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# (54) LONG-FIBER WOVEN FABRIC AND METHOD FOR PRODUCING LONG-FIBER WOVEN FABRIC

(57) This long-fiber woven fabric comprises long fibers formed by two-component conjugate spinning from poly(ethylene terephthalate) and a copolyester, and has an apparent density of 0.1-0.25 g/cc and a recovery from 50% elongation of 55% or greater.

Processed by Luminess, 75001 PARIS (FR)

## Description

### TECHNICAL FIELD

**[0001]** The present invention (first and second aspects of the present invention) relates to a long-fiber nonwoven fabric and a method for producing a long-fiber nonwoven fabric.

### BACKGROUND ART

**[0002]** Patches, bandages, or the like to be used for medical applications or the like are needed to follow the movement of the skin caused by moving a joint or the like. In addition, they are required to have a high bulk density in order to prevent generation of curling-up at an edge during use and to sufficiently obtain drug efficacy.

**[0003]** As a nonwoven fabric that can be used for such an application, Patent Document 1 discloses a long-fiber nonwoven fabric made of a bi-component polymer made of polybutylene terephthalate and polyethylene terephthalate in which crimped long fibers are fused and fixed by a low melting point component in intermittent regions and which has an apparent density is 0.10 g/cm$^3$ or more, a strength at 50% elongation in each of the machine and cross directions is 150 g/cm or less, and has an elongation recovery rate at 50% elongation of 50% or more.

**[0004]** In addition, Patent Document 2 discloses a nonwoven fabric including short fibers composed of composite fibers in which specific copolymerized polyethylene terephthalate (A) and polyethylene terephthalate (B) are bonded side by side, and having an elongation rate of 60% or more and an elongation recovery rate of 55% or more.

### PRIOR ART DOCUMENTS

### PATENT DOCUMENTS

**[0005]**

Patent Document 1: JP-A-07-042061
Patent Document 2: JP-A-2013-044070

### SUMMARY OF THE INVENTION

### PROBLEMS TO BE SOLVED BY THE INVENTION

**[0006]** As described above, conventionally, a long-fiber nonwoven fabric composed of a bi-component polymer composed of polybutylene terephthalate and polyethylene terephthalate and a nonwoven fabric including short fibers made of two components, polyethylene terephthalate and a copolymerized polyethylene terephthalate, are known. On the other hand, no long-fiber nonwoven fabrics made of two components, polyethylene terephthalate and a copolymerized polyethylene terephthalate, have heretofore been known.

**[0007]** Heretofore, as a method for producing a long-fiber nonwoven fabric, a method is known as disclosed also in Patent Document 1 in which a long-fiber web collected on a net is subjected to crimp development treatment and then the crimp-developed long-fiber web is subjected to hot pressure-bonding treatment using an embossing roll, thereby fused and fixed by a low melting point component in intermittent regions.

**[0008]** However, long-fiber webs including a copolymerized polyethylene terephthalate are likely to be crimped and shrunk by heat. For that reason, by the conventional production method involving applying emboss processing or the like at a high temperature, a long-fiber nonwoven fabric having a high bulk density and superior elasticity cannot be obtained due to generation of wrinkles caused by rapid shrinkage.

**[0009]** The present invention (the first and second aspects of the present invention) has been devised in view of the above-described problems, and an object thereof is to provide a long-fiber nonwoven fabric which is a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester but has a high bulk density and superior elasticity. Another object of the present invention is to provide a method for producing the long-fiber nonwoven fabric.

### MEANS FOR SOLVING THE PROBLEMS

**[0010]** The present inventors have intensively studied long-fiber nonwoven fabrics including polyethylene terephthalate and a copolymerized polyester. As a result, the present inventors have found that a long-fiber nonwoven fabric having a high bulk density and superior elasticity can be obtained by employing a novel production method, and have accomplished the present invention (the first and second aspects of the present invention).

**[0011]** That is, the first aspect of the present invention provides the following.

(1) A long-fiber nonwoven fabric including a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester, wherein the long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more and 0.25 g/cc or less, and has an elongation recovery rate at 50% elongation of 55% or more.

**[0012]** As described above, since a long-fiber web containing a copolymerized polyester is likely to be crimped and shrunk by heat, a long-fiber nonwoven fabric having a high bulk density and superior elasticity cannot be obtained by the conventional method for producing a long-fiber nonwoven fabric. For example, in Patent Document 1, emboss processing is applied at 185°C or higher, but when such emboss processing at a high temperature is applied to a long-fiber web containing a copolymerized polyethylene terephthalate, wrinkles are generated due to rapid shrinkage. On the other hand, in the first aspect of the present invention, as will be described in detail later, as a result of temporarily pressure-bonding a long-fiber web containing a copolymerized polyester and then applying crimp processing to the temporarily pressure-bonded long-fiber web, it is possible to obtain a long-fiber nonwoven fabric having a high bulk density and superior elasticity.

**[0013]** As described above, according to the first aspect of the present invention, it is possible to provide a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester, having an apparent density of 0.1 g/cc or more and 0.25 g/cc or less, and an elongation recovery rate at 50% elongation of 55% or more. Owing to the apparent density of 0.1 g/cc or more, even if the rubbing with clothes or the like occurs when the long-fiber nonwoven fabric is used as a patch, a bandage, or the like, the fabric hardly receives friction, and it is possible to prevent occurrence of curling-up during use. In addition, owing to the elongation recovery rate at 50% elongation of 55% or more, the long-fiber nonwoven fabric is superior in elasticity, and exhibits good usability when used as a patch, a bandage, or the like.

**[0014]** (2) In the configuration of (1) above, a 5% elongation load is preferably 1.0 N/25 mm or less.

**[0015]** When the 5% elongation load is 1.0 N/25 mm or less, it is possible to facilitate bending of a joint portion such as an elbow when used as a patch, a bandage, or the like.

**[0016]** (3) In the configuration of (1) or (2) above, the long fiber is preferably a crimped yarn.

**[0017]** When the long fiber is a crimped yarn, further superior elasticity is obtained.

**[0018]** (4) In the configurations of (1) to (3) above, the long fiber preferably has a sheath-core structure.

**[0019]** When the long fiber has a sheath-core structure, crimp processing can be suitably applied during production.

**[0020]** (5) In the configuration of (4) above, in the sheath-core structure, a center of a core component is preferably eccentric by 2% or more.

**[0021]** In the sheath-core structure, when the center of the core component is eccentric by 2% or more, crimp processing can be more suitably applied during production.

**[0022]** (6) In the configurations of (1) to (3) above, the long fiber preferably has a side-by-side structure.

**[0023]** When the long fiber has a side-by-side structure, crimp processing can be suitably applied out during production.

**[0024]** (7) In the configurations of (1) to (6) above, it is preferable that the long-fiber nonwoven fabric has not been subjected to a mechanical interlacing treatment.

**[0025]** As will be described in detail later, the long-fiber nonwoven fabric according to the first aspect of the present invention is obtained by temporarily pressure-bonding a long-fiber web including a copolymerized polyester, and then applying crimp processing to the temporarily pressure-bonded long-fiber web. Amorphous polyester has a property of being hardly bonded up to around 130°C, and is hardly restrained by a bonding point, so that in the step of crimp processing, first, elongation and shrinkage are developed. Then, close adhesion can be attained in a state in which elongation and shrinkage are developed. Therefore, a mechanical interlacing treatment is not required. In a configuration in which a mechanical interlacing treatment is not applied, a nonwoven fabric can be produced at low cost. In addition, as compared with a case where needle punching is employed as the mechanical interlacing treatment, it is possible to avoid a risk such as mixture of needles.

**[0026]** (8) In the configurations of (1) to (7) above, it is preferable that in the copolymerized polyester, the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

**[0027]** When the dicarboxylic acid component of the copolymerized polyester is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol, crystallinity is moderately reduced, so that suitable crimp can be developed in a long-fiber nonwoven fabric.

**[0028]** (9) In the configurations of (1) to (8) above, it is preferable that the long-fiber nonwoven fabric is used as a base fabric of a patch. That is, the long-fiber nonwoven fabric can be suitably used as a base fabric of a patch.

**[0029]** The second aspect of the present invention provides the following.

**[0030]** (10) A long-fiber nonwoven fabric including a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester, wherein the long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more, and has a 10% elongation recovery rate of 65% or more.

**[0031]** As described above, since a long-fiber web containing a copolymerized polyester is likely to be crimped and shrunk by heat, a long-fiber nonwoven fabric having a high bulk density and superior elasticity cannot be obtained by the conventional method for producing a long-fiber nonwoven fabric. On the other hand, in the second aspect of the present invention, as will be described in detail later, as a result of temporarily pressure-bonding a long-fiber web containing a copolymerized polyester and then applying crimp processing to the temporarily pressure-bonded long-fiber web, it is possible to obtain a long-fiber nonwoven fabric having a high bulk density and superior elasticity.

**[0032]** As described above, according to the second aspect of the present invention, it is possible to provide a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester, having an apparent density of 0.1 g/cc or more, and having a 10% elongation recovery rate of 65% or more. Owing to the apparent density of 0.1 g/cc or more, even if the rubbing with clothes or the like occurs when the long-fiber nonwoven fabric is used as a patch, a bandage, or the like, the fabric hardly receives friction, and it is possible to prevent occurrence of curling-up during use. In addition, owing to the 10% elongation recovery rate of 65% or more, the fabric is superior in elasticity, and exhibits good usability when used as a patch, a bandage, or the like.

**[0033]** (11) In the configuration of (10) above, the long fiber is preferably a crimped yarn.

**[0034]** When the long fiber is a crimped yarn, further superior elasticity is obtained.

**[0035]** (12) In the configuration of (10) or (11) above, the long fiber preferably has a sheath-core structure.

**[0036]** When the long fiber has a sheath-core structure, crimp processing can be suitably applied during production.

**[0037]** (13) In the configuration of (12) above, in the sheath-core structure, a center of a core component is preferably eccentric by 2% or more.

**[0038]** In the sheath-core structure, when the center of the core component is eccentric by 2% or more, crimp processing can be more suitably applied during production.

**[0039]** (14) In the configuration of (10) or (11) above, the long fiber preferably has a side-by-side structure.

**[0040]** When the long fiber has a side-by-side structure, crimp processing can be suitably applied out during production.

**[0041]** (15) In the configurations of (10) to (14) above, it is preferable that the long-fiber nonwoven fabric has not been subjected to a mechanical interlacing treatment.

**[0042]** As will be described in detail later, the long-fiber nonwoven fabric according to the second aspect of the present invention is obtained by temporarily pressure-bonding a long-fiber web including a copolymerized polyester, and then applying crimp processing to the temporarily pressure-bonded long-fiber web. Amorphous polyester has a property of being hardly bonded up to around 130°C, and is hardly restrained by a bonding point, so that in the step of crimp processing, first, elongation and shrinkage are developed. Then, close adhesion can be attained in a state in which elongation and shrinkage are developed. Therefore, a mechanical interlacing treatment is not required. In a configuration in which a mechanical interlacing treatment is not applied, a nonwoven fabric can be produced at low cost. In addition, as compared with a case where needle punching is employed as the mechanical interlacing treatment, it is possible to avoid a risk such as mixture of needles.

**[0043]** (16) In the configurations of (10) to (15) above, it is preferable that in the copolymerized polyester, the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

**[0044]** When the dicarboxylic acid component of the copolymerized polyester is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol, crystallinity is moderately reduced, so that suitable crimp can be developed in a long-fiber nonwoven fabric.

**[0045]** The present invention (the first and second aspects of the present invention) provides the following.

**[0046]** (17) A method for producing the long-fiber nonwoven fabric according to any one of (1) to (16) above, wherein the method includes: step A of discharging molten polyethylene terephthalate and a molten copolymerized polyester from a spinneret, cooling and solidifying them, and then pulling and stretching them with an ejector to form long fibers of a bi-component conjugate spun yarn; step B of collecting the long fibers obtained in the step A to form a long-fiber web; step C of temporarily pressure-bonding the long-fiber web; and step D of applying crimp processing to the temporarily pressure-bonded long-fiber web.

**[0047]** Since a long-fiber web containing a copolymerized polyester is likely to be crimped and shrunk by heat, a long-fiber nonwoven fabric having a high bulk density and superior elasticity cannot be obtained by the conventional method for producing a long-fiber nonwoven fabric. On the other hand, in the present invention (the first and second aspects of the present invention), as a result of temporarily pressure-bonding a long-fiber web containing a copolymerized polyester and then applying crimp processing to the temporarily pressure-bonded long-fiber web, it is possible to obtain a long-fiber nonwoven fabric having a high bulk density and superior elasticity.

**[0048]** (18) In the configuration of (17) above, the step D is preferably a step of immersing the long-fiber web in boiling water at 80°C or higher.

**[0049]** When the long-fiber web is immersed in boiling water at 80°C or higher, crimp processing can be suitably applied to the long fibers.

**[0050]** (19) In the configuration of (18) above, the method preferable includes step E of stretching the long-fiber web in a cross direction after the step D.

**[0051]** When the long-fiber web is stretched in a cross direction after the step D, a long-fiber nonwoven fabric having a thickness corresponding to the stretch ratio is obtained. That is, the thickness of the long-fiber nonwoven fabric to be obtained can be adjusted by the stretch ratio in the cross direction.

**[0052]** (20) In the configuration of (19) above, the method preferably includes step F of applying calender processing to the long-fiber web after the step E.

**[0053]** When calender processing is applied to the long-fiber web after the step E, the thickness of the long-fiber nonwoven fabric to be obtained can be more suitably adjusted through the roll clearance in the calender processing. In addition, the thickness can be made uniform.

**[0054]** (21) In the configuration of (20) above, the roll clearance in the calender processing in the step F is preferably 0.1 mm or more.

**[0055]** When the roll clearance in the calender processing in the step F is 0.1 mm or more, it is possible to control a decrease in the stretching function and an increase in the initial tensile stress due to excessive pressure-bonding of the fibers.

**[0056]** (22) In the configuration of (17) above, the step D is preferably a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio.

**[0057]** When, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, crimp processing is applied to the long-fiber web while the speed ratio is gradually decreased, crimp processing can be suitably applied to the long fiber.

**[0058]** (23) In the configurations of (17) to (22) above, the step A preferably includes step A-1 of, with use of an eccentric sheath-core nozzle as the spinneret, discharging the polyethylene terephthalate as a core component and the copolymerized polyester as a sheath component from the eccentric sheath-core nozzle.

**[0059]** When, with use of an eccentric sheath-core nozzle as the spinneret, the polyethylene terephthalate as a core component and the copolymerized polyester as a sheath component are discharged from the eccentric sheath-core nozzle, crimp processing can be suitably applied in the subsequent crimp processing step (step D).

**[0060]** (24) In the configurations of (17) to (23) above, the step A preferably includes step A-2 of, with use of a side-by-side nozzle as the spinneret, discharging the polyethylene terephthalate and the copolymerized polyester from the side-by-side nozzle so as to combine them in a side-by-side form in a fiber length direction.

**[0061]** When, with use of a side-by-side nozzle as the spinneret, the polyethylene terephthalate and the copolymerized polyester are discharged from the side-by-side nozzle so as to combine them in a side-by-side form in a fiber length direction, crimp processing can be suitably applied in the subsequent crimp processing step (step D).

**[0062]** (25) In the configurations (17) to (24), in the copolymerized polyester, it is preferable that the dicarboxylic acid component is terephthalic acid, and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

**[0063]** When the dicarboxylic acid component of the copolymerized polyester is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol, crystallinity is moderately reduced, so that suitable crimp can be developed in a long-fiber nonwoven fabric.

## EFFECT OF THE INVENTION

**[0064]** According to the present invention (the first and second aspects of the present invention), it is possible to provide a long-fiber nonwoven fabric which is a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester but has a high bulk density and superior elasticity. In addition, it is possible to provide a method for producing the long-fiber nonwoven fabric.

## MODE FOR CARRYING OUT THE INVENTION

**[0065]** Hereinafter, embodiments of the present invention (the first and second aspects of the present invention) will be described.

### [Long-fiber nonwoven fabric]

### <Embodiment according to the first aspect of the present invention>

**[0066]** The long-fiber nonwoven fabric according to an embodiment according to the first aspect of the present invention (hereinafter, also referred to as "the first embodiment") includes a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester, has an apparent density of 0.1 g/cc or more and

0.25 g/cc or less, and has an elongation recovery rate at 50% elongation of 55% or more.

**[0067]** The long fibers constituting the long-fiber nonwoven fabric are constituted of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester.

**[0068]** In the present description, a long fiber refers to any fiber having a length at the time of spinning being endless (endless continuous fiber). It is noted that when the long-fiber nonwoven fabric finally obtained is one cut to a prescribed length, the length of the long fibers is the same as the length of the long-fiber nonwoven fabric. On the other hand, a short fiber refers to any fiber contained in a nonwoven fabric and having a length shorter than the length of the nonwoven fabric. That is, the long-fiber nonwoven fabric is a nonwoven fabric constituted of fibers having the same length as the length of the nonwoven fabric (long fibers), and the short-fiber nonwoven fabric refers to a nonwoven fabric constituted of fibers having a length shorter than the length of the short-fiber nonwoven fabric (short fibers).

**[0069]** Since the long fibers contain polyethylene terephthalate, the long-fiber nonwoven fabric is superior in mechanical strength, heat resistance, shape retention property, and the like as compared with the case of using such a resin as polyethylene or polypropylene. The content ratio of the polyethylene terephthalate in the long fibers is preferably 20 mass% or more and 80 mass% or less, more preferably 30 mass% or more and 70 mass% or less, and still more preferably 40 mass% or more and 60 mass% or less. When the content ratio of the polyethylene terephthalate is within the above numerical range, the long-fiber nonwoven fabric is further superior in mechanical strength, heat resistance, shape retention property, and the like. It is noted that polyethylene terephthalate is a polyester that shows an exothermic peak derived from crystallization and/or an endothermic peak derived from crystal fusion in measurement with a differential scanning calorimeter (DSC).

**[0070]** The amorphous polyester is a resin having neither a clear crystallization exothermic peak nor a clear crystal melting peak in measurement with a differential scanning calorimeter (DSC). The amorphous polyester has a glass transition temperature (Tg) of 50°C or higher. The glass transition temperature (Tg) is a value determined from a transition point of latent heat at the time of raising temperature at a temperature raising rate of 20°C/min by DSC. The employment of an amorphous polyester having a glass transition temperature (Tg) of 50°C or higher as the above-mentioned amorphous polyester improves heat resistance. That is, in the long-fiber nonwoven fabric, the copolymerized polyester having a high Tg while being amorphous is employed in order to improve heat resistance and impact resistance.

**[0071]** The copolymerized polyester has lower crystallinity than polyethylene terephthalate (homopolymer). Since the long-fiber nonwoven fabric (the long fibers) is a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester, when heat-treated, a difference occurs in the amount of shrinkage due to a difference in crystallinity and crimp is developed.

**[0072]** Examples of the copolymerization component of the copolymerized polyester include, as a dicarboxylic acid component, aromatic dicarboxylic acids such as terephthalic acid and 2,6-naphthalene dicarboxylic acid; aliphatic dicarboxylic acids such as oxalic acid, succinic acid, adipic acid, sebacic acid, and undecacarboxylic acid; and alicyclic dicarboxylic acids such as hexahydroterephthalic acid; and, as a glycol component, aliphatic glycols such as ethylene glycol, propylene glycol, 1,4-butanediol, neopentyl glycol, and hexamethylene glycol; and aromatic glycols such as bisphenol, 1,3-bis(2-hydroxyethoxy)benzene, and 1,4-(hydroxyethoxy)benzene. These may be used singly or two or more thereof may be used in combination. The copolymerization component is preferably selected within a range in which the Tg of the copolymerized polyester can be maintained at 50°C or higher.

**[0073]** Among them, the following (a) to (d) are preferable, and (a) is more preferable as the copolymerized polyester.

(a) Copolymerized polyester in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.
(b) Copolymerized polyester in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol d of 1,4-cyclohexanedimethanol.
(c) Copolymerized polyester in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of 1,4-butanediol and 15 to 50 mol% of neopentyl glycol.
(d) Copolymerized polyester in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 to 85 mol% of 1,4-butanediol and 15 to 50 mol% of 1,4-cyclohexanedimethanol.

**[0074]** In the cases (a) and (b), the content of ethylene glycol is more preferably 50 to 85 mol%, and still more preferably 65 to 75 mol%.

**[0075]** In the cases (c) and (d), the content of 1,4-butanediol is more preferably 50 to 85 mol%, and still more preferably 65 to 75 mol%.

**[0076]** In the cases (a) and (c), the content of neopentyl glycol is more preferably 15 to 50 mol%, and still more preferably 25 to 35 mol%.

**[0077]** In the cases (b) and (d), the content of 1,4-cyclohexanedimethanol is more preferably 15 to 50 mol%, and still more preferably 25 to 35 mol%.

The copolymerized polyesters (a) to (d) have moderately lowered crystallinity and can develop suitable crimp in a long-fiber nonwoven fabric. In addition, these copolymerized polyesters are good in such characteristics as thermal stability.

**[0078]** The content ratio of the copolymerized polyester in the long fibers is preferably 20 mass% or more and 80 mass% or less, more preferably 30 mass% or more and 70 mass% or less, and still more preferably 40 mass% or more and 60 mass% or less. When the content ratio of the copolymerized polyester is within the above numerical range, crimp can be suitably developed.

**[0079]** The copolymerization method for producing the copolymerized polyester is not particularly limited, and a conventionally known method can be adopted.

**[0080]** The long fiber preferably has a sheath-core structure. When the long fiber has a sheath-core structure, crimp processing can be suitably applied during production.

**[0081]** The sheath-core structure preferably has a fiber cross section that is eccentric. Specifically, the center of the core component is preferably eccentric by 2% or more, and more preferably eccentric by 3% or more. That is, the eccentricity measured by the method described in EXAMPLES is preferably 2% or more, and more preferably 3% or more. The eccentricity of the center of the core component is preferably as large as possible, and can be set to, for example, 80% or less, 60% or less, or the like.

**[0082]** In the sheath-core structure, from the viewpoint of successfully obtaining suitable crimp, the sheath side is preferably a copolymerized polyester and the core side is preferably polyethylene terephthalate.

**[0083]** It is also preferable that the long fiber has a side-by-side structure in which a copolymerized polyester and polyethylene terephthalate are bonded together. When the long fiber has a side-by-side structure, crimp processing can be suitably applied out during production.

**[0084]** The fiber diameter of the long fiber is preferably 5 to 60 μm, more preferably 10 um to 50 μm, and still more preferably 12 um to 40 um. When the fiber diameter is 5 um or more, the spinnability by a spunbonding method is further improved and stable production can be carried out. In addition, when the fiber diameter is 60 um or less, unevenness of the nonwoven fabric is less likely to deteriorate, and seepage of a medicinal ingredient can be controlled when used as a patch.

**[0085]** Preferably, the long-fiber nonwoven fabric has not been subjected to a mechanical interlacing treatment. Examples of the mechanical interlacing treatment include interlacing treatment by a needle punch method or a water punch method. When the long-fiber nonwoven fabric has not been subjected to the mechanical interlacing treatment, this is preferable in that the long-fiber nonwoven fabric can be produced at low cost. It is also preferable in that the risk of mixing of needles that may occur when the needle punch method is adopted can be avoided. In the water punch method, a large amount of water is used and a large amount of energy is required. Therefore, from the viewpoint of environmental preservation and the viewpoint of energy saving, it is preferable that the long-fiber nonwoven fabric has not been subjected to the mechanical interlacing treatment.

**[0086]** The long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more, preferably 0.11 g/cc or more, and more preferably 0.13 g/cc or more. The apparent density is 0.25 g/cc or less. The apparent density is preferably as large as possible, but may be set to, for example, 0.23 g/cc or less, 0.20 g/cc or less, or the like. Owing to the apparent density of 0.1 g/cc or more, even if the rubbing with clothes or the like occurs when the fabric is used as a patch, a bandage, or the like, the fabric hardly receives friction, and it is possible to prevent occurrence of curling-up during use.

**[0087]** The long-fiber nonwoven fabric has an elongation recovery rate at 50% elongation of 55% or more, preferably 57% or more, and more preferably 60% or more. The elongation recovery rate at 50% elongation is preferably as large as possible, but may be set to, for example, 95% or less, 90% or less, or the like. Owing to the elongation recovery rate at 50% elongation of 55% or more, the long-fiber nonwoven fabric is superior in elasticity, and exhibits good usability when used as a patch, a bandage, or the like. For example, when the long-fiber nonwoven fabric is applied to a joint such as an elbow, the fabric can follow the movement of the skin at the bent portion and can control the occurrence of wrinkles. As a result, peeling triggered at a wrinkled site can be prevented.

**[0088]** In the present description, "the elongation recovery rate at 50% elongation is 55% or more" means that the elongation recovery rate at 50% elongation in the MD (machine direction) is 55% or more and the elongation recovery rate at 50% elongation in the CD (cross direction) is 55% or more.

**[0089]** The long-fiber nonwoven fabric preferably has a 5% elongation load of 1.0 N/25 mm or less, more preferably 0.8 N/25 mm or less, and still more preferably 0.6 N/25 mm or less. The 5% elongation load is preferably as small as possible, but can be set to, for example, 0.01 N/25 mm or more, 0.05 N/25 mm or more, or the like. When the 5% elongation load is 1.0 N/25 mm or less, it is possible to facilitate bending of a joint portion such as an elbow when used as a patch, a bandage, or the like.

**[0090]** In the present specification, "a 5% elongation load is 1.0 N/25 mm or less" means that a 5% elongation load in a machine direction (MD) is 1.0 N/25 mm or less and a 5% elongation load in a cross direction (CD) also is 1.0 N/25 mm or less.

**[0091]** Conventionally, it has not been possible to obtain a long-fiber nonwoven fabric having an apparent density of 0.1 g/cc or more and an elongation recovery rate at 50% elongation of 55% or more despite being a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester. On the other hand, in the first embodiment, a novel production method, namely, temporarily pressure-bonding a long-fiber web including a copolymerized polyester and then applying crimp processing in which the long-fiber web is immersed in boiling water at 80°C or higher to the temporarily pressure-bonded long-fiber web, has made it possible to achieve an apparent density of 0.1 g/cc or more and an elongation recovery rate at 50% elongation of 55% or more.

**[0092]** The long-fiber nonwoven fabric is preferably used as a base fabric of a patch. That is, the long-fiber nonwoven fabric can be suitably used as a base fabric of a patch. This is because owing to the apparent density of 0.1 g/cc or more of the long-fiber nonwoven fabric, even if rubbing with clothes or the like occurs when the fabric is used as a patch, a bandage, or the like, the fabric hardly receives friction, and it is possible to prevent occurrence of curling-up during use. That is also because owing to the elongation recovery rate at 50% elongation of 55% or more, the long-fiber nonwoven fabric is superior in elasticity, and exhibits good usability when used as a patch, a bandage, or the like.

**[0093]** The long-fiber nonwoven fabric according to the first embodiment (the embodiment according to the first aspect of the present invention) has been described above.

<Embodiment according to the second aspect of the present invention>

**[0094]** Hereinafter, the long-fiber nonwoven fabric according to an embodiment of the second aspect of the present invention will be described. However, as described above, the long-fiber nonwoven fabric according to the embodiment of the second aspect of the present invention does not need to have an elongation recovery rate at 50% elongation of 55% or more as in the embodiment of the first aspect of the present invention. The long-fiber nonwoven fabric according to the embodiment of the second aspect of the present invention just needs to have an apparent density of 0.1 g/cc or more, and does not need to have an apparent density of 0.1 g/cc or more and 0.25 g/cc or less as in the embodiment of the first aspect of the present invention.

[Long-fiber nonwoven fabric]

**[0095]** The long-fiber nonwoven fabric according to the embodiment according to the second aspect of the present invention (hereinafter, also referred to as "the second embodiment") includes a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester, has an apparent density of 0.1 g/cc or more, and has a 10% elongation recovery rate of 65% or more.

**[0096]** The long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more, preferably 0.11 g/cc or more, and more preferably 0.13 g/cc or more. The apparent density is preferably as large as possible, but may be adjusted to, for example, 0.3 g/cc or less or 0.28 g/cc or less. Owing to the apparent density of 0.1 g/cc or more, even if the rubbing with clothes or the like occurs when the fabric is used as a patch, a bandage, or the like, the fabric hardly receives friction, and it is possible to prevent occurrence of curling-up during use.

**[0097]** The long-fiber nonwoven fabric has a 10% elongation recovery rate of 65% or more, preferably 70% or more, and more preferably 80% or more. The 10% elongation recovery rate is preferably as large as possible, but may be set to, for example, 99.5% or less, 99.0% or less, or the like. Owing to the 10% elongation recovery rate of 65% or more, the film is superior in elasticity, and has good usability when used as a patch, a bandage, or the like. For example, when the long-fiber nonwoven fabric is applied to a joint such as an elbow, the fabric can follow the movement of the skin at the bent portion and can control the occurrence of wrinkles. As a result, peeling triggered at a wrinkled site can be prevented.

**[0098]** In the present description, "the 10% elongation recovery rate is 65% or more" means that the 10% elongation recovery rate in the MD (machine direction) is 65% or more and the 10% elongation recovery rate in the CD (cross direction) is 65% or more.

**[0099]** The long-fiber nonwoven fabric according to the second embodiment can adopt the same configuration as the long-fiber nonwoven fabric according to the first embodiment except for the apparent density and the 10% elongation recovery rate described above.

**[0100]** However, as described above, the long-fiber nonwoven fabric according to the second embodiment does not need to have an elongation recovery rate at 50% elongation of 55% or more as in the first embodiment. The long-fiber nonwoven fabric according to the second embodiment just needs to have an apparent density of 0.1 g/cc or more, and does not need to have an apparent density of 0.1 g/cc or more and 0.25 g/cc or less as in the first embodiment.

**[0101]** Conventionally, it has not been possible to obtain a long-fiber nonwoven fabric having an apparent density of 0.1 g/cc or more and a 10% elongation recovery rate of 65% or more despite being a long-fiber nonwoven fabric including polyethylene terephthalate and a copolymerized polyester. On the other hand, in the second embodiment, a novel production method, namely, temporarily pressure-bonding a long-fiber web including a copolymerized polyester and then applying crimp processing to the temporarily pressure-bonded long-fiber web has made it possible to achieve an apparent density of 0.1 g/cc or more and a 10% elongation recovery rate of 65% or more.

**[0102]** The long-fiber nonwoven fabric according to the second embodiment (the embodiment according to the second aspect of the present invention) has been described above.

**[0103]** Next, a method for producing the long-fiber nonwoven fabric according to the present embodiment (the first embodiment and the second embodiment) will be described.

[Method for producing long-fiber nonwoven fabric]

**[0104]** The method for producing the long-fiber nonwoven fabric according to the present embodiment includes: step A of discharging molten polyethylene terephthalate and a molten copolymerized polyester from a spinneret, cooling and solidifying them, and then pulling and stretching them with an ejector to form long fibers of a bi-component conjugate spun yarn; step B of collecting the long fibers obtained in the step A to form a long-fiber web; step C of temporarily pressure-bonding the long-fiber web; and step D of applying crimp processing to the temporarily pressure-bonded long-fiber web.

<Step A>

**[0105]** In the method for producing a long-fiber nonwoven fabric according to the present embodiment, first, molten polyethylene terephthalate and a molten copolymerized polyester are discharged from a spinneret, cooled and solidified, and then pulled and stretched with an ejector. Thus, long fibers of a bi-component conjugate spun yarn are formed.

**[0106]** This step A can be carried out using a conventionally known bi-component spunbond spinning machine. That is, the long fibers can be produced by a spunbonding method, which is a production method directly connected with spinning in which a nonwoven fabric is produced directly from a step of producing fibers (a spinning step).

**[0107]** As the polyethylene terephthalate and the copolymerized polyester, those described in the above section of the long-fiber nonwoven fabric may be employed.

**[0108]** In the step A, spinning is preferably carried out at a spinning speed of 3500 m/min or more. That is, it is preferable to discharge molten polyethylene terephthalate and a molten copolymerized polyester from a spinneret, cool and solidify them, and then pull and stretch them with an ejector at a spinning speed of 3500 m/min or more to form long fibers of a bi-component conjugate spun yarn. Setting the spinning speed to 3500 m/min or more increases the orientation crystallinity of the polyester terephthalate. When the spinning speed is set to 3500 m/min or more, the orientation of the copolymerized polyester also is advanced. However, since the copolymerized polyester has low crystallinity, shrinkage of the component on the copolymerized polyester side occurs in the subsequent crimp processing step (the heating step in step D), so that crimp is suitably developed. The spinning speed is more preferably 3800 m/min or more, and still more preferably 4200 m/min or more. The spinning speed is preferably 5500 m/min or less, and more preferably 5000 m/min or less from the viewpoint of spinnability.

**[0109]** In the present description, the spinning speed is a value determined by the following Equation (1).

$$V = (10000 \times Q)/T \quad (1)$$

**[0110]** Here, V is a spinning speed (m/min), T is a fineness (dtex) of a single fiber, and Q is a single hole discharge amount (g/min).

**[0111]** The single hole discharge amount Q is preferably 0.2 to 5 g/min as the sum total of the two components. Controlling the single hole discharge amount Q to 0.2 to 5 g/min makes it easy to control the spinning speed V to within a desired range. The single hole discharge amount is more preferably 0.3 to 4 g/min, and still more preferably 0.5 to 3 g/min. The fineness T (dtex) of a single fiber is a value representing the mass in gram of a single fiber of 10,000 meters.

**[0112]** The step A preferably includes step A-1 of, with use of an eccentric sheath-core nozzle as the spinneret, discharging the polyethylene terephthalate as a core component and the copolymerized polyester as a sheath component from the eccentric sheath-core nozzle. As the eccentric sheath-core nozzle, conventionally known ones can be adopted. When, with use of an eccentric sheath-core nozzle as the spinneret, the polyethylene terephthalate as a core component and the copolymerized polyester as a sheath component are discharged from the eccentric sheath-core nozzle, crimp processing can be suitably applied in the subsequent crimp processing step (step D).

**[0113]** The step A preferably includes step A-2 of, with use of a side-by-side nozzle as the spinneret, discharging the polyethylene terephthalate and the copolymerized polyester from the side-by-side nozzle so as to combine them in a side-by-side form in a fiber length direction. As the side-by-side nozzle, conventionally known ones can be adopted. When, with use of a side-by-side nozzle as the spinneret, the polyethylene terephthalate and the copolymerized polyester are discharged from the side-by-side nozzle so as to combine them in a side-by-side form in a fiber length direction, crimp processing can be suitably applied in the subsequent crimp processing step (step D).

**[0114]** In the step A, it is preferable to adopt either the step A-1 or the step A-2.

**[0115]** In any case of adopting either of the step A-1 and the step A-2, it is preferable to carry out spinning from a spinneret having an orifice diameter of 0.1 to 0.5 mm, supply dry air to an ejector at a pressure (jet pressure) of 1.5 to 4.0 kg/cm$^2$, and carry out stretching. The orifice diameter of the spinneret is more preferably 0.15 to mm, and still more preferably 0.18 to 0.45 mm. The jet pressure is more preferably 2.0 to 4.0 kg/cm$^2$, and still more preferably 2.5 to 3.8 kg/cm$^2$. Controlling the orifice diameter within the above range makes it easy to obtain a desired fiber diameter. Controlling the supply pressure (jet pressure) of the dry air within the above range makes it easy to control the spinning speed within a desired range and makes it possible to attain appropriate drying.

<Step B>

**[0116]** Next, the long fibers obtained in the step A are collected to form a long-fiber web (step B). For example, the long fibers may be collected on a lower conveyor while being opened and form a long-fiber web.

<Step C>

**[0117]** Next, the long-fiber web obtained in the step B is temporarily pressure-bonded (step C). The temporary pressure-bonding is carried out within a temperature range in which the long-fiber web does not shrink. As a result, conveyance can be suitably carried out. The temperature at the time of the temporary pressure-bonding is preferably 50°C to 80°C, more preferably 55°C to 75°C, and still more preferably 60°C to 70°C. The temporary pressure-bonding can be carried out using a flat roll. The linear pressure at the time of temporary pressure-bonding is preferably 1 to 10 kg/cm, and more preferably 3 to 7 kg/cm. When the linear pressure is set within the above numerical range, breakage due to conveyance does not occur, and a process can be passed.

<Step D>

**[0118]** Next, crimp processing is applied to the temporarily pressure-bonded long-fiber web (step D). The long fiber subjected to crimp processing is a crimped yarn.

**[0119]** The step D is preferably a step of immersing the long-fiber web in boiling water at 80°C or higher. It is also preferable that the step D is a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio.

**[0120]** In the following, first, a case in which the step D is a step of immersing the long-fiber web in boiling water at 80°C or higher is described.

**[0121]** When the step of applying crimp processing (the step D) is a step of immersing the long-fiber web in boiling water at 80°C or higher, the temperature of the boiling water is not particularly limited as long as it is 80°C or higher, but is preferably 85°C or higher, and more preferably 90°C or higher. The temperature of the boiling water is preferably 99°C or lower, and more preferably 97°C or lower from the viewpoint of controlling the occurrence of wrinkles due to rapid shrinkage. Since the temperature of the boiling water is 80°C or higher, crimp processing can be suitably applied to the long fibers.

**[0122]** The time of immersion in the boiling water is not particularly limited, but is preferably 2 seconds or more, and more preferably 3 seconds or more. When the time of immersion in the boiling water is 5 seconds or more, crimp processing can be sufficiently applied. The time of immersion in the boiling water may be set to, for example, 20 seconds or less, 10 seconds or less, or the like from the viewpoint of productivity.

**[0123]** The moisture to be used as the boiling water is not particularly limited, but a liquid for imparting hydrophilicity may be mixed in order to improve the impregnation rate, and an appropriate amount of a neutral detergent or the like may be added in consideration of the environmental aspect.

**[0124]** In the step D, it is preferable that no tension is applied in the cross direction while the long-fiber web is immersed in the boiling water. By applying no tension in the cross direction, the bulk density can be further increased.

**[0125]** The method for producing a long-fiber nonwoven fabric according to the present embodiment preferably includes step E of stretching the long-fiber web in a cross direction after the step D. When the long-fiber web is stretched in a cross direction after the step D, a long-fiber nonwoven fabric having a thickness corresponding to the stretch ratio is obtained. That is, the thickness of the long-fiber nonwoven fabric to be obtained can be adjusted by the stretch ratio in the cross direction.

**[0126]** As the stretching method in the step E, stretching using a conventionally known tenter is preferable.

**[0127]** The stretch ratio in the cross direction in the step E is preferably 2% or more, and more preferably 5% or more. The stretch ratio is preferably 20% or less, and more preferably 15% or less.

**[0128]** In the present description, the stretch ratio in a cross direction refers to the stretch ratio with respect to the width before stretching. That is, the width after stretching is a width obtained by adding a stretch ratio to the width of 100% before the stretching. For example, when the stretch ratio is 10%, the width after the stretching is 110% of the width before the stretching.

**[0129]** The method for producing a long-fiber nonwoven fabric according to the present embodiment preferably includes step F of applying calender processing to the long-fiber web after the step E. When calender processing is applied to the long-fiber web after the step E, the thickness of the long-fiber nonwoven fabric to be obtained can be more suitably adjusted through the roll clearance in the calender processing. In addition, the thickness can be made uniform.

**[0130]** The roll clearance in the calender processing in the step F is preferably 0.1 mm or more, and more preferably 0.2 mm or more. When the roll clearance in the calender processing in the step F is 0.1 mm or more, it is possible to control a decrease in the stretching function and an increase in the initial tensile stress due to excessive pressure-bonding of the fibers. The roll clearance is preferably 0.7 mm or less, and more preferably 0.5 mm or less from the viewpoint of suitably adjusting the thickness of a resulting long-fiber nonwoven fabric.

**[0131]** The calender temperature (the temperature of the roll) in the step F is preferably 40°C or higher, and more preferably 50°C or higher. By setting the calender temperature to 40°C or higher, the thickness of the fiber nonwoven fabric can be more suitably adjusted. In addition, the uniformity in thickness can be further improved.

**[0132]** The method for producing a long-fiber nonwoven fabric according to the present embodiment preferably includes step G of drying the long-fiber web after the step F.

**[0133]** The drying temperature in the step G is preferably 80°C or higher, and more preferably 90°C or higher from the viewpoint of removing moisture. The drying temperature is preferably 150°C or lower, and more preferably 130°C or lower from the viewpoint of controlling fusion between fibers.

**[0134]** The drying time in the step G is preferably 10 seconds or more, and more preferably 20 seconds or more from the viewpoint of removing moisture. The drying temperature is preferably 100 seconds or less, and more preferably 60 seconds or less from the viewpoint of controlling fusion between fibers.

**[0135]** The case in which the step D is a step of immersing the long-fiber web in boiling water at 80°C or higher has been described above.

**[0136]** Next, description is made to a case in which the step D is a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio.

**[0137]** In the case in which the step D is a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio, as a result of setting the heating roller to have a temperature equal to or higher than that at which crimp occurs, shrinkage also occurs. However, in the present embodiment, since crimp processing is applied while gradually decreasing the speed ratio, the speed ratio of conveyance is decreased by the amount of shrinkage caused by crimping, so that generation of wrinkles and the like caused by rapid shrinkage can be controlled.

**[0138]** The number of the heating rollers is preferably two or more, and preferably four or more. By using a plurality of heating rollers and gradually reducing the speed ratio, the area of the long-fiber web can be reduced according to the amount of shrinkage, and the occurrence of wrinkles and the like can be controlled. The upper limit of the number of the heating rollers is not particularly limited, but may be, for example, 12 or less, 10 or less, or the like from the viewpoint of facility cost.

**[0139]** The heating temperature (the temperature of the heating rollers) at the time of crimp processing is preferably 60 to 150°C, more preferably 70 to 140°C, and still more preferably 80 to 130°C. When the heating temperature is within the above numerical range, crimp can be suitably developed. The conveying speed may be reduced according to the amount of shrinkage of the long-fiber web during crimp processing.

**[0140]** At the time of crimp processing, nipping may be carried out, as necessary. The nipping is preferably carried out at the time of crimp processing with a heating roller having the highest temperature. When nipping is carried out at the time of crimp processing with a heating roller having the highest temperature, adhesion can be improved.

**[0141]** In the above step D, crimp is applied in a state of being in contact with the heating roller. As a result, the long-fiber web can be finished to be smooth, high in apparent density, and thin.

**[0142]** In the above has been described the case in which the step D is a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio.

**[0143]** The method for producing a long-fiber nonwoven fabric according to the present embodiment has been described above.

## EXAMPLES

**[0144]** Hereinafter, the present invention (the first and second aspects of the present invention) will be described in detail with reference to Examples, but the present invention (the first and second aspects of the present invention) is not limited to the following Examples as long as the gist of the present invention is not exceeded.

**[0145]** It is noted that Examples 1 to 8 below are examples relating to the first aspect of the present invention, and Examples 9 to 14 are examples relating to the second aspect of the present invention.

(Intrinsic viscosity)

**[0146]** A resin (polyethylene terephthalate or a copolymerized polyester) (0.1 g) was weighed, dissolved in 25 ml of a mixed solvent of phenol/tetrachloroethane (60/40 (weight ratio)), and measured three times at 30°C using an Ostwald viscometer, and the average value of the measurements was determined.

(Glass transition temperature)

**[0147]** The glass transition temperature of a copolymerized polyester was determined at a temperature rising rate of 20°C/min in accordance with JIS K 7122 (1987).

(Specific gravity)

**[0148]** A density gradient liquid was prepared from calcium nitrate tetrahydrate in a density gradient tube, and using a specific gravity float range of 1.29 to 1.5 g/cm$^3$, a fiber after jet stretching was charged into the density gradient tube and was stabilized for 4 hours or more, a scale at a floating position was read, and a specific gravity was determined from a calibration curve of a float.

(Basis weight)

**[0149]** The mass per unit area was measured in accordance with JIS L 1913 (2000) 5.2.

(Apparent density (bulk density))

**[0150]** A weight per 1 cm$^3$ was calculated from the basis weight determined in accordance with JIS-L 1913 (2010) 5.2 and a thickness, and was taken as a bulk density. Specifically, a thickness was measured with a thickness gauge tester using a terminal of 0.5 g/cm$^2$, and a bulk density is determined by dividing a basis weight by the thickness.

(Fiber diameter)

**[0151]** Five arbitrary points of a sample (a long-fiber web before temporary pressure-bonding) were chosen, and the diameter of a single fiber was measured at n = 20 using an optical microscope, and then an average value was determined.

(Fineness (dtex))

**[0152]** Five arbitrary points of a sample (a long-fiber fleece before temporary pressure-bonding) were chosen, and the diameter of a single fiber was measured at n = 20 using an optical microscope, and then an average single fiber diameter was determined. Fibers at the same five points were taken out, and the specific gravity of the fibers was measured at n = 5 using a density gradient tube, and then an average specific gravity was determined. Then, from the average specific gravity and a single filament cross-sectional area determined from the average single fiber diameter, a fineness [dtex], which is a fiber weight per 10000 m, was determined.

(Eccentricity)

**[0153]** A metal plate with a 0.5 to 2 mm hole was prepared. Fibers made of a nonwoven fabric were cut out and embedded with black fibers. Fibers made of the nonwoven fabric and embedded with the black fibers were packed into the hole of the metal plate, and both ends were cut with a razor. The radius (R) of an outer circle on the sheath side was measured with an optical microscope connected to a computer with installed software capable of measuring a distance. The distance between the central portion on the core side and the central portion on the sheath side was measured and taken as the eccentric distance (L). Next, the eccentricity (%) was determined by the following equation.

$$(\text{Eccentricity}) = (L/R) \times 100$$

(Spinning speed (m/min))

**[0154]** The spinning speed V (m/min) was determined based on the following formula from the fineness T (dtex) and the set single hole discharge amount Q (g/min).

$$V = (10000 \times Q)/T$$

(Elongation recovery rate at 50% elongation)

**[0155]** A 25 × 150 mm specimen was prepared. Using an extension tensile tester of constant rate elongation with autographic recording device, the sample was attached at a clamping distance of 50 mm in a state of being pulled to an extent not to be loosened by hand, and the initial load was set to 0.02 N/25 mm. At this time, "(the clamping distance) + (the length elongated when initial load was applied)" was defined as L0. Thereafter, the sample was stretched to 50% of the clamping distance (25 mm elongation) at a tensile speed of 25 mm/min. The length at this time was defined as L1. Thereafter, the load was immediately removed to the initial load at the same speed, and the resulting specimen length was defined as L2. The elongation recovery rate at 50% elongation was determined by the following equation. Measurement was carried out at n = 5 in each of the machine direction and the cross direction, and the average values were rounded off at the first decimal place.

$$\text{Elongation recovery rate at 50\% elongation (\%)} = [(L1 - L2)/(L1 - L0)] \times 100$$

(5% Elongation load)

**[0156]** A 25 × 150 mm specimen was prepared. Using an extension tensile tester of constant rate elongation with autographic recording device, the sample was attached at a clamping distance of 50 mm in a state of being pulled to an extent not to be loosened by hand, and the sample was stretched at a tensile speed of 25 mm/min to 5% of the clamping distance. The initial load was set to 0.02 N/25 mm, and the value obtained by correcting "(the initial clamping distance 50 mm) + (the length elongated when the initial load was applied)" at this time was taken as a clamping distance. The load at the time of stretching to 5% was defined as a 5% elongation load.

(10% Elongation recovery rate)

**[0157]** A 25 × 150 mm specimen was prepared. Using an extension tensile tester of constant rate elongation with autographic recording device, the sample was attached at a clamping distance of 50 mm in a state of being pulled to an extent not to be loosened by hand, and the initial load was set to 0.02 N/25 mm. At this time, "(the clamping distance) + (the length elongated when initial load was applied)" was defined as L0. Thereafter, the sample was stretched to 10% of the clamping distance (5 mm elongation) at a tensile speed of 25 mm/min. The length at this time was defined as L1. Thereafter, the load was immediately removed to the initial load at the same speed, and the resulting specimen length was defined as L2. The 10% elongation recovery rate was determined by the following equation. Measurement was carried out at n = 5 in each of the machine direction and the cross direction, and the average values were rounded off at the first decimal place.

$$\text{10\% Elongation recovery rate (\%)} = [(L1 - L2)/(L1 - L0)] \times 100$$

(Evaluation of peeling property)

**[0158]** A medical adhesive was applied to a nonwoven fabric sized 140 mm × 100 mm, and the nonwoven fabric was applied to the elbows of five subjects. Then, the subjects were made to wear long-sleeved shirts, and the condition after 8 hours had elapsed was examined and judged. In the case of grade 2 to grade 5, it was determined that peeling was controlled.

| | |
|---|---|
| Grade 0: | dropped off |
| Grade 1: | half or more peeled off |
| Grade 2: | 1/3 peeled off |
| Grade 3: | 1/5 peeled off |

(continued)

| | |
|---|---|
| Grade 4: | edge slightly peeled off |
| Grade 5: | no peeling |

(Example 1)

**[0159]** In a bi-component spunbond spinning facility, a polyethylene terephthalate (intrinsic viscosity (iv value): 0.63) and a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) were spun at a mass ratio of 5.5 (polyethylene terephthalate):4.5 (copolymerized polyester) using a side-by-side nozzle. Spinning was carried out at a single hole discharge amount of 1.0 g/min from a spinneret having an orifice diameter of 0.36 mm. Thereafter, dry air was further supplied to an ejector at a pressure (jet pressure) of 3.5 kg/cm$^2$, stretching was carried out in one step, and fibers were collected while being opened on a conveyor located below, affording a long-fiber web. Next, the obtained long-fiber web was subjected to temporary pressure-bonding. Conditions for the temporary pressure-bonding were a temporary pressure-bonding roll temperature of 60°C and a linear pressure of 5 kg/cm.

**[0160]** The long-fiber web obtained as described above had a fiber diameter of 14.5 um, a spinning speed of 4500 m/min, and a basis weight of 25 g/m$^2$.

**[0161]** Next, the obtained long-fiber web was immersed in boiling water. The temperature of the boiling water and the time of the immersion in the boiling water were as shown in Table 1. During the immersion in the boiling water, no tension was applied in the cross direction.

**[0162]** The long-fiber web was immersed in boiling water, and then the long-fiber web was stretched in a cross direction. The stretch ratio was as shown in Table 1.

**[0163]** The long-fiber web was stretched in the cross direction, and then calender processing was applied to the long-fiber web.

The calender temperature (temperature of rolls) and the roll clearance (calender clearance) in the calender processing were as shown in Table 1.

**[0164]** The long-fiber web was subjected to calender processing, and then the long-fiber web was dried. The drying temperature was as shown in Table 1. As described above, a nonwoven fabric of Example 1 was obtained.

(Example 2)

**[0165]** A nonwoven fabric was obtained under the same conditions as in Example 1 except that a sheath-core nozzle having an eccentricity of 0.1 mm was used, a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was disposed on the sheath side, and the cross stretch ratio was changed to 8%.

(Example 3)

**[0166]** A nonwoven fabric was obtained under the same conditions as in Example 2 except that the ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 6.5 : 3.5 and the cross stretch ratio was changed to 5%.

(Example 4)

**[0167]** A nonwoven fabric was obtained under the same conditions as in Example 2 except that a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 85 mol% of ethylene glycol and 15 mol% of neopentyl glycol (intrinsic viscosity (iv value): 0.75, Tg: 75°C) was used as the copolymerized polyester on the sheath side and the cross stretch ratio was changed to 3%.

(Comparative Example 1)

**[0168]** A nonwoven fabric was obtained under the same conditions as in Example 3 except that the temperature of the boiling water was changed as shown in Table 1 and the cross stretching was not carried out. The reason why the cross stretching was not carried out is that the basis weight before the cross stretching was small in Comparative Example

1. That is, in each of Examples and Comparative Examples, the cross stretching was carried out in order to make the basis weight of the nonwoven fabrics to be obtained about the same (about 100 g/m$^2$), but in Comparative Example 1, the basis weight before the cross stretching was small, and if the cross stretching is carried out, the basis weight is further reduced, and therefore, the cross stretching was not carried out.

(Comparative Example 2)

**[0169]** A nonwoven fabric was obtained under the same conditions as in Example 3 except that the calendar clearance was changed as shown in Table 1.

(Comparative Example 3)

**[0170]** A nonwoven fabric was obtained under the same conditions as in Example 3 except that the calendar clearance was changed as shown in Table 1.

(Comparative Example 4)

**[0171]** A nonwoven fabric was obtained under the same conditions as in Example 3 except that a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 95 mol% of ethylene glycol and 5 mol% of neopentyl glycol (intrinsic viscosity (iv value): 0.75, Tg: 75°C) was used as the copolymerized polyester and the cross stretching was not carried out. The reason why the cross stretching was not carried out is that the basis weight before the cross stretching was small in Comparative Example 4. That is, in each of Examples and Comparative Examples, the cross stretching was carried out in order to make the basis weight of the nonwoven fabrics to be obtained about the same (about 100 g/m$^2$), but in Comparative Example 4, the basis weight before the cross stretching was small, and if the cross stretching is carried out, the basis weight is further reduced, and therefore, the cross stretching was not carried out.

**[0172]** The basis weight, the thickness, the apparent density, the 5% elongation load in the MD direction, the 50 elongation load in the CD direction, the elongation recovery rate at 50% elongation in the MD direction, the elongation recovery rate at 50% elongation in the CD direction, and the grade of peeling property evaluation of the obtained nonwoven fabrics were as shown in Table 1.

[Table 1]

| | | | Example 1 | Example 2 | Example 3 | Example 4 | Comparative Example 1 | Comparative Example 2 | Comparative Example 3 | Comparative Example 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nozzle type | | - | Side-by-side | Sheath-core | Sheath-core | Sheath-core | Sheath-core | Sheath-core | Sheath-core | Sheath-core |
| First component | | - | NPG30% | NPG30% | NPG30% | NPG15% | NPG30% | NPG30% | NPG30% | NPG5% |
| Second component | | - | PET | PET | PET | PET | PET | PET | PET | PET |
| Eccentric distance | | mm | - | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 | 0.32 |
| Weight ratio of first component | | - | 4.5 | 4.5 | 3.5 | 4.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| Weight ratio of second component | | - | 5.5 | 5.5 | 6.5 | 5.5 | 6.5 | 6.5 | 6.5 | 6.5 |
| Single hole discharge amount | | g/min | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Spinning speed | | m/min | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 |
| Temporary pressure-bonding roll temperature | | °C | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Temporary pressure-bonding roll linear pressure | | kg/cm | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Basis weight of long-fiber web | | g/m$^2$ | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Fiber diameter of long-fiber web | | µm | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Crimp processing | Boiling water temperature | °C | 90 | 90 | 90 | 90 | 70 | 90 | 90 | 90 |
| | Immersion time | see | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| | Calender temperature | °C | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| | Calender clearance | mm | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.05 | 0.6 | 0.2 |
| | Cross stretching | % | 10 | 8 | 5 | 3 | - | 5 | 5 | - |
| | Drying temperature | °C | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |

(continued)

| | | | Example 1 | Example 2 | Example 3 | Example 4 | Comparative Example 1 | Comparative Example 2 | Comparative Example 3 | Comparative Example 4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Physical properties | Basis weight of nonwoven fabric | g/m$^2$ | 100 | 98 | 104 | 97 | 85 | 102 | 101 | 80 |
| | Thickness of nonwoven fabric | mm | 0.5 | 0.6 | 0.55 | 0.85 | 0.7 | 0.38 | 1.2 | 0.5 |
| | Apparent density of nonwoven fabric | g/cc | 0.20 | 0.16 | 0.19 | 0.11 | 0.12 | 0.27 | 0.08 | 0.16 |
| | Eccentricity | % | | 17 | 12 | 17 | 12 | 12 | 12 | 12 |
| | 5% Elongation load (MD) | N/ 25mm | 0.80 | 0.60 | 0.20 | 0.18 | 0.15 | 1.20 | 0.12 | 0.16 |
| | 5% Elongation load (CD) | N/ 25mm | 0.60 | 0.45 | 0.20 | 0.15 | 0.15 | 1.10 | 0.10 | 0.14 |
| | 50% Elongation recovery rate (MD) | % | 68 | 65 | 64 | 58 | 45 | 40 | 72 | 46 |
| | 50% Elongation recovery rate (CD) | % | 65 | 66 | 64 | 55 | 50 | 48 | 75 | 45 |
| | Grade of peeling property | Grade | 5 | 5 | 4 | 3 | 3 | 5 | 1 | 4 |

(Example 5)

**[0173]** In a bi-component spunbond spinning facility, a polyethylene terephthalate (intrinsic viscosity (iv value): 0.63) and a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) were spun at a mass ratio of 5.5 (polyethylene terephthalate):4.5 (copolymerized polyester) using a side-by-side nozzle. Spinning was carried out at a single hole discharge amount of 1.0 g/min from a spinneret having an orifice diameter of 0.36 mm. Thereafter, dry air was further supplied to an ejector at a pressure (jet pressure) of 3.5 kg/cm$^2$, stretching was carried out in one step, and fibers were collected while being opened on a conveyor located below, affording a long-fiber web. Next, the obtained long-fiber web was subjected to temporary pressure-bonding. Conditions for the temporary pressure-bonding were a temporary pressure-bonding roll temperature of 60°C and a linear pressure of 5 kg/cm.

**[0174]** The long-fiber web obtained as described above had a fiber diameter of 14.5 um, a spinning speed of 4500 m/min, and a basis weight of 25 g/m$^2$.

**[0175]** Next, crimp processing was applied to the obtained long-fiber web while conveying the long-fiber web with six heating rolls. Specifically, the temperature of each heating roll and the speed ratio of each heating roll were set as shown in Table 2. The speed ratio refers to a speed at which a web is conveyed out from the outlet of each roll with respect to a speed at which the web is conveyed from the inlet of the first roll to the first roll. At the time of crimp processing with the fourth roll, pressurization was carried out with a rubber nip roll. As described above, a nonwoven fabric of Example 5 was obtained.

(Example 6)

**[0176]** A nonwoven fabric was obtained under the same conditions as in Example 5 except that a sheath-core nozzle having an eccentricity of 0.1 mm was used, a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was disposed on the sheath side.

(Example 7)

**[0177]** A nonwoven fabric was obtained under the same conditions as in Example 5 except that the ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 6.5 : 3.5.

(Example 8)

**[0178]** A nonwoven fabric was obtained under the same conditions as in Example 6 except that the ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 6.5 : 3.5.

**[0179]** The basis weight, the thickness, the apparent density, the 5% elongation load in the MD direction, the 50 elongation load in the CD direction, the elongation recovery rate at 50% elongation in the MD direction, the elongation recovery rate at 50% elongation in the CD direction, and the grade of peeling property evaluation of the obtained nonwoven fabrics were as shown in Table 2.

[Table 2]

| | | Example 5 | Example 6 | Example 7 | Example 8 |
|---|---|---|---|---|---|
| Nozzle type | - | Side-by-side | Sheath-core | Side-by-side | Sheath-core |
| First component | - | NPG30% | NPG30% | NPG30% | NPG30% |
| Second component | - | PET | PET | PET | PET |
| Eccentric distance | mm | - | 0.32 | - | 0.32 |
| Weight ratio of first component | - | 4.5 | 4.5 | 3.5 | 3.5 |

(continued)

| | | | Example 5 | Example 6 | Example 7 | Example 8 |
|---|---|---|---|---|---|---|
| Weight ratio of second component | | - | 5.5 | 5.5 | 6.5 | 6.5 |
| Single hole discharge amount | | g/min | 1 | 1 | 1 | 1 |
| Spinning speed | | m/min | 4500 | 4500 | 4500 | 4500 |
| Temporary pressure-bonding roll temperature | | °C | 60 | 60 | 60 | 60 |
| Temporary pressure-bonding roll linear pressure | | kg/cm | 5 | 5 | 5 | 5 |
| Basis weight of long-fiber web | | g/m$^2$ | 25 | 25 | 25 | 25 |
| Fiber diameter of long-fiber web | | μm | 14.5 | 14.5 | 14.5 | 14.5 |
| Stretch ratio | First roll | % | 90 | 90 | 90 | 90 |
| | Second roll | % | 80 | 80 | 80 | 80 |
| | Third roll | % | 60 | 60 | 60 | 60 |
| | Fourth roll | % | 50 | 50 | 50 | 50 |
| | Fifth roll | % | 50 | 50 | 50 | 50 |
| | Sixth roll | % | 50 | 50 | 50 | 50 |
| Temperature | First roll | °C | 80 | 80 | 80 | 80 |
| | Second roll | °C | 80 | 80 | 80 | 80 |
| | Third roll | °C | 110 | 110 | 110 | 110 |
| | Fourth roll | °C | 130 | 130 | 130 | 130 |
| | Fifth roll | °C | 40 | 40 | 40 | 40 |
| | Sixth roll | °C | 40 | 40 | 40 | 40 |
| Nip | First roll | - | Absent | Absent | Absent | Absent |
| | Second roll | - | Absent | Absent | Absent | Absent |
| | Third roll | - | Absent | Absent | Absent | Absent |
| | Fourth roll | - | Present | Present | Present | Present |
| | Fifth roll | - | Absent | Absent | Absent | Absent |
| | Sixth roll | - | Absent | Absent | Absent | Absent |

(continued)

| | | | Example 5 | Example 6 | Example 7 | Example 8 |
|---|---|---|---|---|---|---|
| Physical properties | Basis weight of nonwoven fabric | g/m$^2$ | 100 | 98 | 95 | 97 |
| | Thickness of nonwoven fabric | mm | 0.8 | 0.75 | 0.9 | 0.92 |
| | Apparent density of nonwoven fabric | g/cc | 0.13 | 0.13 | 0.11 | 0.11 |
| | Eccentricity | % | - | 17 | - | 12 |
| | 5% Elongation load (MD) | N/25mm | 0.7 | 0.55 | 0.33 | 0.18 |
| | 5% Elongation load (CD) | N/25mm | 0.5 | 0.4 | 0.28 | 0.15 |
| | 50 Elongation recovery rate (MD) | % | 63 | 61 | 58 | 55 |
| | 50 Elongation recovery rate (CD) | % | 56 | 60 | 57 | 56 |
| | Grade of peeling property | Grade | 5 | 4 | 3 | 3 |

(Example 9)

**[0180]** In a bi-component spunbond spinning facility, a polyethylene terephthalate (intrinsic viscosity (iv value): 0.63) and a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) were spun at a mass ratio of 5.5 (polyethylene terephthalate):4.5 (copolymerized polyester) using a side-by-side nozzle. Spinning was carried out at a single hole discharge amount of 1.0 g/min from a spinneret having an orifice diameter of 0.36 mm. Thereafter, dry air was further supplied to an ejector at a pressure (jet pressure) of 3.5 kg/cm$^2$, stretching was carried out in one step, and fibers were collected while being opened on a conveyor located below, affording a long-fiber web. Next, the obtained long-fiber web was subjected to temporary pressure-bonding. Conditions for the temporary pressure-bonding were a temporary pressure-bonding roll temperature of 60°C and a linear pressure of 5 kg/cm.

**[0181]** The long-fiber web obtained as described above had a fiber diameter of 14.5 um, a spinning speed of 4500 m/min, and a basis weight of 25 g/m$^2$.

**[0182]** Next, crimp processing was applied to the obtained long-fiber web while conveying the long-fiber web with six heating rolls. Specifically, the temperature of each heating roll and the speed ratio of each heating roll were set as shown in Table 1. The speed ratio refers to a speed at which a web is conveyed out from the outlet of each roll with respect to a speed at which the web is conveyed from the inlet of the first roll to the first roll. At the time of crimp processing with the fourth roll, pressurization was carried out with a rubber nip roll.

**[0183]** The obtained nonwoven fabric had a basis weight of 100 g/m$^2$, a thickness of 0.8 mm, an apparent density of 0.13 g/cc, a 10% elongation recovery rate in the MD direction of 84%, and a 10% elongation recovery rate in the CD direction of 87%. In addition, the grade of peeling property evaluation was Grade 5.

(Example 10)

**[0184]** A nonwoven fabric was obtained under the same conditions as in Example 9 except that a sheath-core nozzle having an eccentricity of 0.1 mm was used, a copolymerized polyester (a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was disposed on the sheath side.

**[0185]** The obtained nonwoven fabric had a basis weight of 98 g/m$^2$, a thickness of 0.75 mm, an apparent density of 0.13 g/cc, a 10% elongation recovery rate in the MD direction of 78%, and a 10% elongation recovery rate in the CD direction of 83%. In addition, the grade of peeling property evaluation was Grade 4.

(Example 11)

**[0186]** A nonwoven fabric was obtained under the same conditions as in Example 9 except that the ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 6.5 : 3.5.

**[0187]** The obtained nonwoven fabric had a basis weight of 95 g/m$^2$, a thickness of 0.9 mm, an apparent density of 0.11 g/cc, a 10% elongation recovery rate in the MD direction of 71%, and a 10% elongation recovery rate in the CD direction of 72%. In addition, the grade of peeling property evaluation was Grade 3.

(Example 12)

**[0188]** A nonwoven fabric was obtained under the same conditions as in Example 10 except that the ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 6.5 : 3.5.

**[0189]** The obtained nonwoven fabric had a basis weight of 97 g/m$^2$, a thickness of 0.92 mm, an apparent density of 0.11 g/cc, a 10% elongation recovery rate in the MD direction of 67%, and a 10% elongation recovery rate in the CD direction of 70%. In addition, the grade of peeling property evaluation was Grade 3.

(Example 13)

**[0190]** A nonwoven fabric was obtained under the same conditions as in Example 10 except that a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 85 mol% of ethylene glycol and 15 mol% of neopentyl glycol (intrinsic viscosity (iv value): 0.75, Tg: 75°C) was used as the copolymerized polyester on the sheath side.

**[0191]** The obtained nonwoven fabric had a basis weight of 97 g/m$^2$, a thickness of 0.85 mm, an apparent density of 0.11 g/cc, a 10% elongation recovery rate in the MD direction of 65%, and a 10% elongation recovery rate in the CD direction of 67%. In addition, the grade of peeling property evaluation was Grade 3.

(Example 14)

**[0192]** A nonwoven fabric was obtained under the same conditions as in Example 9 except that a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 50 mol% of ethylene glycol and 50 mol% of neopentyl glycol (intrinsic viscosity (iv value): 0.75, Tg: 75°C) was used as the copolymerized polyester.

**[0193]** The obtained nonwoven fabric had 110 g/m$^2$, a thickness of 0.8 mm, an apparent density of 0.14 g/cc, a 10% elongation recovery rate in the MD direction of 86%, and a 10% elongation recovery rate in the CD direction of 88%. In addition, the grade of peeling property evaluation was Grade 5.

(Comparative Example 5)

**[0194]** A spunbonded nonwoven fabric was obtained under the same conditions as in Example 9 except that crimp processing was carried out by hot air through at 130°C instead of carrying out crimp processing using a heating roll.

**[0195]** The obtained nonwoven fabric had 101 g/m$^2$, a thickness of 1.3 mm, an apparent density of 0.08 g/cc, a 10% elongation recovery rate in the MD direction of 88%, and a 10% elongation recovery rate in the CD direction of 89%. In addition, the grade of peeling property evaluation was Grade 1.

(Comparative Example 6)

**[0196]** An attempt was made to obtain a nonwoven fabric under the same conditions as in Example 9 except that the weight ratio of the polyethylene terephthalate to the copolymerized polyester (the copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 70 mol% of ethylene glycol and 30 mol% of neopentyl glycol, intrinsic viscosity (iv value): 0.75, Tg: 75°C) was changed to 8.5 : 1.5. However, almost no shrinkage caused by crimp occurred.

(Comparative Example 7)

**[0197]** An attempt was made to obtain a nonwoven fabric under the same conditions as in Example 9 except that, as copolymerized polyester, a copolymer in which the dicarboxylic acid component is terephthalic acid and the glycol component is composed of 95 mol% of ethylene glycol and 5 mol% of neopentyl glycol (intrinsic viscosity (iv value): 0.75, Tg: 75°C) was used. However, almost no shrinkage caused by crimp occurred.

[Table 3]

| | | | Example 9 | Example 10 | Example 11 | Example 12 | Example 13 | Example 14 | Comparative Example 5 | Comparative Example 6 | Comparative Example 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nozzle type | | | Side-by-side | Sheath-core | Side-by-side | Sheath-core | Sheath-core | Side-by-side | Side-by-side | Side-by-side | Sheath-core |
| First component | | | NPG30% | NPG30% | NPG30% | NPG30% | NPG15% | NPG50% | NPG30% | NPG30% | NPG5% |
| Second component | | | PET | PET | PET | PET | PET | PET | PET | PET | PET |
| Eccentric distance | | mm | - | 0.32 | - | 0.32 | 0.32 | - | - | - | 0.32 |
| Mass ratio of first component | | - | 4.5 | 4.5 | 3.5 | 3.5 | 4.5 | 4.5 | 4.5 | 1.5 | 4.5 |
| Mass ratio of second component | | - | 5.5 | 5.5 | 6.5 | 6.5 | 5.5 | 5.5 | 5.5 | 8.5 | 5.5 |
| Single hole discharge amount | | g/min | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Spinning speed | | m/min | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 | 4500 |
| Temporary pressure-bonding roll temperature | | °C | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Temporary pressure-bonding roll linear pressure | | kg/cm | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Basis weight of long-fiber web | | g/m$^2$ | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Fiber diameter of long-fiber web | | μm | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 |
| Air through | | - | Absent | Absent | Absent | Absent | Absent | Absent | Present | Absent | Absent |
| Speed ratio | First roll | % | 90 | 90 | 90 | 90 | 90 | 90 | - | 90 | 90 |
| | Second roll | % | 80 | 80 | 80 | 80 | 80 | 80 | - | 80 | 80 |
| | Third roll | % | 60 | 60 | 60 | 60 | 60 | 60 | - | 60 | 60 |
| | Fourth roll | % | 50 | 50 | 50 | 50 | 50 | 50 | - | 50 | 50 |
| | Fifth roll | % | 50 | 50 | 50 | 50 | 50 | 50 | - | 50 | 50 |
| | Sixth roll | % | 50 | 50 | 50 | 50 | 50 | 50 | - | 50 | 50 |

(continued)

| | | | Example 9 | Example 10 | Example 11 | Example 12 | Example 13 | Example 14 | Comparative Example 5 | Comparative Example 6 | Comparative Example 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | First roll | °C | 80 | 80 | 80 | 80 | 80 | 80 | - | 80 | 80 |
| | Second roll | °C | 80 | 80 | 80 | 80 | 80 | 80 | - | 80 | 80 |
| | Third roll | °C | 110 | 110 | 110 | 110 | 110 | 110 | - | 110 | 110 |
| | Fourth roll | °C | 130 | 130 | 130 | 130 | 130 | 130 | - | 130 | 130 |
| | Fifth roll | °C | 40 | 40 | 40 | 40 | 40 | 40 | - | 40 | 40 |
| | Sixth roll | °C | 40 | 40 | 40 | 40 | 40 | 40 | - | 40 | 40 |
| Nip | First roll | °C | Absent | Absent | Absent | Absent | Absent | Absent | - | Absent | Absent |
| | Second roll | °C | Absent | Absent | Absent | Absent | Absent | Absent | - | Absent | Absent |
| | Third roll | °C | Absent | Absent | Absent | Absent | Absent | Absent | - | Absent | Absent |
| | Fourth roll | °C | Present | Present | Present | Present | Present | Present | - | Present | Present |
| | Fifth roll | °C | Absent | Absent | Absent | Absent | Absent | Absent | - | Absent | Absent |
| | Sixth roll | °C | Absent | Absent | Absent | Absent | Absent | Absent | - | Absent | Absent |
| Basis weight of nonwoven fabric | | g/m$^2$ | 100 | 98 | 95 | 97 | 97 | 110 | 101 | - | - |
| Thickness of nonwoven fabric | | mm | 0.8 | 0.75 | 0.9 | 0.92 | 0.85 | 0.8 | 1.3 | - | - |
| Apparent density of nonwoven fabric | | g/cc | 0.13 | 0.13 | 0.11 | 0.11 | 0.11 | 0.14 | 0.08 | - | - |
| Eccentricity | | % | - | 17 | - | 12 | 16 | - | - | - | - |
| Elongation recovery rate (MD) | % | 84 | 78 | 71 | 67 | 65 | 86 | 88 | - | - | |
| Elongation recovery rate (CD) | % | 87 | 83 | 72 | 70 | 67 | 88 | 89 | - | - | |

(continued)

| | | | Example 9 | Example 10 | Example 11 | Example 12 | Example 13 | Example 14 | Comparative Example 5 | Comparative Example 6 | Comparative Example 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade of peeling property | Grade | 5 | 4 | 3 | 3 | 3 | 5 | 1 | - | - | |

## Claims

1. A long-fiber nonwoven fabric comprising a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester,
wherein

   the long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more and 0.25 g/cc or less, and
   has an elongation recovery rate at 50% elongation of 55% or more.

2. The long-fiber nonwoven fabric according to claim 1, wherein the long-fiber nonwoven fabric has a 5% elongation load of 1.0 N/25 mm or less.

3. The long-fiber nonwoven fabric according to claim 1 or 2, wherein the long fiber is a crimped yarn.

4. The long-fiber nonwoven fabric according to any one of claims 1 to 3, wherein the long fiber has a sheath-core structure.

5. The long-fiber nonwoven fabric according to claim 4, wherein in the sheath-core structure, a center of a core component is eccentric by 2% or more.

6. The long-fiber nonwoven fabric according to any one of claims 1 to 3, wherein the long fiber has a side-by-side structure.

7. The long-fiber nonwoven fabric according to any one of claims 1 to 6, wherein the long-fiber nonwoven fabric has not been subjected to a mechanical interlacing treatment.

8. The long-fiber nonwoven fabric according to any one of claims 1 to 7, wherein the copolymerized polyester is composed of a dicarboxylic acid component being terephthalic acid and a glycol component being composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

9. The long-fiber nonwoven fabric according to any one of claims 1 to 8, which is used as a base fabric of a patch.

10. A long-fiber nonwoven fabric comprising a long fiber of a bi-component conjugate spun yarn including polyethylene terephthalate and a copolymerized polyester,
wherein

    the long-fiber nonwoven fabric has an apparent density of 0.1 g/cc or more, and
    has a 10% elongation recovery rate of 65% or more.

11. The long-fiber nonwoven fabric according to claim 10, wherein the long fiber is a crimped yarn.

12. The long-fiber nonwoven fabric according to claim 10 or 11, wherein the long fiber has a sheath-core structure.

13. The long-fiber nonwoven fabric according to claim 12, wherein in the sheath-core structure, a center of a core component is eccentric by 2% or more.

14. The long-fiber nonwoven fabric according to claim 10 or 11, wherein the long fiber has a side-by-side structure.

15. The long-fiber nonwoven fabric according to any one of claims 10 to 14, wherein the long-fiber nonwoven fabric has not been subjected to a mechanical interlacing treatment.

16. The long-fiber nonwoven fabric according to any one of claims 10 to 15, wherein the copolymerized polyester is composed of a dicarboxylic acid component being terephthalic acid and a glycol component being composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

17. A method for producing the long-fiber nonwoven fabric according to any one of claims 1 to 16, the method comprising:

    step A of discharging molten polyethylene terephthalate and a molten copolymerized polyester from a spinneret,

cooling and solidifying them, and then pulling and stretching them with an ejector to form long fibers of a bicomponent conjugate spun yarn;
step B of collecting the long fibers obtained in the step A to form a long-fiber web;
step C of temporarily pressure-bonding the long-fiber web; and
step D of applying crimp processing to the temporarily pressure-bonded long-fiber web.

**18.** The method for producing the long-fiber nonwoven fabric according to claim 17, wherein the step D is a step of immersing the long-fiber web in boiling water at 80°C or higher.

**19.** The method for producing the long-fiber nonwoven fabric according to claim 18, the method comprising step E of stretching the long-fiber web in a cross direction after the step D.

**20.** The method for producing the long-fiber nonwoven fabric according to claim 19, the method comprising step F of applying calender processing to the long-fiber web after the step E.

**21.** The method for producing the long-fiber nonwoven fabric according to claim 20, wherein a roll clearance in the calender processing in the step F is 0.1 mm or more.

**22.** The method for producing the long-fiber nonwoven fabric according to claim 17, wherein the step D is a step of, with use of two or more heating rollers whose temperature modulation and a speed ratio can be changed, applying crimp processing to the long-fiber web while gradually decreasing the speed ratio.

**23.** The method for producing the long-fiber nonwoven fabric according to any one of claims 17 to 22, wherein the step A comprises step A-1 of, with use of an eccentric sheath-core nozzle as the spinneret, discharging the polyethylene terephthalate as a core component and the copolymerized polyester as a sheath component from the eccentric sheath-core nozzle.

**24.** The method for producing the long-fiber nonwoven fabric according to any one of claims 17 to 23, wherein the step A comprises step A-2 of, with use of a side-by-side nozzle as the spinneret, discharging the polyethylene terephthalate and the copolymerized polyester from the side-by-side nozzle so as to combine them in a side-by-side form in a fiber length direction.

**25.** The method for producing the long-fiber nonwoven fabric according to any one of claims 17 to 24, wherein the copolymerized polyester is composed of a dicarboxylic acid component being terephthalic acid and a glycol component being composed of 50 to 85 mol% of ethylene glycol and 15 to 50 mol% of neopentyl glycol.

## INTERNATIONAL SEARCH REPORT

International application No.
**PCT/JP2021/034095**

### A. CLASSIFICATION OF SUBJECT MATTER

***D04H 3/147***(2012.01)i; ***D04H 3/011***(2012.01)i
FI: D04H3/147; D04H3/011

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)

D04H1/00-18/04

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 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

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

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | JP 7-42061 A (KURARAY CO., LTD.) 10 February 1995 (1995-02-10)<br>example 1 | 1-25 |
| A | JP 10-88456 A (UNITIKA LTD.) 07 April 1998 (1998-04-07)<br>example 5 | 1-25 |

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

* Special categories of cited documents:

| | |
|---|---|
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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| **26 October 2021** | **09 November 2021** |

Name and mailing address of the ISA/JP

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**Japan**

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## INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
**PCT/JP2021/034095**

| Patent document cited in search report | Publication date (day/month/year) | Patent family member(s) | Publication date (day/month/year) |
|---|---|---|---|
| JP 7-42061 A | 10 February 1995 | (Family: none) | |
| JP 10-88456 A | 07 April 1998 | (Family: none) | |

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

## REFERENCES CITED IN THE DESCRIPTION

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- JP 7042061 A **[0005]**
- JP 2013044070 A **[0005]**