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(71) Applicant: **Teijin Limited**
Osaka-shi, Osaka 530-0005 (JP)

(72) Inventor: **TAMURA Atsuo**
Osaka-shi Osaka 530-0005 (JP)

(74) Representative: **Carpmaels & Ransford LLP**
One Southampton Row
London WC1B 5HA (GB)

(54) **WOVEN FABRIC AND FIBER PRODUCT**

(57) An object of the present invention is to provide a woven fabric having not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance, and a fiber product formed by using the woven fabric. The solution is a woven fabric including: a composite yarn including a spun yarn that includes a flame-retardant fiber having a limiting oxygen index of 25 or more as measured according to JIS K7201 and a yarn composed of a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric core-in-sheath manner, wherein the weight rate of the yarn composed of the composite fiber included in the composite yarn is from 40 to 60% by weight, and the composite yarn is twisted such that a twist coefficient K thereof is from 270 to 400.

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Description

Technical Field

[0001] The present invention relates to a woven fabric having not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance, and a fiber product formed by using the woven fabric.

Background Art

[0002] Conventionally, in firefighting, electric power, chemical companies, or the like, a flame-retardant cloth is used for work clothes to be worn by people engaged in work involving possible exposure to flame. For the flame-retardant cloth, a flame-retardant fiber is used mainly, with typical examples thereof including a meta-aramid fiber or a para-amide fiber, and it appears to be generally difficult to impart stretchability thereto.

[0003] As the method of imparting stretchability to the cloth formed by using the flame-retardant fiber, a method of using an elastic yarn (for example, refer to PTLs 1 to 3), a method of twisting a flame-retardant fiber and subsequently performing a heat set to untwist the flame-retardant fiber (for example, refer to PTLs 4 to 6), and the like are proposed.

[0004] However, the cloth formed by using an elastic yarn has not only some problems in terms of heat resistance and flame retardance, but also a problem in terms of chemical resistance (especially, a problem that the low chlorine resistance causes rapid lowering of stretchability at the general use or washing).

[0005] On the other hand, the cloth formed by using a flame-retardant fiber, which is subjected to twisting and then a heat set to be untwisted, has some problems that the stretchability becomes lower not only in the weaving step and the post processing step, but also while the cloth is worn, so that sufficient performance and quality of the cloth cannot be exhibited, and the cost is high.

[0006] In terms of solving the problems, proposed is a cloth prepared by weaving with the use of a composite yarn including a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric sheath-core manner and causing heat shrinkage to impart the stretchability thereto, but the cloth is still unsatisfactory in the terms of the anti-pilling properties (for example, referred to PTL 7).

Citation List

Patent Literature

[0007]

PTL 1: JP2003-193314A

PTL 2: JP2006-124865A

PTL 3: JP2007-9378A

PTL 4: JP2001-248027A

PTL 5: JP2005-307429A

PTL 6: JP2008-190103A

PTL 7: JP2014-240532A

Summary of Invention

Technical Problem

[0008] Considering the above background, the present invention is achieved, and the object is to provide a woven fabric having not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance, and a fiber product formed by using the woven fabric.

Solution to Problem

[0009] The present inventor has conducted an intensive research to solve the above problems and has found that, with respect to a cloth including a composite yarn including a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric sheath-core manner, in the case where the weight rate of the composite fiber is too small, it is impossible for the cloth to shrink sufficiently so that the stretchability is not exhibited, and the denseness of the cloth is insufficient and the anti-billing properties are lowered, and has further conducted an intensive research, thereby achieving the present invention. As a result thereof, the following inventive embodiments are provided according to the present invention.

1. A woven fabric including a composite yarn including a spun yarn including a flame-retardant fiber having a limiting oxygen index of 25 or more as measured according to JIS K7201 and a yarn composed of a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric sheath-core manner, wherein the weight rate of the yarn composed of the composite fiber based on the composite yarn is from 40 to 60% by weight, and the composite yarn is twisted such that a twist coefficient K defined by the following expression falls within the range of 270 to 400:

$$\text{Twist Coefficient } K = T \times \sqrt{D}$$

wherein T is a twist number (times/2.54 cm) and D is a total fineness of the composite yarn (dtex).

2. The woven fabric according to the above-described 1, wherein the weight rate of the flame-retardant fiber based on the weight of the woven fabric falls within the range of 65 to 84% by weight and the weight rate of the composite fiber based on the weight of the woven fabric falls within the range of 16 to 35% by weight.

3. The woven fabric according to the above-described 1 or 2, wherein the flame-retardant fiber is at least one selected from the group consisting of a meta-aramid fiber, a para-aramid fiber, a polyparaphenylene benzoxazole fiber, a polybenzimidazole fiber, a polyimide fiber, a polyetherimide fiber, a polyamideimide fiber, a carbon fiber, a polyphenylene sulfide fiber, a polyvinyl chloride fiber, a flame-retardant rayon, a modacrylic fiber, a flame-retardant acrylic fiber, a flame-retardant polyester fiber, a flame-retardant vinylon fiber, a melamine fiber, a fluorine fiber, a flame-retardant wool and a flame-retardant cotton.

4. The woven fabric according to any of the above-described 1 to 3, wherein the yarn composed of the composite fiber is a multifilament having a single fiber fineness of 0.5 to 10.0 dtex and a total fineness of 20 to 200 dtex.

5. The woven fabric according to any of the above-described 1 to 4, wherein at least one component for constituting the composite fiber is derived from recycling or plant.

6. The woven fabric according to any of the above-described 1 to 5, wherein the flame-retardant fiber is a meta-aramid fiber including a flame retardant and the composite fiber includes a flame retardant.

7. The woven fabric according to any of the above-described 1 to 6, wherein the composite yarn is distributed as the weft yarn of the woven fabric and the elongation rate in the weft direction falls within the range of 10 to 50%.

8. The woven fabric according to any of the above-described 1 to 6, wherein the composite yarn is distributed as the weft yarn of the woven fabric and the elongation recovery rate in the weft direction is 70% or more.

9. The woven fabric according to any of the above-described 1 to 8, which has anti-pilling properties of grade 4 or more as measured according to JIS L1076-2012 (Method A, ICI type, for 10 hours).

10. The woven fabric according to any of the above-described 1 to 9, which does not have any irregularities attributable to shrinkage of the composite fiber on a surface thereof.

11. The woven fabric according to any of the above-described 1 to 10, which has a limiting oxygen index of 25 or more as measured according to JIS K7201.

12. A fiber product, which includes the woven fabric according to any of the above-described 1 to 11 and is one selected from the group consisting of firefighting clothing, fire protection clothing, office clothing, racing suits for motor sports, work clothing, gloves, hats, vests, sheets, tents, membrane materials, canopies, construction materials, housing materials, and vehicle interior materials.

Advantageous Effects of Invention

[0010] According to the present invention, a woven fabric having not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance, and a fiber product formed by using the woven fabric can be obtained.

Description of Embodiments

[0011] In the following, the embodiments of the present invention are described in detail. In the present invention, the composite yarn includes a spun yarn and a yarn composed of a composite fiber, and the spun yarn includes a flame-retardant fiber having a limiting oxygen index of 25 or more as measured according to JIS K7201 (hereinafter sometimes referred to as "flame-retardant fiber" simply).

[0012] Examples of the flame-retardant fiber include a meta-aramid fiber (meta-type wholly aromatic polyamide fiber), a para-aramid fiber (para-type wholly aromatic polyamide fiber), a polyparaphenylene benzoxazole fiber, a polybenzimidazole fiber, a polyimide fiber, a polyether imide fiber, a polyamide imide fiber, a carbon fiber, polyphenylene sulfide fiber, a polyvinyl chloride fiber, a flame-retardant rayon, a modacrylic fiber, a flame-retardant acrylic fiber, a flame-retardant polyester fiber, a flame-retardant vinylon fiber, a melamine fiber, a fluorine fiber, a flame-retardant wool, and a flame-retardant cotton. One kind or two or more kinds of these flame-retardant fibers may be used.

[0013] In terms of exhibiting excellent limiting oxygen index and excellent mechanical properties, especially, a meta-aramid finer, namely, a metaphenylene isophthalamide fiber (Examples of the commercially available product include "Conex" (trade name) manufactured by Teijin limited, and "Nomex" (trade name) manufactured by DuPont de Nemours, Inc.) is useful. Further, the para-aramid fiber, namely, a paraphenylene terephthalamide fiber (Examples of the commercially available product include "Twaron" (trade name) manufactured by Teijin Aramid, and "Kevlar" (trade name) manufactured by DuPont-Toray Co., Ltd.), or a coparaphenylene-3,4'-oxydiphenylene terephthalamide fiber (Examples of the commercially available product include "Technora"(trade name) manufactured by Teijin limited.) may be preferably mixed.

[0014] Further, these flame-retardant fibers may include an additive such as an antioxidant, an ultraviolet absorber, a heat stabilizer, a flame retardant, titanium oxide, a colorant, or inert fine particles, as long as the object of the present invention is not impaired.

[0015] Among them, the meta-aramid fiber including a flame retardant is preferred. In this case, examples of the flame retardant include those described in JPH10-251981A, inorganic metals and carriers, and a carrier including a metal, the surface of which a coating is provided on, and the phosphorus flame retardant is preferred in terms of exhibiting excellent flame retardance. The content is preferably from 1 to 15% by weight with respect to the weight of the fiber. Further, as a method of adding the flame retardant, a method of adding the flame retardant into a spinning dope in the step of producing the fiber is preferred.

[0016] With respect to the flame-retardant fiber, the fiber length is preferably in the range of 35 to 110 mm.

[0017] With respect to the spun yarn, the total fineness may be selected appropriately according to the application considering the surface appearance, heat protection property, stretchability, texture, or the like, and the total fineness of the spun yarn is preferably in the range of 58 dtex (which corresponds to a single yarn having an English cotton count of 100) to 580 dtex (which corresponds to an English cotton count of 10).

[0018] Incidentally, the single fiber fineness of the spun yarn is preferably in the range of 0.6 to 5.5 dtex from the viewpoints of a good passableness in the spinning step and the use in the application for clothing to be required for flexibility.

[0019] With respect to the spun yarn, the twist coefficient K is preferably in the range of 190 to 350 in terms of the physical properties and the flexibility of the cloth, provided that the twist coefficient $K = T \times \sqrt{D}$, T is a twist number (times/2.54 cm), and D is a total fineness (dtex) of the spun yarn. Incidentally, the spun yarn may be a single yarn or a two-ply yarn.

[0020] In the present invention, the composite fiber is a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric sheath-core manner. The composite yarn included in the fabric of the present invention includes not only the spun yarn but also such a yarn composed of the composite fiber, and in the heat treatment step to the cloth, the yarn composed of the composite fiber takes on a form of a coil crimped three-dimensionally, whereby stretchability is imparted to the composite fiber, and consequently, stretchability is imparted to the woven fabric as well.

[0021] With respect to the two components which form the composite fiber, examples of the combination include polyester/polyester, or polyester/nylon. More specifically, the combination of polytrimethylene terephthalate/polytrimethylene terephthalate, polytrimethylene terephthalate/polyethylene terephthalate, polyethylene terephthalate/polyethylene terephthalate, or the like, is preferred. In these cases, it is preferred that the two components are different in the intrinsic viscosity from each other. Further, an additive such as an antioxidant, an ultraviolet absorber, a heat stabilizer, a flame retardant, titanium oxide, a colorant, or inert fine particles may be included.

[0022] It is particularly preferred that the composite fiber includes a flame retardant. In this case, as the flame retardant, a phosphorus flame retardant is preferred. Incidentally, as the method of adding the flame retardant, an exhaustion method, a method of adding the flame retardant along with the binder resin, or the like, is preferred.

[0023] With respect to the yarn composed of the composite fiber, the form is not particularly limited, and not only the long fiber (multifilament), but also the short fiber (spun yarn) may be applicable. For exhibiting excellent stretchability, the long fiber (multifilament) is preferred. Furthermore, it is preferred that at least one of the components constituting the composite fiber is derived from recycling or plant. Examples thereof include a polyethylene terephthalate derived from recycling and a

polytrimethylene terephthalate derived from plant.

[0024] With respect to the yarn composed of the composite fiber, the total fineness and the single fiber fineness may be determined appropriately according to the application, and the total fineness is preferably in the range of 20 to 200 dtex and the single fiber fineness is preferably in the range of 0.5 to 10.0 dtex.

[0025] In the present invention, the composite yarn includes the spun yarn and the yarn composed of the composite fiber. In this case, with respect to the weight rate of the yarn composed of the composite fiber included in the composite yarn, it is important that the weight rate of the yarn composed of the composite fiber is in the range of 40 to 60% by weight (more preferably from 45 to 55% by weight) with respect to the weight of the composite yarn, in terms of achieving both flame retardance and stretchability. Incidentally, the composite yarn may include the other fibers.

[0026] With respect to the composite yarn, it is important to be a double-ply twisted yarn. More specifically, it is preferred that twisting is performed by using the spun yarn and the yarn composed of the composite fiber by means of an up-twister, an Italy-style twisting machine, a double twister, or the like, which is commercially available. At this time, it is important that the twist coefficient K is from 270 to 400, provided that the twist coefficient $K = T \times \sqrt{D}$, T is a twist number (times/2.54 cm) and D is a total fineness (dtex) of the composite yarn. In the case where the twist coefficient is smaller than 270, there is a possibility that irregularities appear on the surface of the woven fabric due to the shrinkage of the composite fiber, thereby deteriorating not only the quality of the appearance, but also the anti-pilling properties. On the other hand, in the case where the twist coefficient K is larger than 400, there is a possibility that the heat shrinkage of the composite yarn is inhibited, thereby deteriorating the elongation rate.

[0027] A twist-stopping set may be performed depending on the quality to be required. As the twist stopping set for the composite yarn (double-ply twisted yarn), a vacuum steam set, which is used for setting the ordinary spun yarn, may be used. The temperature for setting the composite double-ply twisted yarn is preferably in the range of 50 to 95°C (more preferably from 50 to 85°C). In the case where the temperature for setting the composite yarn (double-ply twisted yarn) is too high, there is a possibility that the stretchability of the cloth obtained finally is impaired.

[0028] The woven fabric of the present invention is a woven fabric formed by using the composite yarn. In this case, the composite yarn may be distributed in both the warp and weft yarns, however, is distributed preferably in either the warp or the weft yarn (preferably the weft yarn). It is particularly preferred that the entire amount of the composite fiber is distributed in the weft yarn and the spun yarn as described above is distributed in the warp yarn.

[0029] In terms of exhibiting an excellent flame retardance, it is preferred that the weight rate of the flame-retardant fiber based on the weight of the woven fabric is in the range of 60% by weight or more (more preferably from 65% by weight to 84% by weight). In the case where the weight rate of the flame-retardant fiber is less than 60% by weight, there is a possibility that the flame retardance becomes low.

[0030] Further, it is preferred that the weight rate of the composite fiber based on the weight of the woven fabric is in the range of 16% by weight or more (more preferably from 16% by weight to 35% by weight). In the case where the weight rate of the composite fiber based on the weight of the woven fabric is more than 30% by weight, there is a possibility that flames easily spread along the composite fiber to cause burning to easily proceed. In the case where the weight rate of the composite fiber is less than 20% by weight, there is a possibility that not only the stretchability of the woven fabric lowers but also the anti-billing properties deteriorates.

[0031] Examples of the structure of the woven fabric includes a plain structure, a twill structure, and a satin structure, and particularly preferred examples thereof include a plain structure, and 2/1 twill and 2/2 twill structures. In the case where the number of floating is larger, the stretchability is high, however, there is a possibility that the anti-billing properties deteriorate.

[0032] Furthermore, at the time when the woven fabric is subjected to a heat treatment such as refining, relaxing, dyeing processing or a set, the yarn composed of the composite fiber included in the woven fabric takes on the form of a coil crimped three-dimensionally, so that the stretchability is imparted to the cloth. It is particularly preferred that dyeing is performed by means of a jet dyeing machine by raising the temperature to 130°C and circulating the woven fabric, since the woven fabric is shrunk in the width direction, thereby imparting a high stretchability thereto.

[0033] Such a woven fabric may be additionally subjected to a water-absorbing processing, a water-repelling processing, a napping processing, a flame-retardant processing, or respective processings which impart a function of an ultraviolet ray shielding, an antibacterial agent, a deodorant, an insect repellent, a phosphorescent agent, a retroreflective agent, a minus ion generator, or the like.

[0034] Incidentally, it is preferred to subject the woven fabric to a flame-retardant processing by means of an exhaustion method or a binder resin and incorporate the flame retardant into the composite fiber. It is particularly preferred that the flame-retardant fiber is a meta-aramid fiber including a flame retardant such as a phosphorus flame retardant and the composite fiber includes a flame retardant such as a phosphorus flame retardant, since the flame retardance of the woven fabric is further enhanced.

[0035] The thus-obtained woven fabric has the above-described constitution, and therefore, has not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance.

[0036] With respect to the stretchability of the woven fabric, the elongation rate in the weft direction is preferably in the

range of 10 to 50%. Further, with respect to the elongation recovery rate of the woven fabric, the elongation recovery rate in the weft direction is preferably in the range of 70% or more (more preferably from 73 to 99%). In terms of the flame retardance, it is preferred that the limiting oxygen index of the woven fabric as measured according to JIS K7201 is 25 or more (more preferably from 25 to 40). The lingering flame time (second) is preferably 2 seconds or less (more preferably from 0 to 1 second). With respect to the anti-pilling properties, it is measured according to JIS L1076-2012 Method A (ICI, 10hr), and a grade of 4 or more (more preferably a grade of from 4.5 to 5) is preferred. With respect to the quality of appearance, when the surface of the woven fabric is exposed to sun beam through north window at an angle of about 45°, and a tester observes the surface of the woven fabric vertically, it is preferred that the result of the observation is such a degree that irregularities ("Shibo" in Japanese) attributable to the shrinkage of the composite fiber is not confirmed.

[0037] Further, in terms of exhibiting the flame retardance, the weight per unit is preferably 180 g/m^2 or more (more preferably from 200 to 500 g/m^2, particularly preferably from 220 to 260 g/m^2).

[0038] Next, the fiber product of the present invention is one formed by using the above-described woven fabric. The fiber product is formed by using the above-described woven fabric, and therefore, has not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance. Example of the fiber product include firefighting clothing, fire protection clothing, office clothing, racing suits for motor sports, work clothing, gloves, hats, vests, and various industrial materials (such as sheets, tents, membrane materials, canopies, construction materials, housing materials, and vehicle interior materials). Examples of the work clothing include work clothes for steel mills and steel factories, work clothes for welding work, work clothes for explosion-proof areas, and examples of the gloves include work gloves which are used in an aircraft industry, an information equipment industry, and a precision equipment industry, in which precision parts are handled.

EXAMPLES

[0039] In the following, examples of the present invention and comparative examples are described in more details, but the present invention is not limited thereto. Note that the respective measurement items in the working examples were measured according to the following methods.

(1) Flame Retardance

[0040] The limiting oxygen index (LOI) was measured according to JIS K7201:1999 (Determination of burning behavior of plastics by oxygen index), and designated as an index for flame retardance.

(2) Stretchability

[0041] The elongation rate and the elongation recovery rate were measured according to JIS L1096-2010 (Method B, constant load method).

(3) Flammability

[0042] The lingering flame time (second), the afterglow time (second) and the length (cm) of carbonized portion were measured according to JIS L1091-1999, Annex 8, Method A-4, and designated as an index for flammability.

(4) Anti-pilling Properties Test

[0043] The anti-billing property (grade) was measured according to JIS L1076-2012, Method A (ICI, 10 hours).

(5) Quality of Appearance

[0044] The surface of the woven fabric was exposed to sun beam through north window at an angle of about 45°, and the tester visually observes the surface of the woven fabric vertically. The evaluation was performed in two-stage, namely, in the case where the result of the observation is such a degree that irregularities ("Shibo" in Japanese) attributable to the shrinkage of the composite fiber were not confirmed, the quality of appearance was rated as "good", and in the case where irregularities attributable to the shrinkage of the composite fiber were confirmed, the quality of appearance was rated as "bad".

(6) Fineness

[0045] The fineness based on corrected weight was measured according to JIS L1013-2010.

(7) Boiling Water Shrinkage

[0046] The BWS(%) was measured according to JIS L1013-2010, Method B.

(8) Intrinsic Viscosity

[0047] As measured in an ortho-chlorophenol solvent at a temperature of 30°C.

(9) Weight per unit of Woven Fabric

[0048] As measured according to JIS L1096:2010, Method A.

(Spun Yarn 1)

[0049] A single yarn having an English cotton count of 40 (total fineness: 147.6 dtex) and a twist number in the Z direction of 24 times/2.54 cm (twist coefficient: 292) was obtained by mix spinning a short fiber composed of a polymethaphenylene isophthalamide fiber ("Conex" (trade name) manufactured by Teijin limited) having a single fiber fineness of 2.2 dtex, a cut length (fiber length) of 51 mm, and a LOI of 33, and a short fiber composed of a coparaphenylene-3,4'-oxydiphenylene terephthalamide fiber ("Technora"(trade name) manufactured by Teijin limited) having a single fiber fineness of 1.7 dtex, a cut length (fiber length) of 51 mm, and a LOI of 25 in a weight ratio (the former : the latter) of 95:5 in the spinning step.

(Spun Yarn 2)

[0050] A single yarn having an English cotton count of 36 (total fineness: 164 dtex) and a twist number in the Z direction of 19.8 times/2.54 cm (twist coefficient: 254) was obtained by mix spinning a short fiber composed of a polymethaphenylene isophthalamide fiber ("Conex" (trade name) manufactured by Teijin limited) having a single fiber fineness of 2.2 dtex, a cut length (fiber length) of 51 mm, and a LOI of 33, and a short fiber composed of a coparaphenylene-3,4'-oxydiphenylene terephthalamide fiber ("Technora"(trade name) manufactured by Teijin limited) having a single fiber fineness of 1.7 dtex, a cut length (fiber length) of 51 mm, and a LOI of 25 in a weight ratio (the former : the latter) of 95:5 in the spinning step.

(Composite Fiber 1)

[0051] As a yarn composed of the composite fiber, prepared was a multifilament (long fiber) having a total fineness of 167 dtex/72 filaments, an elongation of 26%, and a boiling water shrinkage rate of 55.0%, in which polytrimethylene terephthalate and polyethylene terephthalate were bonded together in an eccentric sheath-core manner.

(Composite Fiber 2)

[0052] As a yarn composed of the composite fiber, a multifilament (long fiber) having a total fineness of 40 dtex/24 filaments, an elongation of 26%, and a boiling water shrinkage rate of 55.0% was prepared by spinning and stretching a polytetramethylene terephthalate having an intrinsic viscosity of 1.26 and a polytetramethylene terephthalate having an intrinsic viscosity of 0.92 through a side-by-side type spinneret by a conventional method so that they were bonded together in a side-by-side manner.

(Composite Fiber 3)

[0053] As a yarn composed of a composite fiber, a multifilament (long fiber) having a total fineness of 84tex/24 filaments, an elongation of 26%, and a boiling water shrinkage rate of 55.0% was prepared by spinning and stretching a polytetramethylene terephthalate having an intrinsic viscosity of 1.26 and a polytetramethylene terephthalate having an intrinsic viscosity of 0.92 through a side-by-side type spinneret by a conventional method so that they were bonded together in a side-by-side manner.

[Example 1]

[0054] A weft yarn was obtained by combining two of the spun yarn 1, twisting the resultant in the S direction at the twisting number as described in Table 1 by means of a double twister, and subsequently subjecting the resulting twisted yarn to a twist stopping set at a set temperature of 120°C for a set time of 20 minutes in a vacuum steam set machine.

[0055] On the other hand, a warp yarn was obtained by combining the spun yarn 1 and composite fiber 1, twisting the

resultant in the S direction at the twisting number as described in Table 3 by means of a double twister, and subsequently subjecting the resulting twisted yarn to a twist stopping set at a set temperature of 70°C for a set time of 20 minutes in a vacuum steam set machine.

[0056] Next, the warp yarn and the weft yarn were used and weaved according to the structure and the densities with respect to the warp and weft yarns as described in Table 1, the resulting woven fabric was subjected to singeing-refining-setting (at a temperature of 150°C for 30 seconds), and then subjected to a dyeing processing at 130°C for 30 minutes in a jet dyeing machine after the temperature in the jet dyeing machine was raised at a 2°C/minute from the ordinary temperature. After the dyeing processing, drying was performed, and maintaining the width, setting (at a temperature of 180°C for 30 seconds) was performed. The evaluation results are shown in Table 1.

[Examples 2 to 5 and Comparative Examples 1 to 7]

[0057] The procedures were performed in the same manner as in Example 1 except for changing the kind of the yarn or the twist coefficient as described in Tables 1 and 2. The evaluation results are shown in Tables 1 and 2.

[Table 1]

			Example 1	Example 2	Example 3	Example 4	Example 5
Warp Yarn	Kind of Spun Yarn		Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 2
	Number of Yarns Combined		2	2	2	2	2
	Twisting Number	times/2.54 cm	24	24	24	24	24
	Total Count	Ne	40/2	40/2	40/2	40/2	36/2
	Total Fineness	dtex	295.2	295.2	295.2	295.2	328
Weft Yarn	Original Yarn for Constitution		Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 2
			-	-	-	-	-
			Composite Fiber 1	Composite Fiber 1	Composite Fiber 1	Composite Fiber 1	Composite Fiber 1
	Twisting Number	times/2.54 cm	22	20	18	18	21.6
	Total Fineness	dtex	314.6	314.6	314.6	314.6	331
	Twist Coefficient		390	355	319	319	393
	Weight Rate of Composite Fiber	%	53	53	53	53	50
Structure			2/1 twill	2/1 twill	2/1 twill	plain	2/1 twill
Density Designed		Warp	73	73	73	48	70.6
		Werf	68	68	68	50	72
Final Density		Warp	90	91	91.5	65	86
		Werf	68	67	67	51	70
Weight Rate	Flame-retardant Fiber	%	74.5	74.5	74.5	74	74.5
	Composite Fiber	%	25.5	25.5	25.5	26	25.5
Weight Per Unit		g/m^2	232	230	229	205	255
L0I			27.6	27.7	27.8	27	28

(continued)

			Example 1	Example 2	Example 3	Example 4	Example 5
Method A-4	Lingering Flame	s	0	0	0	0	0
	Afterglow	s	0	0	0	0	0
	Carbonized portion Length	cm	8	9	9	9	7
Stretchability Rate		%	11	11.5	12	14	12
Recovery Rate		%	90	91	91.5	90	85
Anti-billing properties		grade	4.5	4.5	4.5	4.5	4.5
Quality of Appearance			good	good	good	good	good

[Table 2]

			Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Warp Yarn	Kind of Spun Yarn		Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1
	Number of Yarns Combined		2	2	2	2	2	2	2
	Twisting Number	times/ 2.54 cm	24	24	20.87	20.87	20.9	20.87	24
	Total Count	Ne	40/2	40/2	40/2	40/2	40/2	40/2	40/2
	Total Fineness	dtex	295.2	295.2	295.2	295.2	295.2	295.2	295.2
Weft Yarn	Original Yarn for Constitution		Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1
			-	-	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	Spun Yarn 1	
			Composite Fiber 1	Composite Fiber 1	Composite Fiber 2	Composite Fiber 3	Composite Fiber 2	Composite Fiber 3	Composite Fiber 1
	Twisting Number	times/ 2.54 cm	15	10	19.8	19.8	19.8	19.8	30
	Total Fineness	dtex	314.6	314.6	335.2	379.2	335.2	379.2	314.6
	Twist Coefficient		266	177	363	386	363	386	532
	Weight Rate of Composite Fiber	%	53	53	12	22	12	22	53
Structure			2/1 twill	2/1 twill	plain	plain	2/1 twill	plain	2/1 twill
Density Designed		Warp	73	73	48	48	54	48	73
		Werf	68	68	48	48	63	48	68
Final Density		Warp	92	93	55	55	68	55	74
		Werf	67	67	48	48	64	48	68
Weight Rate	Flame-retardant Fiber	%	74.4	74.3	93.6	87.6	93.6	87.6	74.5
	Composite Fiber	%	25.6	25.7	6.4	12.4	6.4	12.4	25.5

(continued)

			Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7
Weight Per Unit		g/m^2	228	227	190	220	200	190	220
L0I			27.9	28.1	29	28	30	28	27.6
Method A-4	Lingering Flame	s	0	0	0	1	0	1	0
	Afterglow	s	0	0	0	1	0	1	0
	Carbonized portion Length	cm	9	9	3.5	7	3.5	7	8
Stretchability Rate		%	12.5	13	7	12	9	12	9
Recovery Rate		%	92	85	75	83	85	83	95
Anti-billing properties		grade	4	4	3	3	4	3	4.5
Quality of Appearance			bad	bad	good	good	good	good	good

Industrial Applicability

[0058] According to the present invention, a woven fabric having not only flame retardance but also excellent stretchability and anti-pilling properties, and good quality of appearance, and a fiber product formed by using the woven fabric are provided, and the industrial value is extremely large.

Claims

1. A woven fabric comprising a composite yarn including:

a spun yarn including a flame-retardant fiber having a limiting oxygen index of 25 or more as measured according to JIS K7201 and a yarn composed of a composite fiber in which two components are bonded together in a side-by-side manner or an eccentric sheath-core manner,
wherein the weight rate of the yarn composed of the composite fiber based on the composite yarn is from 40 to 60% by weight, and the composite yarn is twisted such that a twist coefficient K defined by the following expression falls within the range of 270 to 400:

$$\text{Twist Coefficient } K = T \times \sqrt{D}$$

wherein T is a twist number (times/2.54 cm) and D is a total fineness of the composite yarn (dtex).

2. The woven fabric according to claim 1, wherein the weight rate of the flame-retardant fiber based on the weight of the woven fabric falls within the range of 65 to 84% by weight and the weight rate of the composite fiber based on the weight of the woven fabric falls within the range of 16 to 35% by weight.

3. The woven fabric according to claim 1, wherein the flame-retardant fiber is at least one selected from the group consisting of a meta-aramid fiber, a para-aramid fiber, a polyparaphenylene benzoxazole fiber, a polybenzimidazole fiber, a polyimide fiber, a polyetherimide fiber, a polyamideimide fiber, a carbon fiber, a polyphenylene sulfide fiber, a polyvinyl chloride fiber, a flame-retardant rayon, a modacrylic fiber, a flame-retardant acrylic fiber, a flame-retardant polyester fiber, a flame-retardant vinylon fiber, a melamine fiber, a fluorine fiber, a flame-retardant wool and a flame-retardant cotton.

4. The woven fabric according to claim 1, wherein the yarn composed of the composite fiber is a multifilament having a single fiber fineness of 0.5 to 10.0 dtex and a total fineness of 20 to 200 dtex.

5. The woven fabric according to claim 1, wherein at least one component for constituting the composite fiber is derived from recycling or plant.

6. The woven fabric according to claim 1, wherein the flame-retardant fiber is a meta-aramid fiber including a flame retardant and the composite fiber includes a flame retardant.

7. The woven fabric according to claim 1, wherein the composite yarn is distributed as the weft yarn of the woven fabric and the elongation rate in the weft direction falls within the range of 10 to 50%.

8. The woven fabric according to claim 1, wherein the composite yarn is distributed as the weft yarn of the woven fabric and the elongation recovery rate in the weft direction is 70% or more.

9. The woven fabric according to claim 1, which has anti-pilling properties of grade 4 or more as measured according to JIS L1076-2012 (Method A, ICI type, for 10 hours).

10. The woven fabric according to claim 1, which does not have any irregularities attributable to shrinkage of the composite fiber on a surface thereof.

11. The woven fabric according to claim 1, which has a limiting oxygen index of 25 or more as measured according to JIS K7201.

12. A fiber product, which comprises the woven fabric according to any of claims 1 to 11 and is one selected from the group

consisting of firefighting clothing, fire protection clothing, office clothing, racing suits for motor sports, work clothing, gloves, hats, vests, sheets, tents, membrane materials, canopies, construction materials, housing materials, and vehicle interior materials.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/031499

A. CLASSIFICATION OF SUBJECT MATTER

D03D 15/47(2021.01)i; ***A41D 31/00***(2019.01)i; ***A41D 31/04***(2019.01)i; ***A41D 31/08***(2019.01)i; ***D02G 3/28***(2006.01)i; ***D03D 15/275***(2021.01)i; ***D03D 15/283***(2021.01)i; ***D03D 15/292***(2021.01)i; ***D03D 15/41***(2021.01)i; ***D03D 15/513***(2021.01)i; ***E04B 1/94***(2006.01)i; ***E04H 15/54***(2006.01)i

FI: D03D15/47 ZAB; D03D15/292; D03D15/513; D03D15/283; D03D15/275; D03D15/41; D02G3/28; A41D31/00 503E; A41D31/08; A41D31/04 F; E04H15/54; E04B1/94 T

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D03D15/47; A41D31/00; A41D31/04; A41D31/08; D02G3/28; D03D15/275; D03D15/283; D03D15/292; D03D15/41; D03D15/513; E04B1/94; E04H15/54

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2023
Registered utility model specifications of Japan 1996-2023
Published registered utility model applications of Japan 1994-2023

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-119635 A (DU PONT TORAY CO LTD) 23 April 2003 (2003-04-23) claims, paragraphs [0012], [0018], [0031], [0039], [0049]-[0069], examples, fig. 1	1-12
A	JP 2021-195681 A (TEIJIN LTD) 27 December 2021 (2021-12-27) claims, examples, entire text	1-12
A	JP 2020-002475 A (TEIJIN LTD) 09 January 2020 (2020-01-09) claims, examples, entire text	1-12
A	JP 2022-003177 A (TEIJIN LTD) 11 January 2022 (2022-01-11) claims, examples, entire text	1-12
A	JP 2014-240532 A (TEIJIN LTD) 25 December 2014 (2014-12-25) claims, examples, entire text	1-12

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 November 2023	**28 November 2023**
Name and mailing address of the ISA/JP **Japan Patent Office (ISA/JP)** **3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915** **Japan**	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2023/031499

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2018-040068 A (TEIJIN LTD) 15 March 2018 (2018-03-15) claims, examples, entire text	1-12

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2023/031499

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2003-119635 A	23 April 2003	(Family: none)	
JP 2021-195681 A	27 December 2021	(Family: none)	
JP 2020-002475 A	09 January 2020	(Family: none)	
JP 2022-003177 A	11 January 2022	(Family: none)	
JP 2014-240532 A	25 December 2014	US 2016/0040326 A1 claims, examples, entire text WO 2014/199969 A1 EP 3009547 A1 TW 201525215 A CA 2909905 A CN 105283593 A KR 10-2016-0019463 A	
JP 2018-040068 A	15 March 2018	(Family: none)	

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- JP 2001248027 A **[0007]**
- JP 2005307429 A **[0007]**
- JP 2008190103 A **[0007]**
- JP 2014240532 A **[0007]**
- JP H10251981 A **[0015]**