step involving producing a heat-shrinkable entangled combined-filament yarn. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 27.7% was obtained.

[0149] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 67 counts/2.54 cm and a weft density of 50 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric of Comparative Example 6 (with a warp density of 83 counts/2.54 cm, a weft density of 65 counts/2.54 cm, and a cover factor (CF) of 2020) was obtained.

(Comparative Example 7)

[0150] A woven fabric was prepared under the conditions same as those in Comparative Example 1 except that a step involving applying an aqueous solution having a composition of formulation 2 to a woven fabric was not carried out and no water repellent treatment was carried out.

(Comparative Example 8)

[0151] A step involving producing a heat-shrinkable entangled combined-filament yarn was carried out under the conditions same as those in Example 1 except that highly-oriented undrawn polyester yarn A with a degree of elongation of 131%, a monofilament fineness of 3.3 dtex, a total fineness of 40 dtex, a filament count of 12, and a boiling water shrinkage rate of 5.1% was used. Thus, a heat-shrinkable entangled combined-filament yarn with a degree of elongation of 26.5% was obtained.

[0152] The resulting heat-shrinkable entangled combined-filament yarn was used in an untwisted state for a warp and a weft and a water jet loom (manufactured by Tsudakoma Corporation) was used to weave a plain-weave grey fabric with a warp density of 145 counts/2.54 cm and a weft density of 115 counts/2.54 cm. Subsequently, refining, dyeing, and water repellent treatment were carried out under the conditions same as those in Example 1, and a water-repellent woven or knitted fabric (with a warp density of 180 counts/2.54 cm, a weft density of 143 counts/2.54 cm, and a cover factor (CF) of 2483) was obtained.

(Comparative Example 9)

[0153] A water-repellent woven or knitted fabric (with a warp density of 197 counts/2.54 cm, a weft density of 144 counts/2.54 cm, and a cover factor (CF) of 2720) was obtained under the conditions same as those in Example 1 except that a step involving applying an aqueous solution having a composition of formulation 2 to a woven fabric was not

carried out and no water repellent treatment was carried out.

[Test results]

5 **[0154]** The structure and the results of evaluation of the water-repellent woven or knitted fabrics of examples and comparative examples are shown in Tables 1 and 2.

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[Table 1]

	Monofilament fineness (dtex)		Total fineness (dtex)			Boiling water shrinkage rate (%) of undrawn yarn B or draw yarn B	Massratio (A/B)	Number of entanglements (entanglements/m)
	Fiber A	Fiber B	Fiber A	Fiber B	Entangled combined-filament yarn			
Example 1	0.41	2.9	35	35	70	22.3 (Undrawn yarn)	51.2/48.8	251
Example 2	0.41	2.9	35	35	70	22.3 (Undrawn yarn)	51.2/48.8	251
Example 3	0.41	2.9	35	35	70	22.3 (Undrawn yarn)	51.2/48.8	251
Example 4	0.41	2.9	35	35	70	22.3 (Undrawn yarn)	51.2/48.8	251
Example 5	0.5	2.9	75	69	144	22.3 (Undrawn yarn)	67.5/32.5	240
Example 6	0.41	2.9	35	70	105	26.0 (Undrawn yarn)	35.8/64.2	235
Example 7	0.41	1.9	35	34	69	16.0 (Undrawn yarn)	52.7/47.3	250
Example 8	0.68	2.9	98	35	133	22.3 (Undrawn yarn)	73.8/26.2	226
Example 9	0.41	2.9	35	35	70	24.5 (Drawn yarn)	52.7/47.3	248
Comparative Example 1	0.48	-	72	-	-	-	-	69
Comparative Example 2	1.17	-	84	-	-	-	-	60
Comparative Example 3	0.45	1.84	158	87	245	19.7 (Undrawn yarn)	63.4/36.6	115
Comparative Example 4	0.41	2.3	37	27	64	5.1 (Undrawn yarn)	58.4/41.6	245
Comparative Example 5	0.5	2.9	150	35	185	22.3 (Undrawn yarn)	81.5/18.5	220
Comparative Example 6	0.41	3.7	35	177	212	22 (Drawn yarn)	17.9/82.1	219
Comparative Example 7	0.48	-	72	-	-	-	-	69
Comparative Example 8	2.8	2.9	33	35	68	22.3 (Undrawn yarn)	44.7/55.3	245

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(continued)

	Monofilament fineness (dtex)		Total fineness (dtex)			Boiling water shrinkage rate (%) of undrawn yarn B or draw yarn B	Mass ratio (A/B)	Number of entanglements (entanglements/m)
	Fiber A	Fiber B	Fiber A	Fiber B	Entangled combined-filament yarn			
Comparative Example 9	0.41	2.9	35	35	70	22 (Undrawn yarn)	51.2/48.8	251

[Table 2]

	SMD	CF of woven fabric	(Course density)/(wale density)	Water-droplet-moving angle	Elongation percentage of woven or knitted fabric	Thickness of grey woven or knitted fabric	Thickness of woven or knitted fabric	Thickness of water-repellent woven or knitted fabric relative to thickness of grey woven or knitted fabric	Mass per unit area	Texture
	(μm)		(per 2.54 cm)						(g/m^2)	
Example 1	1.908	2720	-	13.3	1.7	150	250	1.67	130	○
Example 2	2.923	-	78/55	8.6	102	550	700	1.27	133	○
Example 3	1.957	2720	-	15.5	1.7	150	250	1.67	130	○
Example 4	2.036	2449	-	21.1	1.8	140	225	1.61	115	○
Example 5	2.249	2470	-	19.5	1.9	210	270	1.29	140	○
Example 6	1.763	2452	-	26.8	1.1	200	300	1.50	159	○
Example 7	1.842	2561	-	20.8	2.1	190	230	1.21	125	○
Example 8	2.369	2105	-	35.4	1.7	250	350	1.40	109	○
Example 9	2.017	2720	-	12.7	1.7	150	250	1.67	147	○
Comparative Example 1	1.947	2289	-	44.3	3.2	150	150	1.00	85	×
Comparative Example 2	2.564	-	54/39	17.8	125.6	750	650	0.87	131	×
Comparative Example 3	6.364	2176	-	45.7	4	170	170	1.00	134	×
Comparative Example 4	1.538	2157	-	36.2	2.7	140	140	1.00	84	×
Comparative Example 5	4.134	1804	-	32.1	2	270	290	1.07	167	×
Comparative Example 6	3.697	2020	-	51.2	0.9	280	380	1.36	98	×
Comparative Example 7	2.671	2290	-	-	3.1	150	150	1.00	85	×

(continued)

	SMD	CF of woven fabric	(Course density)/(wale density)	Water-droplet-moving angle	Elongation percentage of woven or knitted fabric	Thickness of grey woven or knitted fabric	Thickness of woven or knitted fabric	Thickness of water-repellent woven or knitted fabric relative to thickness of grey woven or knitted fabric	Mass per unit area	Texture
	(μm)		(per 2.54 cm)	(degrees)	(%)	(μm)	(μm)	(times)	(g/m ²)	
Comparative Example 8	2.968	2483	-	63.7	1.6	145	240	1.66	144	×
Comparative Example 9	1.884	2720	-	34.6	1.7	150	240	1.60	129	○

[0155] In each of the water-repellent woven or knitted fabrics of Examples 1 to 9, the constituent entangled combined-filament yarn formed continuous protrusions made of loops, slacks and the like of polyester fiber A and inside the protrusions (inside the entangled combined-filament yarn), an air-holding layer made of gently-entangled thin polyester fiber A was formed. As shown in Tables 1 and 2, in each of Examples 1 to 9, a water-repellent woven or knitted fabric that was excellent in lightweight properties, sufficient in anti-drape and stiffness, and remarkably excellent in water repellency attributed to the lotus effect was obtained.

[0156] In each of Comparative Examples 1 and 3, the resulting water-repellent woven or knitted fabric contained no entangled combined-filament yarn containing a thread with a high level of hot-water shrinkage and therefore had a high elongation percentage, and because of this high elongation percentage, the water-repellent woven or knitted fabric had insufficient anti-drape and stiffness and a poor water repellency attributed to the lotus effect. In Comparative Example 2, no entangled combined-filament yarn containing a thread with a high level of hot-water shrinkage was contained and polyester fiber A had a great monofilament fineness. Therefore, the knitted fabric of Comparative Example 2 was inferior to the knitted fabric of Example 2 in terms of water repellency as well as anti-drape and stiffness.

[0157] In Comparative Example 4, polyester fiber B had a total fineness smaller than 30 dtex and had insufficient anti-drape and stiffness. In Comparative Example 5, polyester fiber A had a total fineness greater than 100 dtex and a low combination proportion of polyester fiber B, whereby the fluffiness was high but the anti-drape and stiffness were poor. In Comparative Example 6, polyester fiber B had a total fineness greater than 100 dtex and the combination proportion of polyester fiber A was low, whereby the anti-drape and stiffness were too high, the texture was too hard, the fabric surface was slightly raised but the level of raise was small, and the water repellency or the extent of water droplet movement was poor. In Comparative Example 7, the resulting knitted fabric was a knitted fabric the same as that in Comparative Example 1 except for water repellent treatment, whereby the anti-drape and stiffness were insufficient and the water repellency was remarkably poor. In Comparative Example 8, polyester fiber A had a monofilament fineness greater than 0.9 dtex, a high level of fluffiness, poor anti-drape and stiffness, and an insufficient water repellency. In Comparative Example 9, in which no water repellent treatment was carried out, water repellency was poor compared to Example 1. The woven or knitted fabric of Comparative Example 9, when subjected to water repellent treatment, may acquire an excellent water repellency.

[0158] Fig. 3 is a photograph taken with an optical microscope (magnification: 100 times), of a section extending in a thickness direction of the woven or knitted fabric obtained in Comparative Example 1. Because the entangled combined-filament yarn of this woven or knitted fabric did not contain a polyester fiber sufficiently hot-water shrunk, and therefore, as indicated by Fig. 3, this woven or knitted fabric is flat, protrusions made of polyester fiber A are not formed, and the amount of space between constituent fibers is great.

DESCRIPTION OF REFERENCE SIGNS

[0159]

YA: Highly-oriented undrawn polyester yarn A package
 YB: Highly-oriented undrawn polyester yarn B package
 A: Highly-oriented undrawn polyester yarn A
 B: Highly-oriented undrawn polyester yarn B
 1: First feeding roller
 2: Heater
 3: First take-up roller
 4: Second feeding roller
 5: Heater
 6: False-twisting apparatus
 7: Second take-up roller
 8: Fluid nozzle
 9: Third take-up roller
 10: Winding roller
 11: Package
 T1: Twisting area
 T2: Loosening area

Claims

1. A water-repellent woven or knitted fabric containing an entangled combined-filament yarn and having a water re-

pellent agent adhering to a surface of the water-repellent woven or knitted fabric,
the entangled combined-filament yarn comprising polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex
and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a
total fineness of 30 to 100 dtex,

the entangled combined-filament yarn having a ratio (A/B) of the monofilament fineness of polyester fiber A to the
monofilament fineness of polyester fiber B within a range from 1/20 to 1/4,

the entangled combined-filament yarn having a mass ratio (A/B) of polyester fiber A to polyester fiber B within a
range from 20/80 to 80/20,

the entangled combined-filament yarn having protrusions made of polyester fiber A on a surface portion,

the water-repellent woven or knitted fabric having an elongation percentage measured with a constant load method
with a load of 14.7 N according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent
woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-
repellent woven or knitted fabric is a water-repellent knitted fabric.

2. The water-repellent woven or knitted fabric according to claim 1, wherein the number of entanglements formed by
the entangled combined-filament yarn is within a range from 90/m to 300/m,
wherein the number of entanglements is measured by a hook method specified in JIS L1013 8.15.

3. The water-repellent woven or knitted fabric according to claim 1 or 2, wherein the water-repellent woven or knitted
fabric has a mass per unit area of not higher than 200 g/m².

4. The water-repellent woven or knitted fabric according to any one of claims 1 to 3, wherein the water-repellent woven
or knitted fabric has a cover factor (CF) within a range from 1500 to 3000 and a water-droplet-moving angle not
greater than 40 degrees, wherein the water-droplet-moving angle is an angle at which a water droplet starts to move
after the water droplet in a volume of 0.02 mL was gently placed on a flat sample of the woven or knitted fabric fixed
onto a flat plate and then the flat plate was gently tilted, and
wherein the cover factor (CF) is calculated by the following expression, in which D represents the total fineness of
the warp and E represents the total fineness of the weft $CF = D^{1/2} \times (\text{warp density (warps/2.54 cm)}) + E^{1/2} \times (\text{weft density (wefts/2.54 cm)})$.

5. A method of producing the water-repellent woven or knitted fabric as claimed in any one of claims 1 to 4, the method
comprising:

a step involving preparing a heat-shrinkable entangled combined-filament yarn with a degree of elongation of
18 to 50%, wherein the degree of elongation is determined by a tensile test carried out with a tensile tester with
constant speed strain control according to JIS L1013 8.5.1 under conditions of a sample length of 200 mm and
a strain speed of 200 mm/min;

a step involving obtaining a grey woven or knitted fabric by weaving or knitting with the heat-shrinkable entangled
combined-filament yarn;

a step involving subjecting the grey woven or knitted fabric to hot-water shrinkage treatment to obtain a low-
stretchable woven or knitted fabric; and

a step involving subjecting the low-stretchable woven or knitted fabric to water repellent treatment to obtain a
water-repellent woven or knitted fabric,

wherein the step involving preparing a heat-shrinkable entangled combined-filament yarn comprises:

(1) a drawing step involving drawing highly-oriented undrawn polyester yarn B having a monofilament
fineness of 1.0 to 10.0 dtex, a total fineness of 30 to 200 dtex, a degree of elongation of 80 to 150%, and
a boiling water shrinkage rate of not lower than 20% with a draw ratio of 1.3 to 1.7 to obtain drawn polyester
yarn B; or

a step involving preparing drawn polyester yarn B having a monofilament fineness of 0.6 to 4.8 dtex, a total
fineness of 18 to 96 dtex, a degree of elongation of 15 to 60%, and a boiling water shrinkage rate of not
lower than 20%;

(2) a false-twisting step involving false-twisting highly-oriented undrawn polyester yarn A having a mono-
filament fineness of 0.20 to 1.44 dtex, a total fineness of 30 to 160 dtex, and a degree of elongation of 80
to 150% under conditions of a processing speed of 100 to 700 m/minute and a draw ratio of 1.1 to 1.6 to
obtain false-twisted polyester yarn A; and

(3) a combining-and-entangling step involving conducting combined-filament entanglement of false-twisted
polyester yarn A and drawn polyester yarn B with the use of a fluid nozzle under conditions of an air pressure

of 0.1 to 1.0 Mpa and the difference in an overfeeding rate between drawn polyester yarn B and false-twisted polyester yarn A of 0 to 10.0%.

6. The method of producing a water-repellent woven or knitted fabric according to claim 5, wherein a thickness of the water-repellent woven or knitted fabric is 1.01 to 2.00 times a thickness of the grey woven or knitted fabric.
7. A water-repellent woven or knitted fabric intermediate, the water-repellent woven or knitted fabric intermediate consisting of a low-stretchable woven or knitted fabric containing an entangled combined-filament yarn, the entangled combined-filament yarn being composed of polyester fiber A with a monofilament fineness of 0.2 to 0.9 dtex and a total fineness of 30 to 100 dtex and polyester fiber B with a monofilament fineness of 1.0 to 5.0 dtex and a total fineness of 30 to 100 dtex, the entangled combined-filament yarn having a ratio (A/B) of the monofilament fineness of polyester fiber A to the monofilament fineness of polyester fiber B within a range from 1/20 to 1/4, the entangled combined-filament yarn having a mass ratio (A/B) of polyester fiber A to polyester fiber B within a range from 20/80 to 80/20, the entangled combined-filament yarn having protrusions made of polyester fiber A on a surface portion, the water-repellent woven or knitted fabric intermediate having an elongation percentage measured with a constant load method with a load of 14.7 N according to JIS L 1096:2010 of not higher than 3% in the case in which the water-repellent woven or knitted fabric is a water-repellent woven fabric or not higher than 120% in the case in which the water-repellent woven or knitted fabric is a water-repellent knitted fabric.

Patentansprüche

1. Wasserabweisendes Gewebe oder Gewirke, das ein verflochtenes Kombinationsfilamentgarn enthält und ein wasserabweisendes Mittel aufweist, das an einer Oberfläche des wasserabweisenden Gewebes oder Gewirkes haftet, wobei das verflochtene Kombinationsfilamentgarn Polyesterfaser A mit einer Monofilamentfeinheit von 0,2 bis 0,9 dtex und einer Gesamtfeinheit von 30 bis 100 dtex und Polyesterfaser B mit einer Monofilamentfeinheit von 1,0 bis 5,0 dtex und einer Gesamtfeinheit von 30 bis 100 dtex umfasst, wobei das verflochtene Kombinationsfilamentgarn ein Verhältnis (A/B) der Monofilamentfeinheit der Polyesterfaser A zur Monofilamentfeinheit der Polyesterfaser B in einem Bereich von 1/20 bis 1/4 aufweist, wobei das verflochtene Kombinationsfilamentgarn ein Massenverhältnis (A/B) von Polyesterfaser A zu Polyesterfaser B in einem Bereich von 20/80 bis 80/20 aufweist, wobei das verflochtene Kombinationsfilamentgarn Erhebungen aus Polyesterfaser A auf einem Oberflächenabschnitt aufweist, wobei das wasserabweisende Gewebe oder Gewirke einen Dehnungsprozentsatz, der mit einem Konstantbelastungsverfahren mit einer Belastung von 14,7 N gemäß JIS L 1096:2010 gemessen ist, von nicht höher als 3% in dem Fall, in dem das wasserabweisende Gewebe oder Gewirke ein wasserabweisendes Gewebe ist, oder von nicht höher als 120% in dem Fall, in dem das wasserabweisende Gewebe oder Gewirke ein wasserabweisendes Gewirke ist, aufweist.
2. Wasserabweisendes Gewebe oder Gewirke nach Anspruch 1, wobei die Anzahl der durch das verflochtene Kombinationsfilamentgarn gebildeten Verflechtungen in einem Bereich von 90/m bis 300/m liegt, wobei die Anzahl der Verflechtungen durch ein in JIS L1013 8.15 spezifiziertes Hakenverfahren gemessen ist.
3. Wasserabweisendes Gewebe oder Gewirke nach Anspruch 1 oder 2, wobei das wasserabweisende Gewebe oder Gewirke eine Masse pro Flächeneinheit von nicht mehr als 200 g/m² aufweist.
4. Wasserabweisendes Gewebe oder Gewirke nach einem der Ansprüche 1 bis 3, wobei das wasserabweisende Gewebe oder Gewirke einen Deckfaktor (CF) in einem Bereich von 1500 bis 3000 und einen Wassertropfenbewegungswinkel von nicht größer als 40 Grad aufweist, wobei der Wassertropfenbewegungswinkel ein Winkel ist, bei dem sich ein Wassertropfen zu bewegen beginnt, nachdem der Wassertropfen in einem Volumen von 0,02 mL sanft auf eine flache Probe des auf einer flachen Platte befestigten Gewebes oder Gewirkes aufgetragen wurde, und dann die flache Platte sanft geneigt wurde, und wobei der Deckfaktor (CF) durch den folgenden Ausdruck berechnet wird, in welchem D die Gesamtfeinheit der Kette und E die Gesamtfeinheit des Schusses darstellt $CF = D^{1/2} \times (\text{Kettendichte (Ketten/2.54 cm)}) + E^{1/2} \times (\text{Schussdichte (Schüsse/2.54 cm)})$.

5. Verfahren zur Herstellung des wasserabweisenden Gewebes oder Gewirkes nach einem der Ansprüche 1 bis 4, das Verfahren umfassend:

einen Schritt, der das Herstellen eines wärmeschrumpfbaren, verflochtenen Kombinationsfilamentgarns mit einem Dehnungsgrad von 18 bis 50% beinhaltet, wobei der Dehnungsgrad durch einen Zugversuch bestimmt ist, der mit einem Zugprüfgerät mit konstanter Geschwindigkeits-Dehnungsregelung gemäß JIS L1013 8.5.1 unter Bedingungen einer Probenlänge von 200 mm und einer Dehnungsgeschwindigkeit von 200 mm/min durchgeführt wird;

einen Schritt, der das Erhalten eines Rohgewebes oder Rohgewirkes durch Weben oder Stricken mit dem wärmeschrumpfbaren, verflochtenen Kombinationsfilamentgarn beinhaltet;

einen Schritt, der das Unterwerfen des Rohgewebes oder Rohgewirkes einer Heißwasserschrumpfbehandlung beinhaltet, um ein wenig dehnbares Gewebe oder Gewirke zu erhalten; und

einen Schritt, der das Unterwerfen des wenig dehnbaren Gewebes oder Gewirkes einer wasserabweisenden Behandlung beinhaltet, um ein wasserabweisendes Gewebe oder Gewirke zu erhalten,

wobei der Schritt, der das Herstellen eines wärmeschrumpfbaren, verflochtenen Kombinationsfilamentgarns beinhaltet, umfasst:

(1) einen Streckschritt, der das Strecken von hochorientiertem, ungestrecktem Polyestergarn B mit einer Monofilamentfeinheit von 1,0 bis 10,0 dtex, einer Gesamteinheit von 30 bis 200 dtex, einem Dehnungsgrad von 80 bis 150% und einer Siedewasserschrumpfrate von nicht weniger als 20% mit einem Streckverhältnis von 1,3 bis 1,7 zum Erhalten von gestrecktem Polyestergarn B beinhaltet; oder

einen Schritt, der das Herstellen von gestrecktem Polyestergarn B mit einer Monofilamentfeinheit von 0,6 bis 4,8 dtex, einer Gesamteinheit von 18 bis 96 dtex, einem Dehnungsgrad von 15 bis 60% und einer Siedewasserschrumpfrate von nicht weniger als 20% beinhaltet;

(2) einen Falschdrehschritt, der das Falschdrehen von hochorientiertem, ungestrecktem Polyestergarn A mit einer Monofilamentfeinheit von 0,20 bis 1,44 dtex, einer Gesamteinheit von 30 bis 160 dtex und einem Dehnungsgrad von 80 bis 150% unter Bedingungen einer Verarbeitungsgeschwindigkeit von 100 bis 700 m/Minute und einem Streckverhältnis von 1,1 bis 1,6 zum Erhalten von falschgedrehtem Polyestergarn A beinhaltet; und

(3) einen Kombinier- und Verflechtungsschritt, der das Durchführen einer Kombinationsfilamentverflechtung von falschgedrehtem Polyestergarn A und gestrecktem Polyestergarn B unter Verwendung einer Fluiddüse unter Bedingungen eines Luftdrucks von 0,1 bis 1,0 MPa und der Differenz in einer Überfütterungsrate zwischen gestrecktem Polyestergarn B und falschgedrehtem Polyestergarn A von 0 bis 10,0% beinhaltet.

6. Verfahren zur Herstellung eines wasserabweisenden Gewebes oder Gewirkes nach Anspruch 5, wobei eine Dicke des wasserabweisenden Gewebes oder Gewirkes das 1,01 bis 2,00-fache einer Dicke des Rohgewebes oder Rohgewirkes beträgt.

7. Wasserabweisendes Gewebe- oder Gewirkezwischenprodukt, wobei das wasserabweisende Gewebe- oder Gewirkezwischenprodukt aus einem wenig dehnbaren Gewebe oder Gewirke besteht, das ein verflochtenes Kombinationsfilamentgarn enthält,

wobei das verflochtene Kombinationsfilamentgarn aus Polyesterfaser A mit einer Monofilamentfeinheit von 0,2 bis 0,9 dtex und einer Gesamteinheit von 30 bis 100 dtex und Polyesterfaser B mit einer Monofilamentfeinheit von 1,0 bis 5,0 dtex und einer Gesamteinheit von 30 bis 100 dtex aufgebaut ist,

wobei das verflochtene Kombinationsfilamentgarn ein Verhältnis (A/B) der Monofilamentfeinheit der Polyesterfaser A zur Monofilamentfeinheit der Polyesterfaser B in einem Bereich von 1/20 bis 1/4 aufweist,

wobei das verflochtene Kombinationsfilamentgarn ein Massenverhältnis (A/B) von Polyesterfaser A zu Polyesterfaser B in einem Bereich von 20/80 bis 80/20 aufweist,

wobei das verflochtene Kombinationsfilamentgarn Erhebungen aus Polyesterfaser A auf einem Oberflächenabschnitt aufweist,

wobei das wasserabweisende Gewebe- oder Gewirkezwischenprodukt einen Dehnungsprozentsatz, der mit einem Konstantbelastungsverfahren mit einer Belastung von 14,7 N gemäß JIS L 1096:2010 gemessen ist, von nicht höher als 3% in dem Fall, in dem das wasserabweisende Gewebe oder Gewirke ein wasserabweisendes Gewebe ist, oder von nicht höher als 120% in dem Fall, in dem das wasserabweisende Gewebe oder Gewirke ein wasserabweisendes Gewirke ist, aufweist.

Revendications

1. Tissu tissé ou tricoté hydrofuge contenant un fil enchevêtré de filaments combinés et ayant un agent hydrofuge adhérent à une surface du tissu tissé ou tricoté hydrofuge,
 le fil enchevêtré de filaments combinés comprenant une fibre de polyester A avec une finesse monofilament de 0,2 à 0,9 dtex et une finesse totale de 30 à 100 dtex et une fibre de polyester B avec une finesse monofilament de 1,0 à 5,0 dtex et une finesse totale de 30 à 100 dtex,
 le fil enchevêtré de filaments combinés ayant un rapport (A/B) de la finesse monofilament de la fibre de polyester A sur la finesse monofilament de la fibre de polyester B au sein d'une plage de 1/20 à 1/4,
 le fil enchevêtré de filaments combinés ayant un rapport massique (A/B) de la fibre de polyester A sur la fibre de polyester B au sein d'une plage de 20/80 à 80/20,
 le fil enchevêtré de filaments combinés ayant des saillies réalisées en fibre de polyester A sur une portion de surface, le tissu tissé ou tricoté hydrofuge ayant un pourcentage d'allongement mesuré avec un procédé de charge constante avec une charge de 14,7 N selon JIS L 1096:2010 de pas plus de 3 % dans le cas dans lequel le tissu tissé ou tricoté hydrofuge est un tissu tissé hydrofuge ou pas plus de 120 % dans le cas dans lequel le tissu tissé ou tricoté hydrofuge est un tissu tricoté hydrofuge.

2. Tissu tissé ou tricoté hydrofuge selon la revendication 1, dans lequel le nombre d'enchevêtrements formés par le fil enchevêtré de filaments combinés est au sein d'une plage de 90/m à 300/m,
 dans lequel le nombre d'enchevêtrements est mesuré par un procédé de crochet spécifié dans JIS L1013 8.15.

3. Tissu tissé ou tricoté hydrofuge selon la revendication 1 ou 2, dans lequel le tissu tissé ou tricoté hydrofuge a une masse par aire unitaire de pas plus de 200 g/m².

4. Tissu tissé ou tricoté hydrofuge selon l'une quelconque des revendications 1 à 3, dans lequel le tissu tissé ou tricoté hydrofuge a un facteur de couverture (CF) au sein d'une plage de 1500 à 3000 et un angle de déplacement de gouttelette d'eau ne dépassant pas 40 degrés, dans lequel l'angle de déplacement de gouttelette d'eau est un angle auquel une gouttelette d'eau commence à se déplacer après que la gouttelette d'eau dans un volume de 0,02 ml a été placée délicatement sur un échantillon plat du tissu tissé ou tricoté fixé sur une plaque plate, puis la plaque plate a été inclinée délicatement, et
 dans lequel le facteur de couverture (CF) est calculé par l'expression suivante, dans laquelle D représente la finesse totale de la chaîne et E représente la finesse totale de la trame $CF = D^{1/2} \times (\text{densité de chaîne (chaînes/2,54 cm)}) + E^{1/2} \times (\text{densité de trame (trames/2,54 cm)})$.

5. Procédé de production du tissu tissé ou tricoté hydrofuge selon l'une quelconque des revendications 1 à 4, le procédé comprenant :

une étape impliquant la préparation d'un fil enchevêtré thermorétractable de filaments combinés avec un degré d'allongement de 18 à 50 %, dans lequel le degré d'allongement est déterminé par un essai de traction effectué avec un testeur de traction avec une commande de contrainte de vitesse constante selon JIS L1013 8.5.1 dans des conditions d'une longueur d'échantillon de 200 mm et d'une vitesse de contrainte de 200 mm/min ;

une étape impliquant l'obtention d'un tissu tissé ou tricoté gris en tissant ou tricotant avec le fil enchevêtré thermorétractable de filaments combinés ;

une étape impliquant la soumission du tissu tissé ou tricoté gris à un traitement de rétrécissement à l'eau chaude pour obtenir un tissu tissé ou tricoté à faible étirement ; et

une étape impliquant la soumission du tissu tissé ou tricoté à faible étirement à un traitement hydrofuge pour obtenir un tissu tissé ou tricoté hydrofuge,

dans lequel l'étape impliquant la préparation d'un fil enchevêtré thermorétractable de filaments combinés comprend :

(1) une étape d'étirement impliquant l'étirement d'un fil de polyester non étiré à haute orientation B ayant une finesse mono filament de 1,0 à 10,0 dtex, une finesse totale de 30 à 200 dtex, un degré d'allongement de 80 à 150 % et un taux de rétrécissement à l'eau bouillante de pas moins de 20 % avec un rapport d'étirement de 1,3 à 1,7 pour obtenir un fil de polyester étiré B ; ou

une étape impliquant la préparation d'un fil de polyester étiré B ayant une finesse monofilament de 0,6 à 4,8 dtex, une finesse totale de 18 à 96 dtex, un degré d'allongement de 15 à 60 % et un taux de rétrécissement à l'eau bouillante de pas moins de 20 % ;

(2) une étape de fausse torsion impliquant la fausse torsion d'un fil de polyester non étiré à haute orientation

A ayant une finesse monofilament de 0,20 à 1,44 dtex, une finesse totale de 30 à 160 dtex et un degré d'allongement de 80 à 150 % dans des conditions d'une vitesse de traitement de 100 à 700 m/minute et d'un rapport d'étirement de 1,1 à 1,6 pour obtenir un fil de polyester à fausse torsion A ; et
 (3) une étape de combinaison et d'enchevêtrement impliquant la réalisation de l'enchevêtrement de filaments combinés du fil de polyester à fausse torsion A et du fil de polyester étiré B avec l'utilisation d'une buse pour fluide dans des conditions d'une pression d'air de 0,1 à 1,0 MPa et de la différence d'un taux de suralimentation entre le fil de polyester étiré B et le fil de polyester à fausse torsion A de 0 à 10,0 %.

6. Procédé de production d'un tissu tissé ou tricoté hydrofuge selon la revendication 5, dans lequel une épaisseur du tissu tissé ou tricoté hydrofuge est de 1,01 à 2,00 fois une épaisseur du tissu tissé ou tricoté gris.
7. Intermédiaire de tissu tissé ou tricoté hydrofuge, l'intermédiaire de tissu tissé ou tricoté hydrofuge étant constitué d'un tissu tissé ou tricoté à faible étirement contenant un fil enchevêtré de filaments combinés, le fil enchevêtré de filaments combinés étant composé d'une fibre de polyester A avec une finesse monofilament de 0,2 à 0,9 dtex et une finesse totale de 30 à 100 dtex et d'une fibre de polyester B avec une finesse monofilament de 1,0 à 5,0 dtex et une finesse totale de 30 à 100 dtex, le fil enchevêtré de filaments combinés ayant un rapport (A/B) de la finesse monofilament de la fibre de polyester A sur la finesse monofilament de la fibre de polyester B au sein d'une plage de 1/20 à 1/4, le fil enchevêtré de filaments combinés ayant un rapport massique (A/B) de la fibre de polyester A sur la fibre de polyester B au sein d'une plage de 20/80 à 80/20, le fil enchevêtré de filaments combinés ayant des saillies réalisées en fibre de polyester A sur une portion de surface, l'intermédiaire de tissu tissé ou tricoté hydrofuge ayant un pourcentage d'allongement mesuré avec un procédé de charge constante avec une charge de 14,7 N selon JIS L 1096:2010 de pas plus de 3 % dans le cas dans lequel le tissu tissé ou tricoté hydrofuge est un tissu tissé hydrofuge ou pas plus de 120 % dans le cas dans lequel le tissu tissé ou tricoté hydrofuge est un tissu tricoté hydrofuge.

FIG. 1

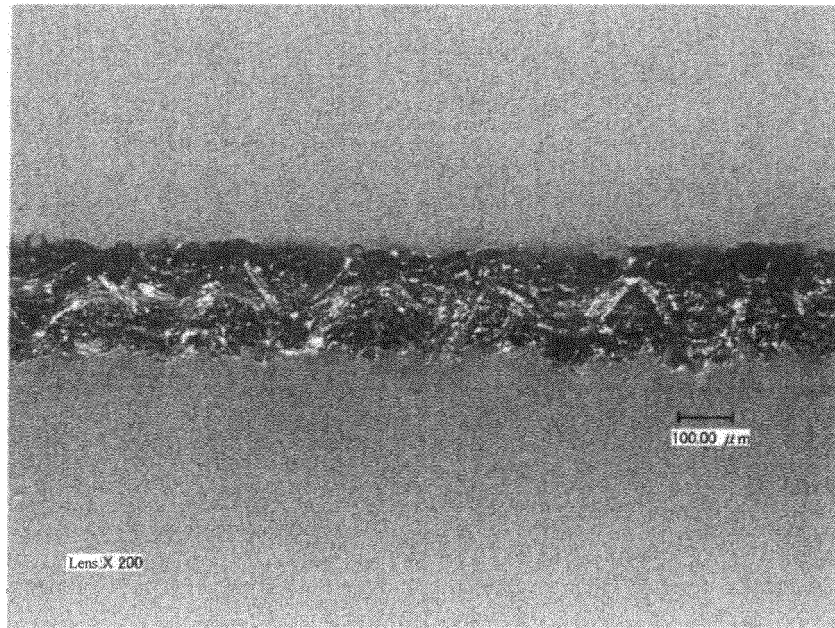


FIG. 2

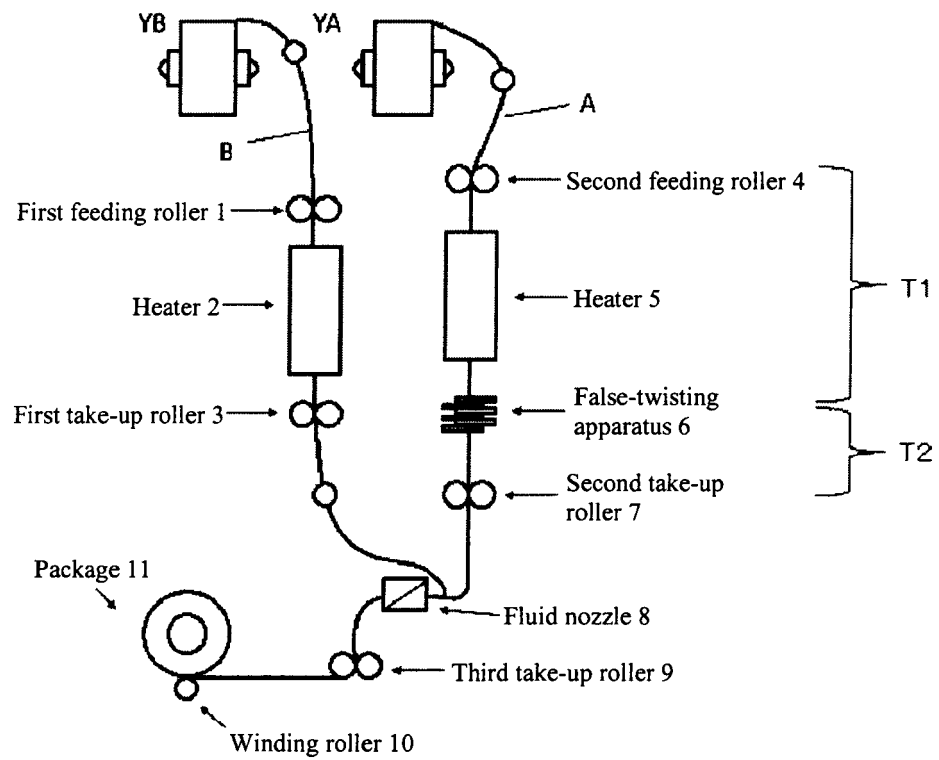
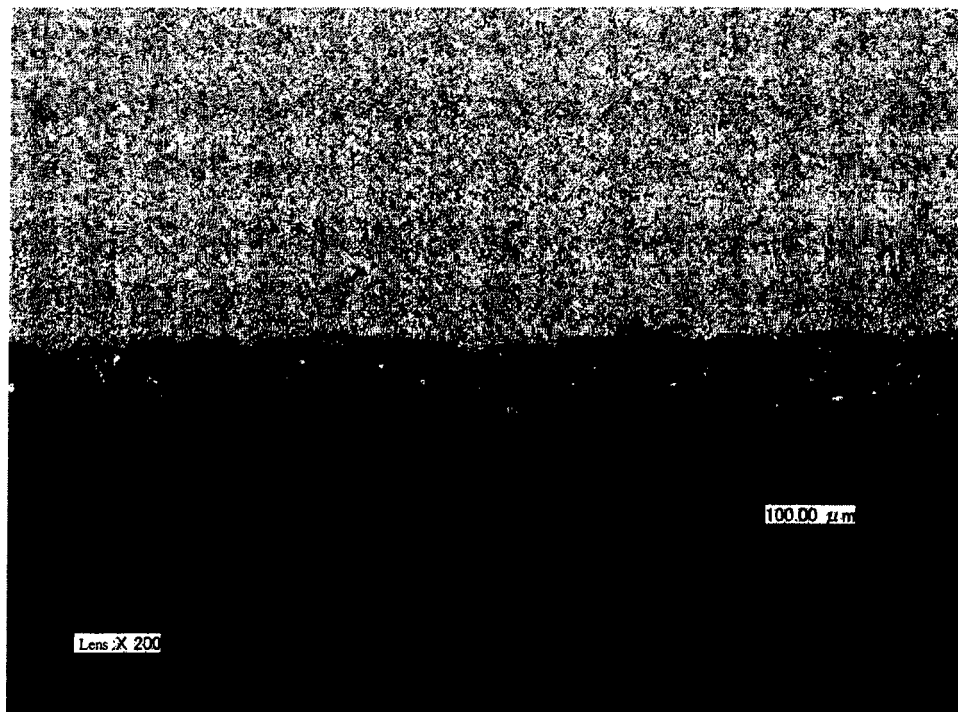


FIG. 3



REFERENCES CITED IN THE DESCRIPTION

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