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(71) Applicant: **Teijin Limited**  
**Osaka-shi, Osaka 541-0054 (JP)**

(72) Inventor: **IWASHITA, Kenji**  
**Osaka-shi**  
**Osaka 541-0054 (JP)**

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

(54) **FABRIC AND FIBER PRODUCT**

(57) In order to provide a fabric and a fiber product, which have hygroscopicity and durability as well as flame retardancy, a hydrophilizing agent is added to a fabric containing aramid fibers.

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**Description**TECHNICAL FIELD

5 **[0001]** The present invention relates to a fabric and fiber product having durable moisture absorbency in addition to flame retardance.

BACKGROUND ART

10 **[0002]** Fabric containing aramid fibers has conventionally been used in fire-fighting clothing and work clothes due to the superior flame retardance thereof. In addition, fire-fighting clothing and work clothes had the problem of excessive perspiration since there are many opportunities for use in environments at high temperature and humidity. However, since priority was placed on protecting firefighters and workers from fire and the like, little consideration has been given to wear comfort of fabric.

15 **[0003]** On the other hand, a fabric that efficiently absorbs perspiration has been proposed for use as a fabric that enhances wear comfort when perspiring (see, for example, Patent Document 1).

**[0004]** However, a fabric has yet to be proposed that demonstrates durable moisture absorbency in addition to flame retardance.

20 Prior Art Documents

Patent Documents

25 **[0005]** Patent Document 1: Japanese Unexamined Patent Publication No. 2011-94285

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

30 **[0006]** With the foregoing in view, an object of the present invention is to provide a fabric and textile product that has durable moisture absorbency in addition to flame retardance.

Means for Solving the Problems

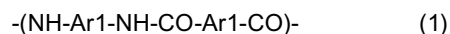
35 **[0007]** As a result of conducting extensive studies to solve the aforementioned problems, the inventors of the present invention found that, by imparting a hydrophilizing agent to a fabric containing aramid fibers, a fabric can be obtained that has durable moisture absorbency in addition to flame retardance, and after conducting additional extensive studies, arrived at the present invention.

40 **[0008]** Thus, according to the present invention, a "fabric comprising aramid fibers, wherein the fabric is imparted with a hydrophilizing agent" is provided.

**[0009]** At that time, the aforementioned aramid fibers preferably comprise 30% by weight to 97% by weight of meta-aramid fibers and 3% by weight to 70% by weight of para-aramid fibers.

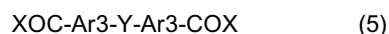
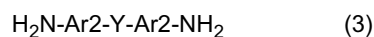
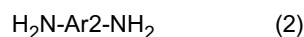
45 **[0010]** In addition, the degree of crystallization of the aforementioned meta-type wholly aromatic polyamide fibers is preferably within the range of 15% to 25%. In addition, the meta-type wholly aromatic polyamide that forms the aforementioned meta-type wholly aromatic polyamide fibers is preferably a meta-type wholly aromatic polyamide obtained by copolymerizing an aromatic diamine component or an aromatic dicarboxylic acid halide component in an aromatic polyamide backbone containing a repeating structural unit represented by the following formula (1), the aromatic diamine component or the aromatic dicarboxylic acid halide component having different primary constituent units in the repeating structures thereof, such that it is copolymerized as a third component at 1 mol% to 10 mol% based on the total amount of repeating structural units of the aromatic polyamide.

50



55 Here, Ar1 represents a divalent aromatic group having a linking group in the meta coordination or a coordination other than the parallel axis.

**[0011]** At that time, the aromatic diamine serving as a third component is preferably represented by formula (2) or formula (3), and the aromatic dicarboxylic acid halide is preferably represented by formula (4) or formula (5).



Here, Ar2 represents a divalent aromatic group different from Ar1, Ar3 represents a divalent aromatic group different from Ar1, Y represents at least one type of atom or functional group selected from the group consisting of an oxygen atom, sulfur atom and alkylene group, and X represents a halogen atom.

**[0012]** In addition, the residual amount of solvent in the aforementioned meta-type aromatic polyamide fibers is preferably 0.1% by weight or less. In addition, the fabric preferably further contains electrically conductive fibers. In addition, the fabric preferably further contains polyester fibers. In addition, the aforementioned polyester fibers are preferably polyester fibers containing a flame retardant. In addition, the aforementioned aramid fibers and/or the aforementioned electrically conductive fibers and/or the aforementioned polyester fibers are preferably contained in the fabric as spun yarn. In addition, the aforementioned aramid fibers and the aforementioned polyester fibers are preferably contained in the fabric as blended yarn. In addition, the fabric preferably has a double weave structure. In addition, the aforementioned hydrophilizing agent is preferably polyethylene glycol diacrylate, a derivative of polyethylene glycol diacrylate, polyethylene terephthalate-polyethylene glycol copolymer, or water-soluble polyurethane. In addition, the basis weight of the fabric is preferably within the range of 130 g/m<sup>2</sup> to 260 g/m<sup>2</sup>. In addition, the fabric is preferably subjected to dyeing. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 is preferably 2.0 seconds or less. In addition, moisture absorption performance as defined in AATCC79 is preferably 10 seconds or less. In addition, water absorption performance as defined in AATCC79 after 20 cycles of laundering as defined in ISO6339-2012 (6N-F) is preferably 30 seconds or less.

**[0013]** In addition, according to the present invention, a textile product that uses the aforementioned fabric is provided that is selected from the group consisting of protective clothing, fire-protective clothing, fire-fighting clothing, rescue clothing, workwear, police uniforms, self defense forces uniforms and military clothing.

#### Effects of the Invention

**[0014]** According to the present invention, a fabric and textile product are obtained that have durable moisture absorbency in addition to flame retardance.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0015]** FIG. 1 is a weave structural diagram used in Example 3.

#### MODE FOR CARRYING OUT THE INVENTION

**[0016]** The following provides a detailed explanation of embodiments of the present invention.

**[0017]** First, the fabric of the present contains aramid fibers (wholly aromatic polyamid fibers). Adequate flame retardance is unable to be obtained in the case aramid fibers are not contained in the fabric, thereby making this undesirable.

**[0018]** The aramid fibers may be meta-aramid fibers or para-aramid fibers.

**[0019]** The meta-aramid fibers may be of the spun-dyed type or dyed type. The meta-aramid fibers may also be of the flame retardant type that contains a flame retardant. Moreover, the amount of residual solvent in the meta-aramid fibers is preferably as low as possible. Since a lower amount of residual solvent enables the fibers per se to be self-extinguishable, the amount of residual solvent is preferably 1% by weight or less, and more preferably 0.3% by weight or less.

**[0020]** The meta-aramid fibers are obtained by linking aromatic rings composing the main backbone with amide bonds at meta-position, and refer to those in which 85 mol% or more of all repeating units of the polymer are meta-phenylene isophthalamide units. Poly(meta-phenylene isophthalamide) homopolymer is particularly preferable. Examples of a third component able to copolymerize at 15 mol% or less, and preferably 5 mol% or less, of all repeating units are indicated to follow. Namely, examples include diamine components in the form of an aromatic diamine such as para-phenylene-diamine, 3,4'-diaminodiphenyl ether, 4,4'-diaminodiphenyl ether, paraxylylenediamine, biphenylenediamine, 3,3'-dichlorobenzidine, 3,3'-dimethylbenzidine, 3,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane or 1,5-naphthlanediamine. In addition, examples of the acid component include aromatic dicarboxylic acids such as terephthalic acid, naphthalene-2,6-dicarboxylic acid or naphthalene-2,7-dicarboxylic acid. In addition, a portion of the hydrogen atoms of

the aromatic rings of these aromatic diamines and aromatic dicarboxylic acids may be substituted with halogen atoms or alkyl groups such as a methyl group. In the case 20% or more of all polymer ends are capped by a monovalent carboxylic acid component or monovalent diamine such as aniline, the decrease in fiber strength even after storing for a long period of time at high temperatures in particular is small, thereby making this preferable. The meta-aramid fibers may also contain a pigment such as carbon black or a flame retardant, ultraviolet absorber or other functional agent in order to retain functional properties. Furthermore, examples of commercially available products of meta-aramid fibers include Conex® and Nomex®.

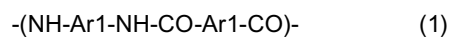
**[0021]** This meta-type wholly aromatic polyamide can be produced according to conventionally known interfacial polymerization methods, and that having a degree of polymerization within the range of 1.3 dl/g to 1.9 dl/g, in terms of intrinsic viscosity (I.V.) as measured in an N-methyl-2-pyrrolidone solution having a concentration of 0.5 g/100 ml, is used preferably.

**[0022]** The aforementioned meta-type wholly aromatic polyamide may also contain an alkylbenzenesulfonate onium salt. Preferable examples of alkylbenzenesulfonate onium salts include compounds such as tetrabutylphosphonium hexylbenzenesulfonate, tributylbenzylphosphonium hexylbenzenesulfonate, tetraphenylphosphonium dodecylbenzenesulfonate, tributyltetradecylphosphonium dodecylbenzenesulfonate, tetrabutylphosphonium dodecylbenzenesulfonate or tributylbenzylammonium dodecylbenzenesulfonate. Among these, tetrabutylphosphonium dodecylbenzenesulfonate and tributylbenzylammonium dodecylbenzenesulfonate are particularly preferable since they are highly soluble in N-methyl-2-pyrrolidone and have favorable thermal stability.

**[0023]** The content ratio of the aforementioned alkylbenzenesulfonate onium salt is preferably 2.5 mol% or more, and more preferably within the range of 3.0 mol% to 7.0 mol%, based on the amount of poly(m-phenylene isophthalamide) in order to obtain the effect of improving adequate dyeability.

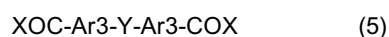
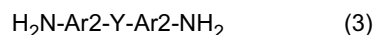
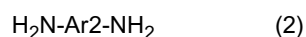
**[0024]** In addition, mixing the poly(m-phenylene isophthalamide) in a solvent and dissolving therein followed by dissolving the alkylbenzenesulfonate onium salt in the solvent may be used as an example of method for mixing the poly(m-phenylene isophthalamide) and alkylbenzenesulfonate onium salt. A dope obtained in this manner is then formed into fibers according to a conventionally known method.

**[0025]** The polymer used for the meta-type wholly aromatic polyamide fibers can also be obtained by polymerizing an aromatic diamine component or an aromatic dicarboxylic acid halide component in an aromatic polyamide backbone containing a repeating structural unit represented by the following formula (1), the aromatic diamine component and the dicarboxylic acid halide component having different primary constituent units of the repeating structures thereof, such that it is copolymerized as a third component at 1 mol% to 10 mol% based on the total amount of repeating structural units of the aromatic polyamide.



Here, Ar1 represents a divalent aromatic group having a linking group in the meta coordination or in a coordination other than the parallel axis.

**[0026]** In addition, the aromatic diamine or aromatic dicarboxylic acid halide component can also be copolymerized as a third component. Specific examples of aromatic diamines represented by formula (2) or formula (3) include p-phenylenediamine, chlorophenylenediamine, methylphenylenediamine, acetylphenylenediamine, aminoanisidine, benzidine, bis(aminophenyl)ether, bis(aminophenyl)sulfone, diaminobenzanilide and diaminoazobenzene. Specific examples of aromatic dicarboxylic acid dichlorides represented by formula (4) or formula (5) include terephthalic acid chloride, 1,4-naphthalene dicarboxylic acid chloride, 2,6-naphthalene dicarboxylic acid chloride, 4,4'-biphenyldicarboxylic acid chloride, 5-chloroisophthalic acid chloride, 5-methoxyisophthalic acid chloride and bis(chlorocarbonylphenyl)ether.



Here, Ar2 represents a divalent aromatic group different from Ar1, Ar3 represents a divalent aromatic group different from Ar1, Y represents at least one type of atom or functional group selected from the group consisting of an oxygen atom, sulfur atom and alkylene group, and X represents a halogen atom.

**[0027]** In addition, the degree of crystallization of the meta-type wholly aromatic polyamide fibers is preferably 5% to 35% from the viewpoints of ensuring favorable dye exhaustion and facilitating adjustment to a target color with a smaller amount of dye or under weaker dyeing conditions. Moreover, the degree of crystallization is more preferably 15% to

25% from the viewpoints of making it more difficult for a dye to become unevenly distributed on a surface, greater resistance to discoloration and fading, and being able to ensure a level of dimensional stability required for practical use.

**[0028]** In addition, the amount of residual solvent in the meta-type wholly aromatic polyamide fibers is preferably 0.1% by weight or less from the viewpoints of not impairing the superior flame retardation performance of meta-type wholly aromatic polyamide fibers, making it more difficult for a dye to become unevenly distributed on a surface, and greater resistance to discoloration and fading.

**[0029]** The aforementioned meta-type wholly aromatic polyamide fibers can be produced by the following method, and the degree of crystallization and amount of residual solvent in particular can be made to be within the aforementioned ranges by using the method to be subsequently described.

**[0030]** There are no particular limitations on the polymerization method of the meta-type wholly aromatic polyamide polymer, and for example, a solution polymerization method or interfacial polymerization method described in Japanese Examined Patent Publication No. S35-14399, U.S. Patent No. 3360595 or Japanese Examined Patent Publication No. S47-10863 may be used.

**[0031]** Although there are no particular limitations on the spinning solution, an amide-based solvent solution containing an aromatic co-polyamide polymer obtained using the aforementioned solution polymerization or interfacial polymerization, or that obtained by isolating the polymer from the aforementioned polymerization solution and dissolving in an amide-based solution, may also be used.

**[0032]** Here, although examples of amide-based solvents used include N,N-dimethylformamide, N,N-dimethylacetamide, N-methyl-2-pyrrolidone (NMP) and dimethylsulfoxide, N,N-dimethylacetamide is particularly preferable.

**[0033]** The aforementioned copolymerized aromatic polyamide polymer solution obtained in the manner described above is stabilized by further containing an alkaline metal salt or alkaline earth metal salt, enabling it to be used at a higher concentration and lower temperature, thereby making this preferable. An alkaline metal salt and alkaline earth metal salt are preferably contained at 1% by weight or less, and more preferably 0.1% by weight or less, based on the total weight of the polymer solution.

**[0034]** In a spinning and coagulation step, the spinning solution obtained in the manner described above (meta-type wholly aromatic polyamide polymer solution) is coagulated by spinning into a coagulating liquid.

**[0035]** There are no particular limitations on the spinning apparatus and a conventionally known wet spinning apparatus can be used. In addition, there is also no particular need to limit the number, arrangement or shape of the spinning holes of the spinneret provided they permit stable wet spinning, and for example, a multi-hole spinneret for spun rayon yarn having 1000 to 30,000 spinning holes and a spinning hole diameter of 0.05 mm to 0.2 mm may be used.

**[0036]** In addition, the temperature of the spinning solution (meta-type wholly aromatic polyamide polymer solution) when spun out from the spinneret is preferably within the range of 20°C to 90°C.

**[0037]** An amide-based solution substantially free of inorganic salt, and preferably an aqueous solution having an NMP concentration of 45% by weight to 60% by weight, is used for the coagulating liquid used to obtain fibers within a liquid temperature range of 10°C to 50°C. If the concentration of amide-based solution, and preferably NMP, is less than 45% by weight, a thick-skinned structure results, resulting in the risk of a decrease in cleaning efficiency in the washing step and difficulty in reducing the residual amount of solvent in the fibers. On the other hand, in the case the concentration of the amide-based solvent, and preferably NMP, exceeds 60% by weight, coagulation is unable to proceed uniformly to the interior of the fibers, thereby again resulting in the risk of difficulty in reducing the amount of residual solvent in the fibers. Furthermore, the amount of time the fibers are immersed in the coagulation bath is preferably within the range of 0.1 seconds to 30 seconds.

**[0038]** Continuing, the fibers are drawn at a draw ratio of 3 to 4 in an amide-based solution, and preferably an aqueous solution having an NMP concentration of 45% by weight to 60% by weight, in a plastic drawing bath in which the temperature of the bath liquid has been made to be within the range of 10°C to 50°C. Following drawing, the fibers are adequately washed by passing through an aqueous solution at 10°C to 30°C having an NMP concentration of 20% by weight to 40% by weight and then through a hot water bath at a temperature of 50°C to 70°C.

**[0039]** The washed fibers are then subjected to dry heat treatment at a temperature of 270°C to 290°C to obtain meta-type wholly aromatic aramid fibers that satisfy the aforementioned ranges for degree of crystallization and amount of residual solvent.

**[0040]** In addition, the para-aramid fibers are fibers composed of a polyamide having aromatic rings in the main chain thereof. This polyamide may be poly(p-phenylene terephthalamide) (PPTA) or the copolymer type, co-poly-p-phenylene-3,4'-oxydiphenylene terephthalamide (PPODPA). Furthermore, examples of commercially available products of this para-aramid fiber include Technora®, Kevlar® and Twaron®.

**[0041]** If meta-aramid fibers are contained at 30% by weight to 97% by weight and para-aramid fibers are contained at 3% by weight to 70% by weight in particular, shrinkage of the fabric during combustion is reduced and it becomes difficult for holes to form therein, thereby making this preferable.

**[0042]** The fabric of the present invention may be composed only of aramid fibers as previously described, or may contain fibers other than aramid fibers (other fibers).

**[0043]** For example, if electrically conductive fibers are contained in the fabric, fires caused by the generation of static electricity can be suppressed due to the synergistic effect with a hydrophilizing agent imparted to the fabric, thereby making this preferable.

**[0044]** The electrically conductive fibers are preferably fibers containing at least one of carbon black, electrically conductive titanium oxide, electrically conductive whiskers and carbon nanotubes for the conductor of the electrically conductive portion of the electrically conductive fibers.

**[0045]** The form of the electrically conductive fibers may be that of a structure in which all of the fibers are composed of electrically conductive portions, or that in which non-conducting portions and electrically conductive portions have a cross-sectional shape in the manner of a core-and-sheath, sandwich or eccentric shape. There are no particular limitations on the resin used to form the electrically conductive portions and non-conducting portions provided it allows the formation of fibers. Specific examples thereof include Nylon resins such as Nylon 6, Nylon 11, Nylon 12 or Nylon 66. In addition, examples of polyester resins include polyethylene terephthalate, polytrimethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polycyclohexane terephthalate, copolymers thereof, and those in which a portion of the acid component (terephthalic acid) thereof has been substituted with isophthalic acid.

**[0046]** Examples of commercially available electrically conductive fibers include Metalian (trade name, Teijin Ltd.), Megana (trade name, Unitika Ltd.), Luana (Toray Corp.) and Kuracarbo (Kuraray Co., Ltd.).

**[0047]** In addition, fibers such as polyester fibers, nylon fibers, acrylic fibers, acrylate-based fibers, flame-retardant rayon fibers or flame-retardant vinylon fibers may also be contained in the fabric. Containing polyester fibers in the fabric further improves moisture absorption performance in particular, thereby making this preferable.

**[0048]** The aforementioned polyester fibers are fibers containing polyester as a component thereof. The polyester is a polyester having terephthalic acid as the main dicarboxylic acid component and having at least one type of glycol, and preferably at least one type of alkylene glycol selected from among ethylene glycol, trimethylene glycol or tetramethylene glycol and the like, as the main glycol component. The polyester may be modified by copolymerizing and/or blending a third component as necessary. The polyester may also be a material-recycled or chemically-recycled polyester, or polyethylene terephthalate obtained by using a monomer component obtained by using biomass, namely a biological substance, as raw material. Moreover, the polyester may be obtained by using a catalyst containing a specific phosphorous compound and titanium compound as described in Japanese Unexamined Patent Publication No. 2004-270097 and Japanese Unexamined Patent Publication No. 2004-211268.

**[0049]** Furthermore, the polyester may contain an arbitrary additive, such as a catalyst, anti-coloring agent, heat-resistant agent, flame retardant, antioxidant or inorganic fine particles as necessary. In particular, providing a flame retardant within the polyester polymer or on the surface of polyester fibers improves flame retardance of the fabric, thereby making this preferable.

**[0050]** Monofilament fineness in the aforementioned polyester fibers is preferably 5.0 dtex or less, and more preferably 0.0001 dtex to 1.5 dtex, in terms of increasing fiber surface area and obtaining superior perspiration absorbency.

**[0051]** In the aforementioned polyester fibers, the cross-sectional shape (transverse cross-sectional shape) of monofilaments is preferably irregular (shape other than a circular shape). This irregularly shaped cross-section is preferably a flat cross-section, W-shaped cross-section, cross-shaped cross-section, hollow cross-section (such as that having a round hollow shape, triangular hollow shape or rectangular hollow shape) or triangular cross-section. Moreover, the irregularly shaped cross-section may also be a flat cross-section having a constricted portion as described in Japanese Unexamined Patent Publication No. 2004-52191, or a cross-section having a fin protruding radially from a hollow core portion as described in Japanese Unexamined Patent Publication No. 2012-97380. As a result of organic fibers having an irregularly shaped cross-section, voids can be formed between fibers and superior moisture absorbency can be obtained due to capillary action. In addition, there is also the synergistic effect of flame retardance being further improved by moisture that has been absorbed by the moisture absorbing action. Among the aforementioned cross-sectional shapes, a W-shaped cross-section is particularly preferable since voids can be easily formed between fibers even with only a small number of fibers.

**[0052]** The aforementioned polyester fibers may also be composite fibers obtained by laminating two components either side-by-side or in the form of an eccentric core-sheath. Since these composite fibers normally have fine crimps demonstrating latent crimping, these polyester fibers not only have stretchability, but also demonstrate superior capillary action.

**[0053]** At that time, the two components composing the composite fibers are preferably any combination selected from the group consisting of the combination of polytrimethylene terephthalate and polytrimethylene terephthalate, the combination of polytrimethylene terephthalate and polyethylene terephthalate, and the combination of polyethylene terephthalate and polyethylene terephthalate.

**[0054]** In the fabric of the present invention, there are no particular limitations on the shape of the aramid fibers and other fibers that compose the fabric, and the fibers may be short fibers (spun yarn) or long fibers (multifilament yarn). Spun yarn is particularly preferable in terms of maintaining favorable laundering durability of the hydrophilizing agent.

**[0055]** At that time, the aramid fibers and other fibers may be blended simultaneously or interknitted or interwoven

separately. In particular, if aramid fibers and the aforementioned polyester fibers are blended and contained in a fabric as blended yarn, in addition to being able to obtain superior flame retardance, the laundering durability of the hydrophilizing agent can be favorably maintained, thereby making this preferable.

**[0056]** In addition, if the aforementioned spun yarn demonstrates a coiled shape, stretchability can be imparted to the fabric, thereby making this preferable. Spun yarn demonstrating a coiled shape can be obtained according to the method indicated below.

**[0057]** Namely, spun yarn containing aramid fibers is first prepared. At that time, electrically conductive yarn or other raw cotton may be blended into the aramid fibers. The spun yarn fineness (count) is preferably such that the cotton count (Ecc) is 20 to 60 count from the viewpoints of thread breakage resistance and strength. The number of monofilaments is preferably 60 or more, and raw cotton monofilament fineness is preferably 3.0 dtex or less, and more preferably 0.001 dtex to 3.0 dtex. The twist factor (first twist factor) of the spun yarn is preferably within the range of 3.6 to 4.2, and more preferably 3.8 to 4.0. Although pilling resistance of the fabric improves as result of the fabric nap converging as the twist factor becomes larger, since the spun fiber becomes rigid, there is the risk of a decrease in the degree of elongation causing a reduction in tear strength of the fabric or causing the fabric to become hard. Furthermore, twist factor is represented with the equation indicated below.

$$\text{Twist factor} = \frac{\text{number of twists (twist/2.54 cm)}}{\text{cotton count (Ecc)}^{1/2}} \text{ of spun yarn}$$

The spinning method of the spun yarn may be an innovative spinning method such as ring spinning, MTS, MJS or MVS, or an ordinary spinning method such as ring spinning. The direction of twisting may be the Z direction or S direction.

**[0058]** Next, after having carried out twist setting (vacuum steaming) on the spun yarn as necessary, two or more strands of the spun yarn, preferably 2 to 4 strands and particularly preferably 2 strands, are uniformly arranged in parallel and twisted together. Examples of twisting machines used for twisting include an up-twister, covering machine, Italian-type twisting machine and double twister.

**[0059]** At that time, the twisting direction of twisting (second twisting) is the direction that results in additional twisting. For example, in the case the twisting direction of the spun yarn is Z twisting, twisting is carried out in the same Z direction. In addition, the number of twists is preferably 2000/m or more, more preferably 2100/m to 3000/m, and particularly preferably 2300/m to 2800/m. In the case the number of twists is less than 2000/m, there is the risk of the spun yarn not taking on a coiled shape after twist setting and untwisting.

**[0060]** Next, twist setting is carried out on the twisted yarn (high-pressure steam setting similar to conventional aramid two ply yarn twist setting). In the case it is necessary to impart firm twist setting, the number of twist setting cycles may be increased or the temperature and duration of twist setting may be changed. For example, although twist setting may be carried out at a setting temperature of 115°C to 125°C, setting time of 20 minutes to 40 minutes, and number of setting cycles of 1 to 3 cycles, a higher setting temperature and longer setting time results in favorable twist setting, thereby making this preferable. Although it is possible to further improve twist setting by increasing the number of twist setting cycles, extending the treatment time or raising the temperature, it is preferable to extend the treatment time in consideration of production management (such as with respect to work management safety or quality control). In addition, a higher degree of vacuum results in better quality, thereby making this preferable.

**[0061]** Next, after having been subjected to twist setting, the twisted yarn is untwisted (by twisting in the direction opposite to the twisting direction during twisting) and then heat-set as necessary. At that time, the number of twisted threads that are untwisted is preferably within the range of 70% to 90% of the aforementioned twisted yarn. As a result of carrying out untwisting on a number of twisted threads within this range, spun yarn is obtained that has stretchability and is formed into a coiled shape. The number of twists in the spun yarn formed into a coiled shape is preferably within the range of 200/m to 860/m in terms of obtaining superior stretchability.

**[0062]** There are no particular limitations on the structure of the fabric, and examples thereof include plain weave, twill and double weave. Among these, the use of a double weave structure having a structure consisting of two layers of fabric results in increased water absorption performance, thereby making this preferable. At that time, although there are no particular limitations on the fibers composing the yarn that composes the two layers, yarn exposed in the layer mainly located on the skin side is preferably composed of polyester fibers at 10% by weight or more, while yarn exposed in the layer mainly located on the outside is preferably composed of polyester fibers within the range of 0% by weight to 10% by weight. Incorporating a larger amount of polyester fibers having superior water absorption performance in yarn exposed in the layer located mainly on the side skin results in increased water absorption performance, while reducing the content rate of polyester fibers in yarn exposed in the layer mainly located on the outside makes it possible to maintain flame retardation performance of the overall fabric.

**[0063]** In the fabric of the present invention, the providing of a hydrophilizing agent not only results in flame retardance but also durable moisture absorbency.

**[0064]** Here, preferable examples of hydrophilizing agents include polyethylene glycol diacrylate, derivatives of polyethylene glycol diacrylate, polyethylene terephthalate-polyethylene glycol copolymers, water-soluble polyurethane, and polyethylene glycolaminosilicone copolymers.

**[0065]** The amount of hydrophilizing agent incorporated in the fabric in terms of the ratio based on the weight of the fabric is preferably 0.1% by weight to 2.0% by weight, and more preferably, 0.1% by weight to 0.7% by weight. Furthermore, the incorporated amount of hydrophilizing agent can be calculated using the equation indicated below.

$$\begin{aligned} &\text{Incorporated amount of hydrophilizing agent (\%)} = \\ &((\text{fabric weight following incorporation of} \\ &\text{hydrophilizing agent}) - (\text{fabric weight prior to} \\ &\text{incorporation of hydrophilizing agent}) / (\text{fabric} \\ &\text{weight prior to incorporating hydrophilizing agent})) \\ &\times 100 \end{aligned}$$

In this equation, the fabric weight following incorporation of hydrophilizing agent refers to the weight after drying.

**[0066]** Examples of methods used to incorporate the hydrophilizing agent include a method using padding treatment and a method consisting of treatment in the same bath as that of the dyeing solution during dyeing processing.

**[0067]** The fabric is preferably subjected to dyeing processing. Moreover, various other types of processing may also be additionally applied by incorporating a water repellent, heat storage agent, ultraviolet screening agent, antistatic agent, disinfectant, deodorant, insect repellent, mosquito repellent, phosphorescent agent or retroreflective agent and the like.

**[0068]** The basis weight of a fabric obtained in this manner is preferably 130 g/m<sup>2</sup> to 260 g/m<sup>2</sup>, and more preferably 140 g/m<sup>2</sup> to 220 g/m<sup>2</sup>.

**[0069]** This fabric demonstrates durable water absorbency in addition to flame retardance as a result of containing aramid fibers and incorporating a hydrophilizing agent as described above.

**[0070]** Here, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 is preferably 2.0 seconds or less. In addition, moisture absorption performance as defined in AATCC79 is preferably initially 10 seconds or less, and more preferably initially 0.1 seconds to 8 seconds. In addition, water absorption performance as defined in AATCC79 after 20 cycles of laundering as defined in ISO6339-2012 (6N-F) is preferably 30 seconds or less, and more preferably 1 second to 20 seconds.

**[0071]** The textile product of the present invention is a textile product that uses the aforementioned fabric and is selected from the group consisting of protective clothing, fire-protective clothing, fire-fighting clothing, rescue clothing, workwear, police uniforms, self defense forces uniforms and military clothing.

**[0072]** The textile product has durable moisture absorbency in addition to flame retardance since it uses the aforementioned fabric.

#### Examples

**[0073]** Although the following provides a detailed description of examples and comparative examples of the present invention, the present invention is not limited thereby. Furthermore, each of the properties described in the examples were measured according to the methods indicated below.

##### (1) Residual Solvent

**[0074]** Approximately 8.0 g of raw fibers were collected and dried for 120 minutes at 105°C followed by allowing to cool in a desiccator and determining fiber weight (M1). Continuing, these fibers were then subjected to reflux extraction using a Soxhlet extractor in methanol for 1.5 hours to extract amide-based solvent contained in the fibers. Following completion of extraction, the fibers were removed and vacuum-dried for 60 minutes at 150°C followed by allowing to cool in a desiccator and determining fiber weight (M2). The amount of residual solvent in the fibers (weight of amide-based solvent) was calculated according to the equation indicated below using the resulting values of M1 and M2.

$$\text{Residual solvent (\%)} = [(M1-M2)/M1] \times 100$$



The resulting raw fibers were then subjected to crimping processing and cutting to obtain staple fibers having a fiber length of 51 mm (raw cotton).

## (2) Degree of Crystallization

**[0075]** Raw fibers were uniformly arranged and formed into a fiber bundle having a diameter of about 1 mm and then installed on a fiber sample stage followed by measuring the diffraction profile thereof using an X-ray diffractometer (RINT TTRIII, Rigaku Corp.). Measurement conditions consisted of the use of a Cu-K $\alpha$  radiation source (50 kV, 300 mA), scanning angle range of 10° to 35°, continuous measurement at width of 0.1° and scanning rate of 1°/minute. The total scattering profile was obtained by correcting the measured diffraction profile based on linear approximations of atmospheric scattering and incoherent scattering therefrom. Next, the amorphous scattering profile was subtracted from the total scattering profile to obtain the crystal scattering profile. The degree of crystallization was then calculated according to the equation indicated below from the integrated intensity of the crystal scattering profile (crystal scattering intensity) and the integrated intensity of the total scattering profile (total scattering intensity).

$$\text{Degree of crystallization (\%)} = \left[ \frac{\text{crystal scattering intensity}}{\text{total scattering intensity}} \right] \times 100$$

### [Example 1]

**[0076]** Staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers composed of Conex® (MA), para-type wholly aromatic polyamide fibers composed of Twaron® (PA), and electrically conductive nylon fibers composed of No Shock® (Solcia Co., Ltd.) (NY) (each having a fiber length of 51 mm) were formed into two-ply spun yarn having a yarn count of 40 obtained by blending MA, PA and NY at a weight ratio of 93/5/2, weaving into a plain weave having a weaving density in the warp direction of 56 threads/25.4 mm and weaving density in the weft direction of 48 threads/25.4 mm, and subjecting to singeing and scouring under processing conditions employed in ordinary methods, followed by imparting a hydrophilizing agent containing polyethylene terephthalate-polyethylene glycol copolymer by a padding treatment method, and subsequently subjecting to heat setting at 180°C to obtain a plain weave fabric having a basis weight of 150 g/m<sup>2</sup> and adhered amount of hydrophilizing agent of 0.2% by weight to 0.5% by weight.

**[0077]** Perspiration absorption performance as defined in AATCC79 in the resulting fabric was initially 2.0 seconds and 25 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. When work clothes were fabricated using this fabric and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort.

### [Example 2]

**[0078]** Example 2 was carried out in the same manner as Example 1 with the exception of blending staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers (MA), para-type wholly aromatic polyamide fibers (PA), electrically conductive nylon fibers (NY) and flame-retardant polyester fibers (PE) (each having a fiber length of 51 mm) at a weight ratio of MA/PA/NY/PE of 73/5/2/20 into two-ply spun yarn having a yarn count of 40.

**[0079]** Moisture absorption performance as defined in AATCC79 in the resulting fabric was initially 0.9 seconds and 11 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. When work clothes were fabricated using this fabric and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort.

### [Example 3]

**[0080]** Example 3 was carried out in the same manner as Example 2 with the exception of weaving a double fabric having a weaving density in the warp direction of 56 threads/25.4 mm and weaving density in the weft direction of 60 threads/25.4 mm as in Example 2 in accordance with the weave structural diagram shown in FIG. 1.

**[0081]** Moisture absorption performance as defined in AATCC79 in the resulting fabric was initially 0.6 seconds and 9.0 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. When work clothes were fabricated using this fabric and worn, they were determined to absorb perspiration when perspiring, not stick to the skin, and have superior wear

comfort.

[Comparative Example 1]

**[0082]** Comparative Example 1 was carried out in the same manner as Example 1 with the exception of not imparting a hydrophilizing agent as in Example 1. Moisture absorption performance of the resulting fabric as defined in AATCC79 was initially 58 seconds and 48.0 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has no moisture absorbency. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. When work clothes were fabricated using this fabric and worn, perspiration was not absorbed when perspiring and were determined to be uncomfortable.

[Example 4]

**[0083]** Staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers (MA), para-type wholly aromatic polyamide fibers (PA), W-shaped cross-section polyester fibers (PE) and electrically conductive nylon fibers (NY) (each having a fiber length of 51 mm) were formed into two-ply spun yarn having a yarn count of 40 obtained by blending MA, PA, PE and NY at a weight ratio of 78/5/15/2, weaving into a plain weave having a weaving density in the warp direction of 56 threads/25.4 mm and weaving density in the weft direction of 48 threads/25.4 mm, and subjecting to singeing and scouring under processing conditions employed in ordinary methods, followed by imparting a perspiration absorption processing agent containing polyethylene terephthalate-polyethylene glycol copolymer by a padding treatment method, and subsequently subjecting to heat setting at 180°C to obtain a plain weave fabric having a basis weight of 150 g/m<sup>2</sup>.

**[0084]** Moisture absorption performance as defined in AATCC79 in the resulting fabric was initially 0.5 seconds and 8.0 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior perspiration absorbency. In addition, afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. When work clothes were fabricated using this fabric and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort.

[Example 5]

**[0085]** Example 5 was carried out in the same manner as Example 4 with the exception of blending staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers (MA), para-type wholly aromatic polyamide fibers (PA), W-shaped cross-section flame retardant polyester fibers (NPE) and electrically conductive nylon fibers (NY) (each having a fiber length of 51 mm) at a weight ratio of MA/PA/NPE/NY of 78/5/15/2 into two-ply spun yarn having a yarn count of 40.

**[0086]** Afterflame obtained by measuring flammability in the resulting fabric as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. In addition, moisture absorption performance as defined in AATCC79 was initially 1.1 seconds and 13 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency, and when work clothes were fabricated and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort.

[Example 6]

**[0087]** Example 6 was carried out in the same manner as Example 4 with the exception of blending staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers (MA), para-type wholly aromatic polyamide fibers (PA), round-shaped cross-section polyester fibers (PE) and electrically conductive nylon fibers (NY) (each having a fiber length of 51 mm) at a weight ratio of MA/PA/PE/NY of 78/5/15/2 into two-ply spun yarn having a yarn count of 40.

**[0088]** Afterflame obtained by measuring flammability of the resulting fabric as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. In addition, moisture absorption performance as defined in AATCC79 was initially 1.2 seconds and 12 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency, and when work clothes were fabricated and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort.

[Example 7]

**[0089]** Example 7 was carried out in the same manner as Example 4 with the exception of blending staple fibers respectively consisting of meta-type wholly aromatic polyamide fibers (MA), para-type wholly aromatic polyamide fibers (PA) and electrically conductive nylon fibers (NY) (each having a fiber length of 51 mm) at a weight ratio of MA/PA/NY

of 93/5/2 into two-ply spun yarn having a yarn count of 40 and using as warp yarn, and twisting this two-ply spun yarn having a yarn count of 40 with composite fibers composed of polyethylene terephthalate and polytrimethylene terephthalate (total fineness: 84 dtex/24 filaments) and using as weft yarn, followed by weaving the yarns into a plain weave having a weaving density in the warp direction of 56 threads/25.4 mm and weaving density in the weft direction of 43 threads/25.4 mm.

**[0090]** Afterflame obtained by measuring flammability of the resulting fabric as defined in Method A-4 of JIS L 1091-1992 was 2.0 seconds or less and did not present a problem. In addition, moisture absorption performance as defined in AATCC79 was initially 1.0 seconds and 14 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F), demonstrating that the fabric has superior moisture absorbency, and when work clothes were fabricated and worn, they were determined to absorb perspiration when perspiring and have superior wear comfort. In addition, the work clothes also demonstrated stretchability in the horizontal direction and were easy to move in.

[Example 8]

**[0091]** Meta-type wholly aromatic aramid fibers were produced according to the method indicated below.

**[0092]** 20.0 parts by weight of powdered poly(meta-phenylene isophthalamide), produced by interfacial polymerization in compliance with the method described in Japanese Examined Patent Publication No. S47-10863 and having an intrinsic viscosity (I.V.) of 1.9, were suspended in 80.0 parts by weight of N-methyl-2-pyrrolidone (NMP) cooled to -10°C and formed into a slurry. Continuing, the suspension was heated to 60°C to dissolve and obtain a transparent polymer solution. 3.0% by weight, based on the weight of the polymer, of powdered 2-[2H-benzotriazol-2-yl]-4,6-bis(1-methyl-1-phenylethyl) phenol (solubility in water: 0.01 mg/L) were mixed into this polymer solution and dissolved followed by vacuum degassing to obtain a spinning solution (spinning dope).

[Spinning/Coagulation Step]

**[0093]** The aforementioned spinning dope was discharged from a spinneret having a hole diameter of 0.07 mm and 500 holes into a coagulation bath at a bath temperature of 30°C to spin the dope into fibers. The composition of the coagulation bath consisted of water and NMP at a ratio of 45/55 (parts by weight), and the spinning dope was spun into fibers by discharging into the coagulation bath at a yarn speed of 7 m/min.

[Plastic Drawing Bath Drawing Step]

**[0094]** Continuing, drawing was carried out at a draw rate of 3.7 in a plastic drawing bath composed of water and NMP at a ratio 45/55 parts by weight at a temperature of 40°C.

[Washing Step]

**[0095]** Following drawing, washing was carried out in a bath containing water and NMP at a ratio of 70/30 parts by weight at 20°C (immersion length: 1.8 m) followed by washing in a water bath at 20°C (immersion length: 3.6 m), and further washing thoroughly by passing through a hot water bath at 60°C (immersion length: 5.4 m).

[Dry Heat Treatment Step]

**[0096]** The washed fibers were subjected to dry heat treatment with a heated roller having a surface temperature of 280°C to obtain meta-type wholly aromatic aramid fibers.

[Properties of Raw Fibers]

**[0097]** Properties of the resulting meta-type wholly aromatic aramid fibers consisted of fineness of 1.7 dtex, residual solvent of 0.08% by weight and degree of crystallization of 19%. The fibers indicated below were used for the other staple fibers.

Polyester fibers: Polyethylene terephthalate fibers, Teijin Ltd.

Flame-retardant rayon fibers: Lenzing FR®, Lenzing AG

Para-aramid fibers: Twaron®, Teijin Aramid B.V.

Electrically conductive yarn (nylon): No Shock®, Solcia Co., Ltd. (electrically conductive nylon yarn incorporating electrically conductive carbon fine particles)

**[0098]** Next, staple fibers respectively consisting of meta-type wholly aromatic aramid fibers (MA) (length: 51 mm), para-type wholly aromatic polyamide fibers (PA) (length: 50 mm), polyester fibers (length: 38 mm) and flame-retardant rayon (Ry) (length: 51 mm) were formed into two-ply spun yarn having a yarn count of 40 obtained by blending MA, PA, PE and RY at a weight ratio of 55/5/15/25, and then weaving at a weaving density in the warp direction of 67 threads/25.4 mm and weaving density in the weft direction of 56 threads/25.4 mm to obtain a twill fabric having a basis weight of 170 g/m<sup>2</sup>. After subjecting the fabric to dyeing and finishing processing according to ordinary methods, the fabric was subjected to the perspiration absorption processing indicated below.

[Fabric Perspiration Absorption Processing]

**[0099]** The fabric was immersed in a perspiration absorption processing agent in the form of polyethylene glycol-aminosilicone copolymer (50 g/L) and then compressed and dried followed by subjecting to dry heat setting for 2 minutes at 180°C.

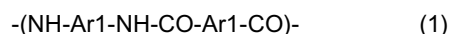
**[0100]** Afterflame obtained by measuring flammability in the resulting fabric as defined in Method A-4 of JIS L1091-1992 was 2.0 seconds or less and did not present a problem. In addition, moisture absorption performance as defined in AATCC79 was initially 0.9 seconds and 9.0 seconds after 20 cycles of laundering as defined in ISO6339-2012 (6N-F). When work clothes were fabricated using this fabric and worn, they were determined to absorb perspiration when perspiring, not stick to the skin and have superior wear comfort.

## INDUSTRIAL APPLICABILITY

**[0101]** According to the present invention, a fabric and textile product are provided that have durable moisture absorbency in addition to flame retardance, thereby having extremely high industrial value.

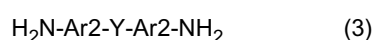
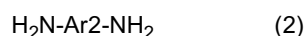
## Claims

1. A fabric comprising aramid fibers, wherein the fabric is imparted with a hydrophilizing agent.
2. The fabric according to claim 1, wherein the aramid fibers comprise 30% by weight to 97% by weight of meta-aramid fibers and 3% by weight to 70% by weight of para-aramid fibers.
3. The fabric according to claim 2, wherein the degree of crystallization of the meta-type wholly aromatic polyamide fibers is within the range of 15% to 25%.
4. The fabric according to claim 2, wherein the meta-type wholly aromatic polyamide that forms the meta-type wholly aromatic polyamide fibers is a meta-type wholly aromatic polyamide obtained by copolymerizing an aromatic diamine component or an aromatic dicarboxylic acid halide component in an aromatic polyamide backbone containing a repeating structural unit represented by the following formula (1), the aromatic diamine component or the aromatic dicarboxylic acid halide component having different primary constituent units in the repeating structures thereof, such that it is copolymerized as a third component at 1 mol% to 10 mol% based on the total amount of repeating structural units of the aromatic polyamide:



wherein, Ar1 represents a divalent aromatic group having a linking group in the meta coordination or in a coordination other than the parallel axis.

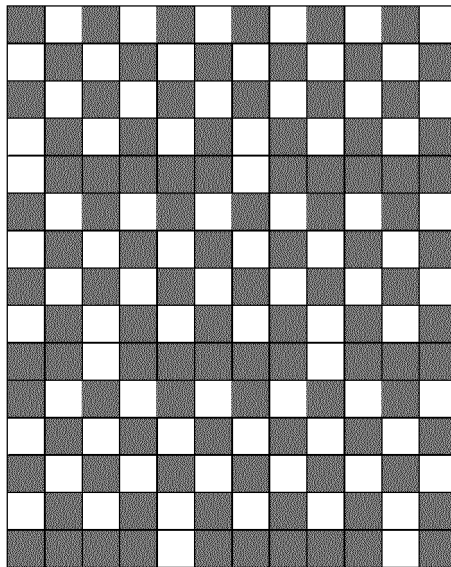
5. The fabric according to claim 4, wherein the aromatic diamine serving as a third component is represented by formula (2) or formula (3) and the aromatic dicarboxylic acid halide is represented by formula (4) or formula (5):



(wherein, Ar2 represents a divalent aromatic group different from Ar1, Ar3 represents a divalent aromatic group different from Ar1, Y represents at least one type of atom or functional group selected from the group consisting of an oxygen atom, sulfur atom and alkylene group, and X represents a halogen atom).

- 5 6. The fabric according to claim 2, wherein the residual amount of solvent in the meta-type aromatic polyamide fibers is 0.1% by weight or less.
- 10 7. The fabric according to claim 1, further containing electrically conductive fibers.
8. The fabric according to claim 1, further containing polyester fibers.
9. The fabric according to claim 8, wherein the polyester fibers are polyester fibers that contain a flame retardant.
- 15 10. The fabric according to claim 8, wherein the polyester fibers have an irregularly shaped cross-section.
11. The fabric according to claim 8, wherein the cross-sectional shape of monofilaments in the polyester fibers is flat, W-shaped, cross-shaped, hollow or triangular.
- 20 12. The fabric according to claim 8, wherein the aramid fibers and/or the electrically conductive fibers and/or the polyester fibers are contained in the fabric as spun yarn.
13. The fabric according to claim 8, wherein the aramid fibers and the polyester fibers are contained in the fabric as blended yarn.
- 25 14. The fabric according to claim 1, wherein the fabric has a double weave structure.
15. The fabric according to claim 1, wherein the hydrophilizing agent is polyethylene glycol diacrylate, a derivative of polyethylene glycol diacrylate, polyethylene terephthalate-polyethylene glycol copolymer, water-soluble polyurethane, or polyethylene glycol-aminosilicone copolymer.
- 30 16. The fabric according to claim 1, wherein the basis weight of the fabric is within the range of 130 g/m<sup>2</sup> to 260 g/m<sup>2</sup>.
17. The fabric according to claim 1, wherein the fabric is subjected to dyeing processing.
- 35 18. The fabric according to claim 1, wherein afterflame obtained by measuring flammability as defined in Method A-4 of JIS L1091-1992 is 2.0 seconds or less.
19. The fabric according to claim 1, wherein moisture absorption performance as defined in AATCC79 is 10 seconds or less.
- 40 20. The fabric according to claim 1, wherein water absorption performance as defined in AATCC79 after 20 cycles of laundering as defined in ISO6339-2012 (6N-F) is 30 seconds or less.
- 45 21. A textile product that uses the fabric according to claim 1 and is selected from the group consisting of protective clothing, fire-protective clothing, fire-fighting clothing, rescue clothing, workwear, police uniforms, self defense forces uniforms and military clothing.

FIG. 1



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/074013

## A. CLASSIFICATION OF SUBJECT MATTER

D03D15/00(2006.01)i, D03D11/00(2006.01)i, D03D15/12(2006.01)i, D06M15/27(2006.01)i, D06M15/507(2006.01)i, D06M15/53(2006.01)i, D06M15/564(2006.01)i, D06M101/32(2006.01)n, D06M101/36(2006.01)n

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)

D03D1/00-27/18, D06M13/00-15/715, D06M101/32, D06M101/36

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015  
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

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

DWPI(Thomson Innovation)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2004-115970 A (Teikoku Sen-i Co., Ltd.),	1, 2, 14-21
Y	15 April 2004 (15.04.2004), claim 1; paragraphs [0001], [0006]; examples (Family: none)	3-13
Y	JP 2014-129616 A (Teijin Ltd.), 10 July 2014 (10.07.2014), claims 1, 3 to 7, 9; paragraphs [0008], [0017] to [0019], [0022], [0027], [0034]; examples (Family: none)	3-13

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search  
04 November 2015 (04.11.15)

Date of mailing of the international search report  
24 November 2015 (24.11.15)

Name and mailing address of the ISA/  
Japan Patent Office  
3-4-3, Kasumigaseki, Chiyoda-ku,  
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/074013

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/104411 A1 (Teijin Ltd.), 03 July 2014 (03.07.2014), claims; page 5, lines 8 to 18; page 6, line 4 to page 8, line 8; page 9, line 1 to page 10, line 17; examples & CA 2895042 A claims; page 8, line 15 to page 9, line 14; page 10, line 21; page 14, line 19; page 16, lines 3 to 14; examples & CN 104903502 A & TW 201504492 A	3-13
Y	JP 2011-026727 A (Asahi Kasei Fibers Corp.), 10 February 2011 (10.02.2011), paragraph [0027] (Family: none)	10, 11
Y	JP 2006-057205 A (Asahi Kasei Fibers Corp.), 02 March 2006 (02.03.2006), paragraph [0018] (Family: none)	10, 11

Form PCT/ISA/210 (continuation of second sheet) (July 2009)



**REFERENCES CITED IN THE DESCRIPTION**

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- JP S4710863 B [0030] [0092]
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- JP 2012097380 A [0051]