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(54) FIREPROOF FABRIC AND SEAT

(57) A task is to provide a fire-resistant fabric and a seat each having excellent flame retardancy, fire resistance, strength, comfortability, and formability, and a solution to problem is that a fire-resistant fabric which has a bending resistance of 95 mm or less in the warp direction or in the weft direction, as measured by the method prescribed in JIS L 1096 (2010) A method (45° cantilever method), is obtained using a flame-retardant fiber having an LOI of 26 or more, as measured in accordance with JIS L 1091 (1999) E-2 method.

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Description

Technical Field

[0001] The present invention relates to a fire-resistant fabric and a seat each having excellent flame retardancy, fire resistance, strength, comfortability, and formability.

Background Art

[0002] In recent years, as the people's lifestyle is being more advanced, seat cushions for furniture, for bedding articles, especially beds used for nursing home and hospital, and for various facilities of transportation and the like are required to have a heat resistance and flame retardancy. Particularly, with respect to the seat cushion for use in aircraft, it is most important to protect precious lives from flames and the like, and there are extremely strict flame retardancy standards made by the Federal Aviation Administration (FAA) regulations.

[0003] Conventionally, a cushion of this type generally has fire-resistant fabric called an FBL (Fire Blocking Layer) laminated on a material having elastic properties, such as urethane. With respect to the fire-resistant fabric, for example, PTL 1 has proposed nonwoven fabric using a flame-resistant fiber.

[0004] However, such nonwoven fabric has a problem in that the fabric is so hard that it makes the person who seats on the fabric feel uncomfortable, and it is difficult to seat on the fabric for a long time.

Citation List

Patent Literature

[0005] PTL 1: International Patent Application Publication No. 1994/003393 pamphlet

Summary of Invention

Technical Problem

[0006] In view of the above, the present invention has been made, and an object of the invention is to provide a fire-resistant fabric and a seat each having excellent flame retardancy, fire resistance, strength, comfortability, and formability.

Solution to Problem

[0007] The present inventors have conducted extensive and intensive studies with a view toward achieving the above-mentioned object. As a result, it has been found that, by appropriately selecting the type of the fiber constituting the fire-resistant fabric and the cloth structure and the like, there can be obtained a fire-resistant fabric having excellent flame retardancy, fire resistance, strength, comfortability, and formability, and further extensive and intensive studies have been made, and the present invention has been completed.

[0008] Specifically, in the present invention, there is provided "a fire-resistant fabric comprising a flame-retardant fiber having an LOI of 26 or more, as measured in accordance with JIS L 1091 (1999) E-2 method, wherein the fire-resistant fabric has a bending resistance of 95 mm or less in the warp direction or in the weft direction, as measured by the method prescribed in JIS L 1096 (2010) A method (45° cantilever method)".

[0009] In the invention, it is preferred that the fire-resistant fabric has a circular knitted structure. It is preferred that the fire-resistant fabric is formed from double knit. It is preferred that the fire-resistant fabric contains a meta-aramid fiber and a para-aramid fiber and/or an oxidized polyacrylonitrile fiber as the flame-retardant fiber.

[0010] Further, the fire-resistant fabric of the invention preferably has a weight per unit of 400 g/m^2 or less. The fire-resistant fabric preferably has an air permeability of 90 cm^3/cm^2•sec or more. The fire-resistant fabric preferably has an elongation of 8% or more, as measured in accordance with JIS 1096 (2010) D method (constant load method) Cut strip method, at a distance between two gage marks: 200 mm, and at a constant load: 4.9 N, and has a stretch modulus of 70% or more, as measured in accordance with JIS L 1096 (2010) E method (constant load method) Cut strip method at a constant load: 0.89 N, with repeating loading: once. The fire-resistant fabric preferably has a burst strength of 1,000 kPa or more, as measured in accordance with JIS L 1096 (2010) A method (Mullen method).

[0011] Further, in the invention, a seat having the fire-resistant fabric sandwiched between face fabric and a cushioning material is provided. In the seat, it is preferred that the fire-resistant fabric is fixed to the face fabric by sewing. It is preferred that the seat is for use in aircraft, vehicle, rolling stock, vessel, hospital, nursing home, theater, or interior decoration.

Advantageous Effects of Invention

[0012] By the present invention, there are obtained a fire-resistant fabric and a seat each having excellent flame retardancy, fire resistance, strength, comfortability, and formability.

Description of Embodiments

[0013] Hereinbelow, an embodiment of the present invention will be described in detail. The flame-retardant fiber used in the invention is a flame-retardant fiber having an LOI of 26 or more, as measured in accordance with JIS L 1091 (1999) E-2 method.

[0014] With respect to the flame-retardant fiber, for example, wholly aromatic polyamide fibers, such as a meta-type wholly aromatic polyamide fiber (meta-aramid fiber) and a para-type wholly aromatic polyamide fiber (para-aramid fiber), a polybenzimidazole fiber, a polyimide fiber, a polyamide-imide fiber, a polyether imide fiber, a polyarylate fiber, a polyparaphenylenebenzobisoxazole fiber, a novoloid fiber, a flame-retardant acrylic fiber, a polychlal fiber, a flame-retardant polyester fiber, a flame-retardant cotton fiber, a flame-retardant rayon fiber, a flame-retardant vinylon fiber, a flame-retardant wool fiber, and the like can be used individually or in combination.

[0015] Further, it is preferred that the flame-retardant fiber has a melting point of 300°C or higher. Examples of such fibers include wholly aromatic polyamide fibers (a meta-type wholly aromatic polyamide fiber and a para-type wholly aromatic polyamide fiber), a polybenzimidazole fiber, a polyimide fiber, a polyamide-imide fiber, and an oxidized polyacrylonitrile fiber.

[0016] These flame-retardant fibers may contain an additive, such as an antioxidant, an ultraviolet light absorber, a heat stabilizer, a flame retardant, titanium oxide, a coloring agent, or inert fine particles, in such an amount that the effects aimed at by the invention are not sacrificed.

[0017] Particularly, it is preferred that the flame-retardant fiber has an LOI of 26 or more and a melting point of 400°C or higher. Examples of such fibers include wholly aromatic polyamide fibers (a meta-type wholly aromatic polyamide fiber and a para-type wholly aromatic polyamide fiber).

[0018] The meta-type wholly aromatic polyamide fiber is a fiber formed from a polymer in which 85 mol% or more of the repeating units are m-phenyleneisophthalamide. The meta-type wholly aromatic polyamide may be a copolymer containing a third component in an amount in the range of less than 15 mol%.

[0019] The meta-type wholly aromatic polyamide can be produced by a known interfacial polymerization method, and there is preferably used the meta-type wholly aromatic polyamide having, in terms of the degree of polymerization of the polymer, an intrinsic viscosity (I.V.) in the range of from 1.3 to 1.9 dl/g, as measured in the form of an N-methyl-2-pyrrolidone solution of the polymer having a concentration of 0.5 g/100 ml.

[0020] The meta-type wholly aromatic polyamide may contain an alkylbenzenesulfonic acid onium salt. Examples of alkylbenzenesulfonic acid onium salts include compounds, such as tetrabutylphosphonium hexylbenzenesulfonate, tributylbenzylphosphonium hexylbenzenesulfonate, tetraphenylphosphonium dodecylbenzenesulfonate, tributyltetradecylphosphonium dodecylbenzenesulfonate, tetrabutylphosphonium dodecylbenzenesulfonate, and tributylbenzylammonium dodecylbenzenesulfonate. Of these, especially preferred is tetrabutylphosphonium dodecylbenzenesulfonate or tributylbenzylammonium dodecylbenzenesulfonate because they are easily available and have excellent thermal stability as well as high solubility in N-methyl-2-pyrrolidone.

[0021] For obtaining a satisfactory improvement effect for the dyeing properties, the amount of the alkylbenzenesulfonic acid onium salt contained is preferably 2.5 mol% or more, preferably in the range of from 3.0 to 7.0 mol%, based on the mole of the poly-m-phenyleneisophthalamide.

[0022] With respect to the method for mixing poly-m-phenyleneisophthalamide with an alkylbenzenesulfonic acid onium salt, there is used a method in which poly-m-phenyleneisophthalamide is mixed into and dissolved in a solvent and then an alkylbenzenesulfonic acid onium salt is dissolved in the solvent, or the like. The thus obtained dope is formed into a fiber by a known method.

[0023] For the purpose of improving the dyeing properties and the resistance to discoloration and color fading and the like, with respect to the polymer used in the meta-type wholly aromatic polyamide fiber, which has an aromatic polyamide skeleton comprising repeating structural units represented by the formula (1) below, an aromatic diamine component different from the main constituent units of the repeating structure, or an aromatic dicarboxylic acid halide component can be copolymerized as a third component with the aromatic polyamide skeleton so that the amount of the third component becomes 1 to 10 mol%, based on the total mole of the repeating structural units of the aromatic polyamide:

$$-(NH\text{-}Ar1\text{-}NH\text{-}CO\text{-}Ar1\text{-}CO)- \qquad \text{Formula (1)}$$

wherein Ar1 is a divalent aromatic group having a bonding group at a position other than the meta position or the parallel axis direction.

[0024] As a third component, an aromatic diamine or aromatic dicarboxylic acid dichloride represented by the formula (2), (3), (4), or (5) below can be copolymerized.

[0025] Specific examples of aromatic diamines represented by the formula (2) or (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 the formula (4) or (5) include terephthalic acid chloride, 1,4-naphthalenedicarboxylic acid chloride, 2,6-naphthalenedicarboxylic acid chloride, 4,4'-biphenyldicarboxylic acid chloride, 5-chloroisophthalic acid chloride, 5-methoxyisophthalic acid chloride, and bis(chlorocarbonylphenyl) ether.

$H_2N\text{-}Ar2\text{-}NH_2$ Formula (2)

$H_2N\text{-}Ar2\text{-}Y\text{-}Ar2\text{-}NH_2$ Formula (3)

XOC-Ar3-COX Formula (4)

XOC-Ar3-Y-Ar3-COX 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 atom or functional group selected from the group consisting of an oxygen atom, a sulfur atom, and an alkylene group, and X represents a halogen atom.

[0026] The crystallinity of the meta-type wholly aromatic polyamide fiber is preferably 5 to 35% because the absorption for a dye is excellent such that an intended color can be easily achieved even when using the dye in a reduced amount or even under poor dyeing conditions. Further, the crystallinity is more preferably 15 to 25% because localization of a dye in the surface is unlikely to occur and a high resistance to discoloration and color fading is obtained and further dimensional stability required for the practical use can be secured.

[0027] The residual solvent content of the meta-type wholly aromatic polyamide fiber is preferably 0.1% by weight or less (preferably 0.001 to 0.1% by weight) because excellent flame retardancy of the meta-type wholly aromatic polyamide fiber is not sacrificed.

[0028] With respect to the meta-type wholly aromatic polyamide fiber, in view of obtaining excellent lightfastness, preferred is, for example, the dope-dyed meta-type wholly aromatic polyamide fiber described in International Patent Application Publication No. 2013/061901 pamphlet. Examples of pigments used in the fiber include organic pigments, such as azo, phthalocyanine, perinone, perylene, and anthraquinone pigments, and inorganic pigments, such as carbon black, ultramarine blue, red iron oxide, titanium oxide, and iron oxide.

[0029] Examples of methods for mixing the meta-type wholly aromatic polyamide with a pigment include a method in which an amide solvent slurry having a pigment uniformly dispersed in an amide solvent is prepared, and the amide solvent slurry is added to a solution having the meta-type wholly aromatic polyamide dissolved in an amide solvent, and a method in which a pigment powder is directly added to a solution having the meta-type wholly aromatic polyamide dissolved in an amide solvent.

[0030] The amount of the pigment incorporated is 10.0% by weight or less, preferably 5.0% by weight or less, based on the weight of the meta-type wholly aromatic polyamide. When the pigment is added in an amount of more than 10.0% by weight, the obtained fiber is likely to be poor in physical properties.

[0031] With respect to the polymerization method for the meta-type wholly aromatic polyamide polymer, for example, the solution polymerization method or interfacial polymerization method described in JP-B-35-14399, U.S. Patent No. 3,360,595, JP-B-47-10863, or the like may be used.

[0032] As a spinning solution, an amide-solvent solution containing an aromatic copolyamide polymer obtained by the above-mentioned solution polymerization, interfacial polymerization, or the like may be used, or a solution obtained by isolating the polymer from the above-mentioned polymerization solution and dissolving the polymer in an amide solvent may be used.

[0033] Examples of amide solvents used in the polymerization include N,N-dimethylformamide, N,N-dimethylacetamide, N-methyl-2-pyrrolidone (NMP), and dimethyl sulfoxide.

[0034] When the copolymerized aromatic polyamide polymer solution obtained as mentioned above further contains an alkali metal salt or an alkaline earth metal salt, the solution is stabilized and can be advantageously used in a higher concentration at low temperatures. The amount of the alkali metal salt or alkaline earth metal salt is preferably 1% by weight or less, more preferably 0.1% by weight or less, based on the weight of the polymer solution. In this case, the polymer solution preferably contains a flame retardant.

[0035] In the spinning and coagulation step, the above-obtained spinning solution (meta-type wholly aromatic polyamide polymer solution or dope-dyed meta-type wholly aromatic polyamide polymer solution) is discharged into a coagulation liquid so as to undergo coagulation.

[0036] With respect to the spinning apparatus, there is no particular limitation, and a known wet spinning apparatus can be used. Further, with respect to the number of spinning holes of a spinning nozzle, the arrangement of the holes, the form of the hole, and the like, there is no particular limitation as long as wet spinning can be stably made, and, for example, a multihole spinning nozzle for rayon yarn having 1,000 to 30,000 holes and having a spinning hole diameter of 0.05 to 0.2 mm, or the like may be used.

[0037] The temperature of the above-obtained spinning solution (meta-type wholly aromatic polyamide polymer solution) being discharged from a spinning nozzle is suitably in the range of from 20 to 90°C.

[0038] In a coagulation bath used for obtaining a fiber, an amide solvent containing substantially no inorganic salt is used. Particularly, an aqueous solution having an NMP concentration of 45 to 60% by weight at a bath solution temperature in the range of from 10 to 50°C is preferably used. When the amide solvent (preferably NMP) concentration is less than 45% by weight, a structure having a thick skin is disadvantageously formed, so that the washing efficiency in the washing step is lowered, making it difficult to reduce the residual solvent content of the fiber. On the other hand, when the amide solvent (preferably NMP) concentration is more than 60% by weight, coagulation throughout the inside of the fiber cannot be achieved, making it difficult to reduce the residual solvent content of the fiber. The time for immersing the fiber in the coagulation bath is suitably in the range of from 0.1 to 30 seconds.

[0039] Drawing is conducted using an amide solvent. Particularly, it is preferred that, in a plasticized drawing bath containing an aqueous solution having an NMP concentration of 45 to 60% by weight at a bath solution temperature in the range of from 10 to 50°C, the fiber is subjected to drawing at a draw ratio of 3 to 4 times. After drawing, the resultant fiber is well washed through an aqueous solution having an NMP concentration of 20 to 40% by weight at 10 to 30°C and further through a warm water bath at 50 to 70°C.

[0040] The fiber after being washed is subjected to dry heat treatment at a temperature of 270 to 290°C, obtaining a meta-type wholly aromatic polyamide fiber which satisfies the crystallinity and residual solvent content in the above-mentioned respective ranges.

[0041] By the above-described method, the crystallinity and residual solvent content in the above-mentioned respective preferred ranges can be achieved.

[0042] The meta-type wholly aromatic polyamide fiber may be in the form of either a continuous fiber (multifilament) or a short fiber. When mixed with another fiber, a short fiber having a fiber length of 25 to 200 mm is preferred, and the short fiber having a single fiber fineness of 1 to 5 dtex is more preferred.

[0043] Further, with respect to the meta-type wholly aromatic polyamide fiber, in view of improving the strength of the cloth, it is preferred that a mixed yarn of the meta-type wholly aromatic polyamide fiber and a para-type wholly aromatic polyamide fiber and/or an oxidized polyacrylonitrile fiber is contained in the cloth.

[0044] The para-type wholly aromatic polyamide fiber used in this case is more preferably a paraphenyleneterephthalamide fiber or a coparaphenylene-3,4'-oxydiphenyleneterephthalamide fiber.

[0045] In the fire-resistant fabric of the invention, the flame-retardant fiber is preferably contained in an amount of 80% by weight or more (more preferably 100% by weight), based on the cloth weight of the fire-resistant fabric.

[0046] With respect to the fiber used in the invention, a multifilament (continuous fiber) or a spun yarn obtained by mix spinning of the above-mentioned fiber is preferably used. Particularly, from a functional point of view, a spun yarn is preferred. In this case, the spun yarn is preferably of a yarn count that is generally used for clothing, for example, English cotton yarn count 20 to 60. The spun yarn may be used in the form of a single yarn or may be used after being twisted.

[0047] The fire-resistant fabric of the invention is required to have such stretchability and flexibility that the fabric can follow the deformation caused during seating and to have air permeability, and therefore is preferably knitted fabric. The knitted fabric may be warp-knitted fabric, but is preferably circular knitted fabric (weft-knitted fabric).

[0048] When used in the vehicle and aircraft applications, the fire-resistant fabric is required to be lightweight, and is further needed to have heat shield properties, and therefore preferably has a thickness. In view of the above, double knit is preferred. The method for producing such double knit may be a known method, and production of the double knit by means of a circular knitting machine is preferred.

[0049] The structure of the double knit is preferably interlock as a general structure, but may be rib, purl, or a modified structure thereof. For improving the heat shield properties, a structure having an uneven surface is also preferably used.

[0050] With respect to the cloth, it is preferred that, after knitting (or weaving), an oil agent or a wax is removed from the cloth in view of surely achieving flame retardancy. Especially preferred is washing processing by a general method.

[0051] For surely achieving aesthetic properties of a seat using the fire-resistant fabric, it is preferred that the fabric is colored with a deep color, and, for example, black or dark blue pigment dope-dyeing, or dyeing using a carrier, or the like is preferably used. Further, as another processing for imparting a function, a sweat absorber, a water repellent, a thermal storage agent or an antistatic agent, an anti-fungus agent, a deodorant, a mothproofing agent, a mosquito repellent, a mosquito repellent, a phosphorescent agent, a retroreflective agent, or the like may be applied to the fabric.

[0052] It is important that the thus obtained fire-resistant fabric has a bending resistance of 95 mm or less (preferably 10 to 80 mm, more preferably 30 to 60 mm) in the warp direction or in the weft direction, as measured by the method

prescribed in JIS L 1096 (2010) A method (45° cantilever method). Particularly, it is preferred that the fire-resistant fabric has a bending resistance of 95 mm or less (preferably 10 to 80 mm, more preferably 30 to 60 mm) in the warp direction and the weft direction (the wales direction and the course direction). When the bending resistance in the warp direction and the weft direction is larger than 95 mm, the fire-resistant fabric is likely to be so hard that the comfortability or formability becomes poor.

[0053] With respect to the fire-resistant fabric of the invention, in view of the lightweight properties, it is preferred that the fire-resistant fabric has a weight per unit in the range of 400 g/m^2 or less (preferably 200 to 400 g/m^2). Further, the fire-resistant fabric preferably has a thickness in the range of 0.5 to 2.0 mm. In view of the comfortability, the fire-resistant fabric preferably has an air permeability of 90 cm^3/cm^2•sec or more (more preferably 100 to 300 cm^3/cm^2•sec). Further, it is preferred that the fire-resistant fabric has an elongation of 8% or more, as measured in accordance with JIS 1096 (2010) D method (constant load method) Cut strip method, at a distance between two gage marks: 200 mm, and at a constant load: 4.9 N, and has a stretch modulus of 70% or more, as measured in accordance with JIS L 1096 (2010) E method (constant load method) Cut strip method at a constant load: 0.89 N, with repeating loading: once. In view of surly obtaining the strength during seating, the fire-resistant fabric preferably has a burst strength of 1,000 kPa or more (more preferably 1,000 to 3,000 kPa), as measured in accordance with JIS L 1096 (2010) A method (Mullen method).

[0054] In the case of forming a seat by sewing the fabric, for maintaining excellent appearance even when the fire-resistant fabric is exposed through stitches, the fire-resistant fabric preferably has a deep color, i.e., a low lightness, and preferably has an L* of 30 or less (more preferably 5 to 25), as measured in accordance with JIS Z 8781-4.

[0055] Further, the fire-resistant fabric is required to have durability when exposed to a flame, and therefore, when the fire-resistant fabric is subjected to flame hole forming test in which the fabric is brought into contact with a burner flame at about 1,100 to 1,200°C and a period of time required until the fabric is carbonized and torn is measured, the above-mentioned time is preferably 100 seconds or more (more preferably 200 to 1,000 seconds).

[0056] By virtue of having the above-mentioned construction, the fire-resistant fabric of the present invention has excellent flame retardancy, fire resistance, strength, comfortability, and formability.

[0057] The fire-resistant fabric is preferably used for a seat. Especially preferred is a seat having the fire-resistant fabric sandwiched between face fabric and a cushioning material. In the seat, it is preferred that the fire-resistant fabric is stacked on the face fabric without using a bonding agent. For example, it is preferred that the fire-resistant fabric is fixed to the face fabric by sewing.

[0058] For example, it is preferred that the fire-resistant fabric is used as an upholstery backing material, and a cushioning material, such as urethane, is covered with the fire-resistant fabric, and further covered with upholstery face fabric. In the seat, it is preferred that the face fabric and the fire-resistant fabric are not bonded but the fire-resistant fabric is partially fixed to the face fabric by sewing or the like. By virtue of this, formation of wrinkles caused due to a difference between the stretchability of the face fabric and the stretchability of the fire-resistant fabric can be suppressed, and the fire-resistant fabric can exhibit air permeability, so that a seat also having comfortability and the like can be obtained. The seat uses the above-mentioned fire-resistant fabric, and therefore has excellent flame retardancy, heat shield properties, air permeability, and cushioning properties.

[0059] The seat is advantageously used as a seat for use in aircraft, vehicle, rolling stock, vessel, hospital, nursing home, theater, interior decoration, or the like.

Examples

[0060] Hereinbelow, the present invention will be described in detail with reference to the following Examples, which should not be construed as limiting the scope of the invention.

(1) Weight per unit
A weight per unit was measured in accordance with JIS L 1096 (2010) A method.
(2) Thickness
A thickness was measured in accordance with JIS L 1096 (2010) A method.
(3) Air permeability
An air permeability was measured in accordance with JIS L 1096 (1990) Air permeability A method (Frajour method).
(4) Burst strength
A burst strength was measured in accordance with JIS L 1096 (2010) A method (Mullen method).
(5) Bending resistance
A bending resistance was measured in accordance with JIS L 1096 (2010) A method (45° cantilever method).
(6) Elongation
An elongation was measured in accordance with JIS 1096 (2010) D method (constant load method) Cut strip method at a distance between two gage marks: 200 mm, and at a constant load: 4.9 N.
(7) Stretch modulus

A stretch modulus was measured in accordance with JIS L 1096 (2010) E method (constant load method) Cut strip method at a constant load: 0.89 N, with repeating loading: once.

(8) Wrinkle evaluation

An urethane foam was formed into a seating face form, and the double knit described in Example 1, 2, or 4 below was cut according to the above form, and sewn at the corners of the seating face end side, and bonded to the urethane foam in the seating face form using an urethane bonding agent. Further, a leather was cut into forms of the seating face and the side, and fixed to the double knit by sewing. Further, the seating face of the leather was sewn with the seating face end side.

[0061] With respect to the sewing site of the seating face with the seating face end side, examination was made to check whether or not fine sewing winkles along the stitches and relatively large wavy winkles formed by waving of the leather itself were caused, and evaluation was made according to the criteria shown below. The fabric having excellent form following properties is unlikely to cause wrinkles even when covering a structure having a curved sheet form.

[0062] ○: Excellent such that neither sewing winkles nor wavy winkles are found.

[0063] ×: Poor such that both sewing winkles and wavy winkles are found.

(9) Lightness

[0064] An L* was measured in accordance with JIS Z 8781-4.

(10) Flame hole forming test

[0065] Using a heat source under the conditions shown below, a flame was brought into contact with a piece of the double knit described in the Examples below, and simultaneously measurement of a time was started, and a period of time required until the double knit was carbonized and a through-hole was formed in the knit so that the flame was able to be seen was measured.

- Burner: Bunsen burner having an inner diameter of 1.1 to 1.2 mm
- Fuel: LP gas
- Fuel feed pressure: 0.55 to 0.6 MPa
- Height of a flame: 13 to 15 cm
- Distance between the burner and the double knit: 7 cm

[Example 1]

[0066] Using the materials shown below, a single yarn of English cotton yarn count 40 was produced by a known method.

(Material)

[0067] "Meta-type wholly aromatic polyamide fiber dope-dyed short fiber": "Conex" (registered trademark), manufactured by Teijin Limited; average single fiber fineness: 1.7 dtex; fiber length: 51 mm (hereinafter, referred to as "meta-aramid fiber") "Para-type wholly aromatic polyamide short fiber": "Technora" (registered trademark), manufactured by Teijin Limited; average single fiber fineness: 1.7 dtex; fiber length: 51 mm (hereinafter, referred to as "para-aramid fiber")

[0068] Then, the obtained yarn count 40 single yarn was double-ply twisted at 19.8 twists/2.54 cm, and subjected to steam setting at 100°C for 60 minutes.

[0069] Using the yarn count 40 double-ply yarn, and using a 20-gauge double knit circular knitting machine in which the cylinder diameter is 30 inches (1 inch = 2.54 cm), and the number of fed yarns for each of cylinder and dial is 48, knitting of double knit having an interlock structure was conducted, and the resultant knit was subjected to washing, drying, cutting, and heat setting by a general method. The obtained double knit had properties and results of the evaluation shown in Table 1.

[Example 2]

[0070] Using the materials shown below, a single yarn of English cotton yarn count 40 was produced by a known method.

(Material)

[0071] "Meta-type wholly aromatic polyamide fiber dope-dyed short fiber": "Conex" (registered trademark), manufac-

tured by Teijin Limited; average single fiber fineness: 1.7 dtex; fiber length: 51 mm (hereinafter, referred to as "meta-aramid fiber")

[0072] "Para-type wholly aromatic polyamide short fiber": "Technora" (registered trademark), manufactured by Teijin Limited; average single fiber fineness: 1.7 dtex; fiber length: 51 mm (hereinafter, referred to as "para-aramid fiber")

[0073] "Oxidized polyacrylonitrile fiber": "Pyromex" (registered trademark), manufactured by Teijin Limited; average single fiber fineness: 2.2 dtex; fiber length: 51 mm

[0074] Then, the obtained yarn count 40 single yarn was double-ply twisted at 19.8 twists/2.54 cm, and subjected to steam setting at 100°C for 60 minutes.

[0075] Using the yarn count 40 double-ply yarn, and using a 20-gauge double knit circular knitting machine in which the cylinder diameter is 30 inches (1 inch = 2.54 cm), and the number of fed yarns for each of cylinder and dial is 48, knitting of double knit having an interlock structure was conducted, and the resultant knit was subjected to washing, drying, cutting, and heat setting by a general method. The obtained double knit had properties and results of the evaluation shown in Table 1.

[Example 3]

[0076] Evaluation for wrinkles was made in substantially the same manner as in the wrinkle evaluation in Example 1 except that a leather was fixed to the double knit by bonding the entire surface using an urethane bonding agent, instead of sewing. In the wrinkle evaluation, sewing winkles and wavy winkles were found.

[Example 4]

[0077] Using the material shown below, a single yarn of English cotton yarn count 30 was produced by a known method.

[0078] "Unpigmented meta-type wholly aromatic polyamide fiber short fiber": "Conex" (registered trademark), manufactured by Teijin Limited; average single fiber fineness: 1.7 dtex; fiber length: 51 mm (hereinafter, referred to as "meta-aramid fiber")

[0079] Using the yarn count 30 single yarn, and using a 20-gauge double knit circular knitting machine in which the cylinder diameter is 30 inches (1 inch = 2.54 cm), and the number of fed yarns for each of cylinder and dial is 48, knitting of double knit having a tuck mock structure was conducted, and the resultant knit was subjected to washing, drying, cutting, and heat setting by a general method. The obtained double knit had properties and results of the evaluation shown in Table 1.

[Table 1]

				Example 1	Example 2	Example 3	Example 4
Use of yarn	Cylinder	Material	Meta-aramid fiber	95%	65%	95%	100%
			Para-aramid fiber	5%	5%	5%	-
			Oxidized acrylic fiber	-	30%	-	-
		Yarn count		40/2	40/2	40/2	-
	Dial	Material	Meta-aramid fiber	95%	65%	95%	100%
			Para-aramid fiber	5%	5%	5%	-
			Oxidized acrylic fiber	-	30%	-	
		Yarn count		40/2	40/2	40/2	30/1
Gauge Course/ 2.54 cm				20	20	20	20
				37	37	37	37

(continued)

				Example 1	Example 2	Example 3	Example 4
Wales/2.54 cm				28	28	28	28
Structure				Interlock	Interlock	Interlock	Tuck mock
Weight per unit Thickness		g/m^2		340	345	340	250
Air permeability		mm		1.3	1.3	1.3	1.0
Burst strength		cm^3/cm^2•sec		110	110	110	220
		kPa		1890	1700	1890	1000
Bending resistance		mm	Wales	51	55	51	30
			Course	33	40	33	20
Elongation		%	Wales	11	9	11	20
			Course	28.3	25	28.3	50
Stretch modulus		%	Wales	75.8	72	75.8	80
Wrinkle evaluation			Course	94.1	85	94.1	95
L*				○	○	×	○
Flame hole forming				19	19	19	86
		sec		262	262	262	4

[Comparative Examples 1 and 2]

[0080] As a meta-type wholly aromatic polyamide fiber, the above-mentioned "Conex" (registered trademark), manufactured by Teijin Limited, was used, and, as a flame-resistant crimped short fiber, an oxidized polyacrylonitrile fiber ("Pyromex" (registered trademark), manufactured by Teijin Limited; 2.2 dtex; 74 mm) obtained by oxidizing a polyacrylonitrile fiber having a weight residue of 48%, as measured by a nonflammability test method, was used. As a thermoplastic elastic fiber, an eccentric sheath-core manner conjugate fiber (single fiber fineness: 6.6 dtex) was used, wherein the conjugate fiber was obtained in such a way that a block copolymerized polyether polyester elastomer as a sheath portion and polybutylene terephthalate as a core portion were spun by a general method so that the core/sheath weight ratio became 50:50, and drawn at 2.0 times and cut into 64 m, and then subjected to heat treatment with warm water at 95°C to reduce shrinkage and cause crimps, and dried and then an oil agent was applied to the resultant fiber, wherein the block copolymerized polyether polyester elastomer was obtained by, while heating, reacting 38% by weight of polybutylene terephthalate obtained by polymerizing an acid component having terephthalic acid and isophthalic acid mixed in a 80/20 (mol%) ratio and butylene glycol with 62% by weight of polybutylene glycol (molecular weight: 2,000).

[0081] 70% by weight of the matrix fiber (the above-mentioned meta-type wholly aromatic polyamide fiber:the above-mentioned oxidized polyacrylonitrile fiber = 1:0.2) and 30% by weight of the above-mentioned thermoplastic elastic fiber were subjected to fiber blending by means of a card to obtain a web. The obtained webs were stacked and placed in a mold in a flat plate form so that the thickness became 10 cm, and subjected to heat treatment at 200°C for 10 minutes. Two types of web specimens having different numbers of the webs were prepared. With respect to the obtained webs, the properties and the results of the evaluation are shown in Table 2. Both Comparative Examples 1 and 2 were unsatisfactory in respect of the burst strength.

[Table 2]

		Comparative Example 1	Comparative Example 2
Weight per unit	g/m^2	300	450

(continued)

		Comparative Example 1	Comparative Example 2
Air permeability	cm^3/cm^2•sec	110	90
Burst strength	kPa	500	700
Bending resistance	mm	100	100
Elongation	%	30	30
Stretch modulus	%	80	80
Wrinkle evaluation		○	○
L*		30	30
Flame hole forming	sec	300 or more	300 or more

Industrial applicability

[0082] In the present invention, there are provided a fire-resistant fabric and a seat each having excellent flame retardancy, fire resistance, strength, comfortability, and formability, and the invention is of extremely great industrial significance.

Claims

1. A fire-resistant fabric comprising a flame-retardant fiber having an LOI of 26 or more, as measured in accordance with JIS L 1091 (1999) E-2 method, wherein the fire-resistant fabric has a bending resistance of 95 mm or less in the warp direction or in the weft direction, as measured by the method prescribed in JIS L 1096 (2010) A method (45° cantilever method).

2. The fire-resistant fabric according to claim 1, which has a circular knitted structure.

3. The fire-resistant fabric according to claim 1 or 2, which is formed from double knit.

4. The fire-resistant fabric according to any one of claims 1 to 3, which contains a meta-aramid fiber and a para-aramid fiber and/or an oxidized polyacrylonitrile fiber as the flame-retardant fiber.

5. The fire-resistant fabric according to any one of claims 1 to 4, which has a weight per unit of 400 g/m^2 or less.

6. The fire-resistant fabric according to any one of claims 1 to 5, which has an air permeability of 90 cm^3/cm^2•sec or more.

7. The fire-resistant fabric according to any one of claims 1 to 6, which has an elongation of 8% or more, as measured in accordance with JIS 1096 (2010) D method (constant load method) Cut strip method, at a distance between two gage marks: 200 mm, and at a constant load: 4.9 N, and which has a stretch modulus of 70% or more, as measured in accordance with JIS L 1096 (2010) E method (constant load method) Cut strip method, at a constant load: 0.89 N, with repeating loading: once.

8. The fire-resistant fabric according to any one of claims 1 to 7, which has a burst strength of 1,000 kPa or more, as measured in accordance with JIS L 1096 (2010) A method (Mullen method).

9. A seat having the fire-resistant fabric according to any one of claims 1 to 8 sandwiched between face fabric and a cushioning material.

10. The seat according to claim 9, wherein the fire-resistant fabric is fixed to the face fabric by sewing.

11. The seat according to claim 9 or 10, which is for use in aircraft, vehicle, rolling stock, vessel, hospital, nursing home, theater, or interior decoration.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/030003

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. D04B1/16(2006.01)i, A47C27/22(2006.01)i
FI: D04B1/16, A47C27/22 B

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)
Int. Cl. A47C27/00-27/22, A47C31/00-31/12, D03D1/00-27/18, D04B1/00-1/28, D04B21/00-21/20

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	1971-2020
Registered utility model specifications of Japan	1996-2020
Published registered utility model applications of Japan	1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JSTPlus/JMEDPlus/JST7580 (JDreamIII)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2018-188753 A (TEIJIN LTD.) 29 November 2018, claims, paragraph [0037]	1-8
X	JP 10-072743 A (TOYOBO CO., LTD.) 17 March 1998, claims, paragraphs [0001], [0003], [0019], [0024], examples	1-11
A	JP 2006-169687 A (TOYOBO CO., LTD.) 29 June 2006, claims	1-11
A	US 2016/0183694 A1 (FINE COTTON FACTORY INC.) 30 June 2016	1-11
A	US 2011/0173757 A1 (DENVER MATTRESS CO. LLC) 21 July 2011	1-11

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

☒ See patent family annex.

* Special categories of cited documents:
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29.09.2020	20.10.2020
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/030003

Patent Documents referred to in the Report	Publication Date	Patent Family	Publication Date
JP 2018-188753 A	29.11.2018	(Family: none)	
JP 10-072743 A	17.03.1998	(Family: none)	
JP 2006-169687 A	29.06.2006	(Family: none)	
US 2016/0183694 A1	30.06.2016	WO 2015/013825 A1	
US 2011/0173757 A1	21.07.2011	(Family: none)	

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 1994003393 A **[0005]**
- WO 2013061901 A **[0028]**
- JP 3514399 B **[0031]**
- US 3360595 A **[0031]**
- JP 47010863 B **[0031]**