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(54) FIBER STRUCTURE BODY AND METHOD FOR MANUFACTURING SAME

(57) The present invention relates to a fiber structure including coil-shaped crimped fibers (a) and non-coil-shaped crimped fibers (b), the fiber structure having an entangled part (A) including the coil-shaped crimped fibers (a) and entangled parts (B) including the non-coil-shaped crimped fibers (b), at least one distance between the entangled parts (B) in a machine direction of the fiber structure being less than the apparent average fiber length of the coil-shaped crimped fibers (a).

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Description

TECHNICAL FIELD

[0001] The present invention relates to a fiber structure suitably usable as a bandage or the like, and a method for manufacturing the same.

BACKGROUND ART

[0002] Conventionally, in the fields of medicine, sports, and the like, tapes such as various bandages and supporters have been used for the purpose of appropriately pressing, fixing, and protecting application sites such as limbs and affected parts. These tapes are required to have fixing ability by self-adhesion or adhesion in addition to stretchability, followability, sweat absorption, air permeability, and the like.

[0003] In general, a soft component such as a rubber or acrylic latex is applied to the surface of a bandage for the purpose of fulfilling stretchability and fixing ability (PTL 1 to 5). These soft components, however, are not preferable from the viewpoint of safety because they may possibly cause irritation to the skin and stuffiness due to loss of air permeability, and may even cause allergy.

[0004] For the purpose of reducing skin irritation, a medical material containing a low-protein natural rubber latex as a pressure-sensitive adhesive (PTL 6), and a self-adhesive bandage containing a specific acrylic polymer as a pressure-sensitive adhesive (PTL 7) have been proposed. These medical material and self-adhesive bandage, however, still contain a pressure-sensitive adhesive, and do not provide a fundamental solution.

[0005] As a nonwoven fabric that can be self-adhesive without any pressure-sensitive adhesive applied thereto, there have been proposed a nonwoven fabric including a latently thermally crimpable conjugated fiber, which has stretchability and can be easily cut by hand (PTL 8), and a stretchable nonwoven fabric that is of a high-stress type and can be used repeatedly (PTL 9).

CITATION LIST

PATENT LITERATURE

[0006]

PTL 1: Patent Publication No. 48-000309
PTL 2: Japanese Patent Laying-Open No. 63-068163
PTL 3: Japanese Patent Laying-Open No. 63-260553
PTL 4: Japanese Patent Laying-Open No. 01-19035
PTL 5: Japanese Patent Laying-Open No. 11 -089874
PTL 6: National Patent Publication No. 2003-514105
PTL 7: Japanese Patent Laying-Open No. 2005-095381
PTL 8: International Publication No. 2008/015972
PTL 9: International Publication No. 2016/031818

SUMMARY OF INVENTION

TECHNICAL PROBLEMS

[0007] It was found that the nonwoven fabric described in PTL 8, however, is easily torn when tightly wound. It was also found that although the nonwoven fabric described in PTL 9 has, owing to the high stress of the fabric, a property of being hardly torn even when tightly wound, the nonwoven fabric tends to have high stress even at low extension, and there is room for improvement of the initial conformity.

[0008] Therefore, an object of the present invention is to provide a fiber structure that is easy to extend but is hardly torn, which has very high stress at high extension and can be tightly wound while having very low stress at low extension and being excellent in the initial conformity.

SOLUTIONS TO PROBLEMS

[0009] The present inventors found that the nonwoven fabric described in PTL 8 has low strength because the crimps that have been expressed are entangled with each other, and the nonwoven fabric is easy to extend but is likely to break.

The present inventors also found that in the nonwoven fabric described in PTL 9, which is obtained by entanglement by the spunlace method or needle punch method and then treated with high-speed steam, the sheet itself is entangled and the expressed crimps cannot be used, and the nonwoven fabric hardly exhibits shrinkability.

[0010] The present inventors have conducted intensive studies to achieve the above-described object. As a result, they found that a fiber structure described below can achieve the above-described object: a fiber structure having an entangled part (A) including coil-shaped crimped fibers (a) and two or more entangled parts (B) including non-coil-shaped crimped fibers (b), at least one distance between the entangled parts (B) in a machine direction of the fiber structure being less than the apparent average fiber length of the coil-shaped crimped fibers (a).

[0011] More specifically, the present invention includes the following.

[1] A fiber structure including coil-shaped crimped fibers (a) and non-coil-shaped crimped fibers (b), the fiber structure having an entangled part (A) including the coil-shaped crimped fibers (a) and two or more entangled parts (B) including the non-coil-shaped crimped fibers (b), at least one distance between the entangled parts (B) in a machine direction of the fiber structure being less than the apparent average fiber length of the coil-shaped crimped fibers (a).

[2] The fiber structure according to [1], wherein, in a surface of the fiber structure, the area rate of the entangled part (A) to the surface area of the fiber structure is 20 to 85%.

[3] The fiber structure according to [1] or [2], wherein a thickness (T_A) of the entangled part (A) and a thickness (T_B) of the entangled parts (B) have a ratio of T_A/T_B = 1.1 to 10.

[4] The fiber structure according to any one of [1] to [3], having, in the machine direction of the fiber structure, a stress at 50% extension of less than or equal to 15 N/5 cm, and a stress at 80% extension of greater than or equal to 20 N/5 cm.

[5] The fiber structure according to any one of [1] to [4], having, in the machine direction of the fiber structure, a ratio between a stress at 50% extension and a stress at 80% extension, that is, stress at 80% extension/stress at 50% extension of greater than or equal to 2.7.

[6] The fiber structure according to any one of [1] to [5], wherein the coil-shaped crimped fibers (a) include a conjugated fiber in which a plurality of resins having different thermal shrinkage factors form a phase structure.

[7] The fiber structure according to any one of [1] to [6], having a basis weight of 50 to 200 g/m^2,

[8] A bandage including the fiber structure according to any one of [1] to [7].

[9] A method for manufacturing the fiber structure according to any one of [1] to [8], the method including:

1) forming a fiber into a web;
2) entangling part of the web by spraying or injection of water to form the entangled parts (B); and
3) heating the web with high-temperature steam to form the entangled part (A).

ADVANTAGEOUS EFFECTS OF INVENTION

[0012] The fiber structure according to the present invention is excellent in the initial conformity and can be tightly wound, so that the fiber structure can be suitably used as a bandage or the like.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

Fig. 1 is an outline diagram showing an arrangement pattern of entangled parts (B) in a machine direction of a fiber structure obtained in Example 1.

Fig. 2 is a schematic diagram showing a method of preparing a sample for measuring curved surface sliding stress.

Fig. 3 is a cross-sectional schematic diagram showing the sample for measuring the curved surface sliding stress.

Fig. 4 is a schematic diagram showing a method of measuring the curved surface sliding stress.

DESCRIPTION OF EMBODIMENTS

[Fiber structure]

[0014] The fiber structure according to the present invention (hereinafter also simply referred to as a "fiber structure") has an entangled part (A) including coil-shaped crimped fibers (a) and entangled parts (B) including non-coil-shaped crimped fibers (b). The fiber structure according to the present invention has, in the entangled part (A), a structure in which the coil-shaped crimped fibers (a) are entangled with each other at their crimped coil portions and bound or hooked. Meanwhile, in the entangled parts (B), the entangled parts are formed not by the crimp of the non-coil-shaped crimped fibers (b) but by the packing of the fibers. The coil-shaped crimped fibers (a) and the non-coil-shaped crimped fibers (b) are preferably oriented in the machine direction of the fiber structure, and the coil-shaped crimped fibers (a) are preferably crimped into a coil shape along the orientation axis.

[0015] The "machine direction" of the fiber structure is a machine direction of the fiber structure in a production process (that is, MD direction). When the fiber structure has, for example, a length direction and a width direction like a bandage, the machine direction is preferably the length direction. In this case, the fiber structure as a bandage can be wrapped around an application site while being extended along the length direction thereof. When the fiber structure has a length direction and a width direction, a CD direction orthogonal to the MD direction is preferably the width direction.

[0016] In the fiber structure according to the present invention, fibers are relatively weakly entangled with each other in the entangled part (A), so that the fiber structure has very low stress at low extension and is excellent in the initial conformity. Further, since fibers are strongly entangled with each other in the entangled parts (B), the fiber structure has very high stress at high extension and can be tightly wound.

[0017] In the fiber structure according to the present invention, at least one distance between the entangled parts (B) in the machine direction of the fiber structure (hereinafter, the distance is also simply referred to as a "distance between the entangled parts (B)") is less than the apparent average fiber length of the coil-shaped crimped fibers (a). The "distance between the entangled parts (B) in the machine direction of the fiber structure" refers to the shortest distance in the machine direction between any one of the entangled parts (B) of the fiber structure and another one of the entangled parts (B) that is present closest to the above-described entangled part (B) in the machine direction. If the distance between the entangled parts (B) is greater than or equal to the apparent average fiber length of the coil-shaped crimped fibers (a), the entangled parts (B) are entangled with each other only by the crimped coil portions of the coil-shaped crimped fibers (a), and the entangled coil portions are extended and finally unwrapped at high extension, so that the fiber structure tends to be broken at the coil portions. On the contrary, when the distance between the entangled parts (B) is less than the apparent average fiber length of the coil-shaped crimped fibers (a), at least one ends of the coil-shaped crimped fibers (a) are entangled at the entangled parts (B), so that the coil-shaped crimped fibers (a) do not unwrap even at high extension, and the fiber structure tends to easily exhibit high stress at high extension. From the above-described viewpoint, it is preferable that in at least part of the coil-shaped crimped fibers (a), both ends thereof are entangled at the entangled parts (B).

[0018] It is preferable that pairs of the entangled parts (B) constituting the distances between the entangled parts (B) are arranged so that at least part thereof can be entangled with the coil-shaped crimped fibers (a) oriented in the machine direction. When the entangled parts (B) are entangled with the coil-shaped crimped fibers (a), high stress tends to be easily obtained at high extension. As the number of the coil-shaped crimped fibers (a) entangled with the entangled parts (B) is larger, strong entanglement between the entangled parts (B) and the coil-shaped crimped fibers (a) tends to occur easily. When the fiber structure has a sheet shape, the entangled parts (B) may be formed regularly in the sheet plane, and it is preferable that the entangled part (A) and the entangled parts (B) are arranged in a border pattern in which the entangled part (A) and the entangled parts (B) are alternately arranged in the machine direction, or a plane lattice pattern in which the entangled parts (B) having a specific shape are regularly arranged, such as a square lattice pattern, an orthorhombic lattice pattern, or a rectangular lattice pattern. Fig. 1 shows, as for a fiber structure 1 having an orthorhombic lattice pattern and obtained in Example 1 described later, entangled parts (B) 2, an entangled part (A) 3, and a distance 4 between the entangled parts (B).

[0019] When the entangled parts (B) are arranged in a border pattern, the width (length in the machine direction) of one entangled part (B) may be, for example, 0.5 to 30 mm, and is preferably 1 to 20 mm, more preferably 2 to 10 mm, still more preferably 3 to 8 mm.

[0020] When the entangled parts (B) are arranged in a plane lattice pattern, the interval in a direction perpendicular to the machine direction (the interval in a direction perpendicular to the "distance between the entangled parts (B)") may be, for example, 0.5 to 30 mm, and is preferably 1 to 20 mm, more preferably 2 to 10 mm, still more preferably 3 to 8 mm.

[0021] When the entangled parts (B) are arranged in a plane lattice pattern, the shape of the entangled parts (B) is not particularly limited, but may be, for example, an oval shape, an elliptical shape, a circular shape, a square shape, or a rectangular shape, and is preferably an oval shape. When the entangled parts (B) have an oval shape, the length in the major axis direction may be, for example, 1 to 80 mm, and is preferably 5 to 60 mm, more preferably 10 to 40 mm, and the length in the minor axis direction is, for example, 1 to 80 mm, and is preferably 3 to 50 mm, more preferably 5 to 30 mm.

[0022] In the fiber structure, the higher the percentage of the distances between the entangled parts (B) that are less than the apparent average fiber length of the coil-shaped crimped fibers (a) is, the easier it tends to be for the fiber structure to exhibit high stress at high extension. Therefore, in the fiber structure, for example, greater than or equal to 10% of the distances between the entangled parts (B) in the machine direction of the fiber structure are less than the apparent average fiber length of the coil-shaped crimped fibers (a). Preferably greater than or equal to 30%, more preferably greater than or equal to 60%, still more preferably greater than or equal to 90%, particularly preferably greater than or equal to 95% of the distances between the entangled parts (B) present in the machine direction of the fiber structure are less than the apparent average fiber length of the coil-shaped crimped fibers (a).

[0023] The apparent average fiber length of the coil-shaped crimped fibers (a) (hereinafter also simply referred to as an "apparent average fiber length") is not the fiber length obtained by unwinding the coil-shaped crimped fibers into straight lines (actual fiber length) but the average of lengths of fibers crimped into a coil shape (apparent fiber length). Therefore, the apparent average fiber length is measured as being shorter than the actual fiber length. The apparent average fiber length was obtained by observing a surface of the fiber structure with an electron microscope, measuring the apparent fiber lengths of 100 fibers arbitrarily selected from the coil-shaped crimped fibers (a) present per any 1 cm^2 of a surface of the entangled part (A) of the fiber structure, and calculating the average of the apparent fiber lengths.

[0024] The apparent average fiber length may be, for example, greater than or equal to 10 mm, and is preferably greater than 10 mm, more preferably greater than or equal to 11 mm, still more preferably greater than or equal to 12 mm, particularly preferably greater than or equal to 13 mm. Meanwhile, the apparent average fiber length may be, for example, less than or equal to 70 mm, and is preferably less than or equal to 55 mm, more preferably less than or equal to 40 mm, still more preferably less than or equal to 30 mm, particularly preferably less than or equal to 21 mm.

[0025] The distance between the entangled parts (B) may be, for example, greater than or equal to 2.5 mm, and is preferably greater than or equal to 3 mm, more preferably greater than or equal to 3.5 mm. In addition, at least one of the distances between the entangled parts (B) may be, for example, less than or equal to 20 mm, and is preferably less than 20 mm, more preferably less than or equal to 15 mm, still more preferably less than or equal to 10 mm. When at least one of the distances between the entangled parts (B) is between the above-described upper and lower limits, the entangled parts (B) are entangled with each other by the coil-shaped crimped fibers (a), and the fiber structure has high stress at high extension and tends to be hardly torn even when tightly wound.

[0026] In the present invention, the entangled parts (B) may include a small amount of the coil-shaped crimped fibers (a), for example, up to 3% by mass of the coil-shaped crimped fibers (a) based on the total mass of the entangled parts (B), and the entangled part (A) may include a small amount of the non-coil-shaped crimped fibers (b), for example, up to 3% by mass of the non-coil-shaped crimped fibers (b) based on the total mass of the entangled part (A). Further, one fiber may have a coil-shaped crimped portion and a non-coil-shaped crimped portion.

[0027] In the fiber structure, in a surface of the fiber structure, the area rate of the entangled part (A) to the surface area of the fiber structure may be, for example, 20 to 85%, and is preferably 30 to 83%, more preferably 40 to 81%. The area of the entangled part (A) is a value determined by a measurement method described in examples described later. When the area rate of the entangled part (A) is within the above-described range, the fiber structure tends to have low stress at low extension, and excellent conformity tends to be easily obtained.

[0028] In the fiber structure, the thickness (T_A) of the entangled part (A) and the thickness (T_B) of the entangled parts (B) may have, for example, a ratio T_A/T_B of 1.1 to 10, and the ratio is preferably 2 to 7, more preferably 3 to 5. When the ratio between the thickness (T_A) of the entangled part (A) and the thickness (T_B) of the entangled parts (B), T_A/T_B, is within the above-described range, it is advantageous in that the fiber structure has a good balance between softness and strength.

[0029] The thickness (T_A) of the entangled part (A) may be, for example, 1 to 10 mm, and is preferably 1.5 to 7 mm, more preferably 2 to 5 mm.

[0030] The thickness (T_B) of the entangled parts (B) may be, for example, 0.2 to 1 mm, and is preferably 0.3 to 0.9 mm, more preferably 0.4 to 0.8 mm.

[0031] The thickness (T_A) of the entangled part (A) and the thickness (T_B) of the entangled parts (B) were measured in accordance with the "Test methods for nonwovens" specified in JIS L 1913.

[0032] The fiber structure preferably has a basis weight of 50 to 200 g/m^2, and the basis weight is more preferably 70 to 180 g/m^2.

[0033] When the basis weight and the thickness are within the above-described ranges, the fiber structure has a good balance among stretchability, flexibility, touch feeling, and cushioning property. The densities (bulk densities) of the entangled parts (A) and (B) of the fiber structure can each be a value corresponding to the above-described basis weight and thickness. The density (bulk density) of the entangled part (A) of the fiber structure may be, for example, 0.03 to 0.15 g/cm^3, and is preferably 0.04 to 0.1 g/cm^3. The density (bulk density) of the entangled parts (B) of the fiber structure can be a value corresponding to the above-described basis weight and thickness, and is, for example, 0.15 to 1.5 g/cm^3, preferably 0.2 to 1 g/cm^3.

[0034] The fiber structure may have, in the machine direction of the fiber structure, a stress at 50% extension of, for example, less than or equal to 15 N/5 cm, and the stress at 50% extension is preferably less than or equal to 13 N/5 cm, more preferably less than or equal to 12 N/5 cm. When the stress at 50% extension in the machine direction of the fiber structure is less than or equal to the above-described upper limit, the fiber structure tends to have low stress at low extension, and tends to be excellent in the initial conformity. The lower limit of the stress at 50% extension in the machine direction of the fiber structure is not particularly limited, but may be, for example, greater than or equal to 1 N/5 cm.

[0035] The fiber structure may have, in the machine direction of the fiber structure, a stress at 80% extension of, for example, greater than or equal to 20 N/5 cm, and the stress at 80% extension is preferably greater than or equal to 25

N/5 cm, more preferably greater than or equal to 30 N/5 cm. When the stress at 80% extension in the machine direction of the fiber structure is greater than or equal to the above-described value, the fiber structure tends to have high stress at high extension, and tends to be hardly torn even when tightly wound. The upper limit of the stress at 80% extension in the machine direction of the fiber structure is not particularly limited, but is, for example, usually less than or equal to 50 N/5 cm.

[0036] The fiber structure may have, in the machine direction of the fiber structure, a ratio between the stress at 50% extension and the stress at 80% extension, that is, stress at 80% extension/stress at 50% extension of, for example, greater than or equal to 2.7, and stress at 80% extension/stress at 50% extension is preferably greater than or equal to 3.0, more preferably greater than or equal to 3.2. When the ratio between the stress at 50% extension and the stress at 80% extension in the machine direction of the fiber structure is greater than or equal to the above-described lower limit, the fiber structure tends to have low stress at low extension, to have high stress at high extension while being excellent in the initial conformity, and to be hardly torn even when tightly wound. The ratio between the stress at 50% extension and the stress at 80% extension, that is, stress at 80% extension/stress at 50% extension in the machine direction of the fiber structure is not particularly limited, but may be, for example, less than or equal to 10, and is preferably less than or equal to 8, more preferably less than or equal to 5.

[0037] The stress at 50% extension and the stress at 80% extension in the machine direction of the fiber structure respectively mean stresses at extension immediately after extension at extension rates of 50% and 80% in the machine direction of the fiber structure, and can be measured by a tensile test in accordance with the "Test methods for nonwovens" specified in JIS L 1913. The stress at 50% extension and the stress at 80% extension in the machine direction of the fiber structure according to the present invention are values obtained using AG-IS manufactured by Shimadzu Corporation as a constant rate extension tensile tester.

[0038] The fiber structure may have a recovery rate after 50% extension in at least one direction (hereinafter also referred to as a "recovery rate after 50% extension") of, for example, greater than or equal to 70%, and the recovery rate after 50% extension is preferably greater than or equal to 80%, more preferably greater than or equal to 90%. The upper limit of the recovery rate after 50% extension is not particularly limited, but is usually less than or equal to 100%. When the recovery rate after 50% extension is within the above-described range, the followability to extension is enhanced. For example, when the fiber structure is used as a bandage, the bandage satisfactorily follows the shape of a portion around which the bandage is wrapped, and at the same time, it is advantageous for improvement of the self-adhesiveness due to friction between the overlapped fiber structures. If the extension recovery rate is excessively small, the fiber structure cannot follow movement of a portion around which the fiber structure is wrapped in the case where the portion has a complex shape or moves during use of the fiber structure, and a portion deformed by body movement does not return to its original shape, thus weakening fixation of the wrapped fiber structure.

[0039] The above-described "at least one direction" is preferably the above-described machine direction of the fiber structure. When the fibrous sheet has, for example, a length direction and a width direction like a bandage, the at least one direction is preferably the length direction of the fibrous sheet.

[0040] The recovery rate after 50% extension is defined by the following formula:

$$\text{Recovery rate after 50\% extension (\%)} = 100 - X,$$

wherein X is a residual strain (%) after a tensile test in accordance with the "Test methods for nonwovens" specified in JIS L 1913 when a load is removed immediately after the extension rate reaches 50%.

[0041] The recovery rate after 50% extension in a direction other than the at least one direction of the fiber structure, for example, in the CD direction or, when the fiber structure has a length direction and a width direction like a bandage, in the width direction may be, for example, greater than or equal to 70% (less than or equal to 100%), and is preferably greater than or equal to 80%.

[0042] The fiber structure preferably exhibits self-adhesiveness. In the present specification, the "self-adhesiveness" refers to a property allowing fibers on a fiber structure surface to engage with each other or come into close contact with each other due to superposition (contact) of the fibers and to be hooked or fixed. The fiber structure having self-adhesiveness is advantageous when the fiber structure is a bandage or the like. For example, in the case where the fiber structure is a bandage, after the bandage is wrapped around an application site, the wrapped fibrous sheets are pressed against each other while being extended by such an operation that an end of the bandage is overlapped on a bandage surface located under the end, so that the fiber structures are joined and fixed to each other, thereby expressing self-adhesiveness.

[0043] When the fiber structure has self-adhesiveness, it is unnecessary to form a layer formed of a self-adhesive agent such as an elastomer or a pressure-sensitive adhesive on a surface of the fiber structure or to prepare separately a fastener for fixing the tip after wrapping. It is preferable that the fiber structure is constituted only of a non-elastomer material. More specifically, it is preferable that the fiber structure is constituted only of fibers. For example, Japanese Patent Laying-Open No. 2005-095381 (PTL 7, claim 1, paragraphs [0004] to [0006]) describes that an acrylic polymer or a latex is caused to adhere as a self-adhesive agent to at least one side of a bandage base material. However, when such a layer formed of an elastomer is formed on the fibrous sheet surface, this may cause problems such as blood circulation disturbance and pain when the sheet is wrapped around an application site for a long time. The layer formed of an elastomer may induce skin irritation and allergy when wrapped around an application site.

[0044] The self-adhesiveness of the fiber structure can be evaluated by a curved surface sliding stress. The fiber structure may have a curved surface sliding stress of, for example, greater than or equal to 1 N/50 mm, and the curved surface sliding stress is preferably greater than or equal to 3 N/50 mm. Moreover, the curved surface sliding stress is preferably higher than the breaking strength. Since it is relatively easy to unwrap the wrapped fiber structure if desired, the curved surface sliding stress is preferably less than or equal to 30 N/50 mm, more preferably less than or equal to 25 N/50 mm. The curved surface sliding stress can be measured using a tensile tester in accordance with the method described in the section of EXAMPLES (Figs. 2 to 4).

[0045] The fiber structure preferably has a hand cut property. In the present specification, the "hand cut property" refers to a property enabling breakage (cutting) by hand tension. The hand cut property of the fiber structure can be evaluated by breaking strength. When the fiber structure has a sheet shape, the breaking strength in at least one direction in the sheet plane is preferably 5 to 100 N/50 mm, more preferably 8 to 60 N/50 mm, still more preferably 10 to 40 N/50 mm from the viewpoint of hand cut property. When the breaking strength is within the above range, it is possible to impart a good hand cut property enabling relatively easy breakage (cutting) by hand. If the breaking strength is too large, the hand cut property deteriorates, and it tends to be difficult to cut the fiber structure with one hand, for example. Meanwhile, if the breaking strength is too small, the strength of the fiber structure is insufficient to cause easy breakage of the fiber structure, and durability and handleability tend to be lowered. The breaking strength can be measured by a tensile test in accordance with the "Test methods for nonwovens" specified in JIS L 1913.

[0046] The at least one direction in the sheet plane is a tensile direction when the fiber structure is cut by hand, and is preferably the above-described machine direction of the fiber structure. When the fiber structure has, for example, a length direction and a width direction like a bandage, the at least one direction is preferably the length direction of the fiber structure. That is, when the fiber structure is used as a bandage, it is usual to break the bandage in the length direction after the bandage is wrapped around an application site while being extended along the length direction thereof, and therefore the machine direction is preferably the length direction as the tensile direction.

[0047] The breaking strength in a direction other than the at least one direction in the sheet plane, for example, in the CD direction or, when the fibrous sheet has a length direction and a width direction like a bandage, in the width direction may be, for example, 0.1 to 300 N/50 mm, and is preferably 0.5 to 100 N/50 mm, more preferably 1 to 20 N/50 mm.

[0048] From the viewpoint of the hand cut property, it is preferable that the fiber structure is constituted only of a non-elastomer material. More specifically, it is preferable that the fiber structure is constituted only of fibers. If a layer formed of an elastomer or the like is formed on the fiber structure surface, the hand cut property may be lowered.

[0049] The fiber structure may have an elongation at break in at least one direction in the sheet plane of, for example, greater than or equal to 50%, and the elongation at break is preferably greater than or equal to 60%, more preferably greater than or equal to 80%. When the elongation at break is within the above-described range, it is advantageous for enhancing the stretchability of the fiber structure. Moreover, in the case where the fiber structure is used as a bandage, the followability can be enhanced when the fiber structure is applied to a site with large movement, such as a joint. The elongation at break in at least one direction in the sheet plane is usually less than or equal to 300% and preferably less than or equal to 250%. The elongation at break can also be measured by a tensile test in accordance with the "Test methods for nonwovens" specified in JIS L 1913.

[0050] At least one direction in the sheet plane is preferably the above-described first direction. The first direction may be the MD direction, and when the fiber structure has, for example, a length direction and a width direction like a bandage, the first direction is preferably the length direction of the fiber structure.

[0051] The elongation at break in a direction other than the at least one direction in the sheet plane, for example, in the CD direction, or when the fiber structure has a length direction and a width direction like a bandage, in the width direction may be, for example, 10 to 500%, and is preferably 100 to 350%.

[0052] The coil-shaped crimped fibers (a) can include a latently thermally crimpable conjugated fiber (hereinafter also simply referred to as a "conjugated fiber").

[0053] The conjugated fiber is a conjugated fiber in which a plurality of resins having different thermal shrinkage factors or thermal expansion coefficients form a phase structure. The conjugated fiber is a fiber having an asymmetric or layered (so-called bimetal) structure crimped by heating due to a difference in thermal shrinkage factor or thermal expansion coefficient. The plurality of resins usually have mutually different softening points or melting points. The plurality of resins may be selected from thermoplastic resins such as polyolefin-based resins (e.g., poly-C_{2-4} olefin-based resins such as low-density, medium-density, or high-density polyethylene and polypropylene); acrylic resins (e.g., acrylonitrile-based resins having an acrylonitrile unit, such as acrylonitrile-vinyl chloride copolymers); polyvinyl acetal-based resins (e.g., polyvinyl acetal resins); polyvinyl chloride-based resins (e.g., polyvinyl chloride, vinyl chloride-vinyl acetate copolymers, and vinyl chloride-acrylonitrile copolymers); polyvinylidene chloride-based resins (e.g., vinylidene chloride-vinyl chloride copolymers and vinylidene chloride-vinyl acetate copolymers); styrene-based resins (e.g., heat-resistant polystyrene); polyester-based resins (e.g., poly-C_{2-4} alkylene arylate-based resins such as polyethylene terephthalate resins, polytrimethylene terephthalate resins, polybutylene terephthalate resins, and polyethylene naphthalate resins); polyamide-based resins (e.g., aliphatic polyamide-based resins such as polyamide 6, polyamide 66, polyamide 11, polyamide 12, polyamide 610, and polyamide 612, semi-aromatic polyamide-based resins, and aromatic polyamide-based resins such as polyphenylene isophthalamide, polyhexamethylene terephthalamide, and poly-p-phenyleneterephthalamide); polycarbonate-based resins (e.g., bisphenol A-type polycarbonate); polyparaphenylene benzobisoxazole resins; polyphenylene sulfide resins; polyurethane-based resins; and cellulose-based resins (e.g., cellulose esters). These thermoplastic resins may contain other copolymerizable units.

[0054] Among the thermoplastic resins, non thermal adhesive resins under moisture (or heat-resistant hydrophobic resins or nonaqueous resins) having a softening point or melting point greater than or equal to 100°C, such as polypropylene-based resins, polyester-based resins, and polyamide-based resins are preferable from the viewpoint that fibers are not melted or softened to be fused even when subjected to heating treatment with high-temperature steam. Particularly, aromatic polyester-based resins and polyamide-based resins are more preferable because they are excellent in the balance among heat resistance, fiber formability, and the like. In the present invention, the resin exposed on the surface of the conjugated fiber is preferably a non thermal adhesive fiber so that the fibers constituting the fiber structure may not be fused even when treated with high-temperature steam.

[0055] The plurality of resins forming the conjugated fiber may have different thermal shrinkage factors, and may be a combination of resins of the same kind, or a combination of different kinds of resins.

[0056] In the present invention, it is preferable that the conjugated fiber is formed from a combination of resins of the same kind from the viewpoint of adhesion. In the case where the conjugated fiber is formed from a combination of resins of the same kind, usually a combination of a component (A) forming a homopolymer and a component (B) forming a modification polymer (copolymer) is used. That is, for example, a copolymerizable monomer for reducing the crystallization degree, the melting point, the softening point, or the like may be copolymerized with a homopolymer to perform modification, whereby the crystallization degree may be reduced as compared to that of the homopolymer, or the polymer may be made noncrystalline to reduce the melting point or softening point as compared to that of the homopolymer. As described above, a difference in thermal shrinkage factor can be provided by changing the crystallinity, the melting point, or the softening point. The difference in melting point or softening point may be, for example, 5 to 150°C, preferably 50 to 130°C, more preferably about 70 to 120°C. The rate of the copolymerizable monomer used for the modification may be, for example, 1 to 50 mol%, and is preferably 2 to 40 mol%, more preferably about 3 to 30 mol% (particularly 5 to 20 mol%) based on the whole amount of monomers. While the composite ratio (mass ratio) between the component forming a homopolymer and the component forming a modification polymer can be selected according to the structure of fibers, the ratio of homopolymer component (A)/modification polymer component (B) may be, for example, 90/10 to 10/90, and is preferably 70/30 to 30/70, more preferably about 60/40 to 40/60.

[0057] The conjugated fiber may be a combination of aromatic polyester-based resins, in particular, a combination of a polyalkylene arylate-based resin (a) and a modified polyalkylene arylate-based resin (b) from the viewpoint of ease of production of the latently crimpable conjugated fiber. The polyalkylene arylate-based resin (a) may be a homopolymer of an aromatic dicarboxylic acid (e.g., a symmetric aromatic dicarboxylic acid such as terephthalic acid or naphthalene-2,6-dicarboxylic acid) and an alkanediol component (e.g., a C_{2-6} alkanediol such as ethylene glycol or butylene glycol). Specifically, a poly-C_{2-4} alkylene terephthalate-based resin such as polyethylene terephthalate (PET) or polybutylene terephthalate (PBT) is used, and usually, PET for use in general PET fibers having an intrinsic viscosity of about 0.6 to 0.7 is used.

[0058] Meanwhile, as for the modified polyalkylene arylate-based resin (b), a copolymerization component for reducing the melting point, the softening point, or the crystallization degree of the polyalkylene arylate-based resin (a), for example, dicarboxylic acid components such as an asymmetric aromatic dicarboxylic acid, an alicyclic dicarboxylic acid, and an aliphatic dicarboxylic acid; an alkanediol component having a chain length longer than that of the alkanediol of the polyalkylene arylate-based resin (a); and/or an ether bond-containing diol component can be used.

[0059] These copolymerization components may be used singly, or in combination of two or more kinds thereof. Among these components, as the dicarboxylic acid component, asymmetric aromatic dicarboxylic acids (e.g., isophthalic acid, phthalic acid, and 5-sodium sulfoisophthalic acid), aliphatic dicarboxylic acids (C_{6-12} aliphatic dicarboxylic acids such as adipic acid), or the like are generally used. As the diol component, alkanediols (e.g., C_{3-6} alkanediols such as 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, and neopentyl glycol), polyoxyalkylene glycols (e.g., polyoxy-C_{2-4} alkylene glycols such as diethylene glycol, triethylene glycol, polyethylene glycol, and polytetramethylene glycol), or the like are generally used. Among them, asymmetric aromatic dicarboxylic acids such as isophthalic acid, and polyoxy-C_{2-4} alkylene glycols such as diethylene glycol are preferable. The modified polyalkylene arylate-based resin (b) may be an elastomer having a C_{2-4} alkylene arylate (e.g., ethylene terephthalate or butylene terephthalate) as a hard segment and a (poly)oxyalkylene glycol or the like as a soft segment.

[0060] In the modified polyalkylene arylate-based resin (b), the rate of the dicarboxylic acid component (e.g., isophthalic acid) for reducing the melting point or softening point may be, for example, 1 to 50 mol%, and is preferably 5 to 50 mol%, more preferably about 15 to 40 mol% based on the whole amount of dicarboxylic acid components. The rate of the diol component (e.g., diethylene glycol) for reducing the melting point or softening point may be, for example, less than or equal to 30 mol%, and is preferably less than or equal to 10 mol% (for example, about 0.1 to 10 mol%) based on the whole amount of diol components. If the rate of copolymerization components is too low, sufficient coil-shaped crimps are not expressed, and thus the form stability and stretchability of the fiber structure after expression of crimps are lowered. Meanwhile, if the rate of copolymerization components is too high, although the performance of expressing coil-shaped crimps is improved, it is difficult to stably perform spinning.

[0061] The modified polyalkylene arylate-based resin (b) may contain, as monomer components, polyvalent carboxylic acid components such as trimellitic acid and pyromellitic acid, polyol components such as glycerol, trimethylolpropane, trimethylolethane, and pentaerythritol, and the like as necessary.

[0062] The transverse cross-sectional shape of the conjugated fiber (that is, the shape of a cross section perpendicular to the length direction of the fiber) is not limited to a general solid cross-sectional shape such as a circular cross-sectional shape or an irregular cross-sectional shape [flat shape, elliptical shape, polygonal shape, 3 to 14-foliated shape, T-shape, H-shape, V-shape, dog-bone (I-shape) or the like], and it may be a hollow cross-sectional shape or the like. Usually, the transverse cross-sectional shape of the conjugated fiber is a circular cross-sectional shape.

[0063] Examples of the transverse cross-sectional structure of the conjugated fiber include phase structures formed of a plurality of resins, such as structures of core-sheath type, sea-island type, blend type, parallel type (side-by-side type or multilayer lamination type), radial type (radial lamination type), hollow radial type, block type, and random composite type. Among these transverse cross-sectional structures, a structure in which phase parts neighbor each other (so-called bimetal structure), and a structure in which a phase structure is asymmetric, such as a structure of eccentric core-sheath type or parallel type are preferable from the viewpoint of ease of expression of spontaneous crimps by heating.

[0064] In the case where the conjugated fiber has a structure of core-sheath type such as a structure of eccentric core-sheath type, the core part may be made from a thermal adhesive resin under moisture (e.g., a vinyl alcohol-based polymer such as an ethylenevinyl alcohol copolymer or polyvinyl alcohol), or a thermoplastic resin having a low melting point or softening point (e.g., polystyrene or low-density polyethylene) as long as the resin of the core part has a difference in thermal shrinkage from the non thermal adhesive resin under moisture of the sheath part situated at the surface, and thus the fiber can be crimped.

[0065] The conjugated fibers may have an average fineness of, for example, 1 to 5 dtex, and the average fineness is preferably 1.3 to 4 dtex, more preferably 1.5 to 3 dtex. If the fineness is too small, it is difficult to produce fibers themselves, and, in addition, it is difficult to secure fiber strength. Further, it is difficult to express fine coil-shaped crimps in a process of expressing crimps. Meanwhile, if the fineness is too large, fibers are rigid, so that it is difficult to express sufficient crimps.

[0066] The conjugated fibers may have an average fiber length (actual fiber length) of, for example, 20 to 70 mm, and the average fiber length is preferably 25 to 65 mm, more preferably 40 to 60 mm. If the fiber length is too short, it is difficult to form a fibrous web, and, in addition, entanglement of fibers is insufficient in a process of expressing crimps, so that it may be difficult to secure the strength and stretchability. Meanwhile, if the fiber length is too long, it is difficult to form a fibrous web with a uniform basis weight, and further, a large number of entanglements of fibers are expressed at the time of forming the web, so that fibers may obstruct one another at the time of expressing crimps, resulting in difficulty in expression of stretchability. Further, in the present invention, when the fiber length is within the above-described range, part of the crimped fibers at the surface of the fiber structure are moderately exposed on the surface of the fiber structure, so that the self-adhesiveness of the fiber structure can be improved.

[0067] When the conjugated fibers are heat-treated, crimps are expressed (or appear), and thus fibers having substantially coil-shaped (helical or spiral spring-shaped) three-dimensional crimps are obtained.

[0068] The number of crimps (number of mechanical crimps) before heating may be, for example, 0 to 30 crimps/25 mm, and is preferably 1 to 25 crimps/25 mm, more preferably 5 to 20 crimps/25 mm. The number of crimps after heating may be, for example, 20 to 120 crimps/25 mm, and is preferably 25 to 120 crimps/25 mm.

[0069] As described above, the coil-shaped crimped fibers (a) have substantially coil-shaped crimps. The average curvature radius of the circles formed by the coils of crimped fibers can be selected, for example, from a range of about 10 to 250 μm, and is, for example, 20 to 200 μm (for example, 50 to 200 μm), preferably 50 to 160 μm (for example, 60 to 150 μm), more preferably about 70 to 130 μm. Herein, the average curvature radius is an index expressing the average size of circles formed by the coils of crimped fibers. In the case where this value is large, the formed coil has a loose shape, i.e., a shape having a small number of crimps. If the number of crimps is small, the number of entanglements of fibers is also small, so that it tends to be disadvantageous for expressing sufficient stretching performance. Conversely, if coil-shaped crimps having too small an average curvature radius are expressed, the fibers are not sufficiently entangled with each other, and it is not only difficult to secure the web strength, but also the production of latently crimped fibers that express such crimps tends to be very difficult.

[0070] In the coil-shaped crimped fibers (a), the average pitch of the coils is preferably 0.03 to 0.5 mm, more preferably 0.03 to 0.3 mm, still more preferably 0.05 to 0.2 mm.

[0071] The non-coil-shaped crimped fibers (b) may include the conjugated fiber used in the above-described coil-shaped crimped fibers (a), or may include another fiber other than the conjugated fiber (a non-conjugated fiber). Use of the same conjugated fibers in the coil-shaped crimped fibers (a) and the non-coil-shaped crimped fibers (b) tends to be advantageous in view of simplicity of the production process. Further, the fiber structure may include, irrespective of the type of the fibers constituting the coil-shaped crimped fibers (a) and the non-coil-shaped crimped fibers (b), another fiber (non-conjugated fiber) in the entangled part (A) and/or the entangled parts (B) in such an amount that the object of the present invention is achieved.

[0072] Examples of the non-conjugated fiber include, in addition to fibers containing the above-described non thermal adhesive resin under moisture or thermal adhesive resin under moisture, cellulose-based fibers [e.g., natural fibers (e.g., cotton, wool, silk, and hemp), semi-synthetic fibers (e.g., acetate fibers such as triacetate fibers), and regenerated fibers (e.g., rayon, polynosic, cupra, and lyocell (e.g., registered trademark "Tencel"))]. The average fineness and average fiber length of the non-conjugated fibers are the same as those of the conjugated fibers. These non-conjugated fibers may be used singly, or in combination of two or more kinds thereof. Among these non-conjugated fibers, regenerated fibers such as rayon, semi-synthetic fibers such as acetate, polyolefin-based fibers such as polypropylene fibers and polyethylene fibers, polyester fibers, and polyamide fibers are preferable. In particular, from the viewpoint of blending properties and the like, a fiber of the same type as the conjugated fiber may be used. For example, when the conjugated fiber is a polyester-based fiber, the non-conjugated fiber may also be a polyester-based fiber.

[0073] When the fiber structure includes a conjugated fiber and a non-conjugated fiber in the entangled part (A) and/or the entangled parts (B), the ratio (mass ratio) between the conjugated fiber and the non-conjugated fiber may be, for example, conjugated fiber/non-conjugated fiber = 80/20 to 100/0 (for example, 80/20 to 99/1), and is preferably 90/10 to 100/0, more preferably about 95/5 to 100/0. Blending of the non-conjugated fiber can adjust the strength of the fiber structure. However, if the ratio of the conjugated fiber (latently crimped fiber) is too small, when the crimped fiber is extended and shrinks after the expression of crimps, particularly when the crimped fiber shrinks after extension, the non-conjugated fiber may serve as a resistance to shrinkage, and it tends to be difficult to secure the recovery stress.

[0074] The fiber structure (fibrous web) may further contain commonly used additives, such as stabilizers (e.g., thermal stabilizers such as copper compounds, ultraviolet absorbers, light stabilizers, and antioxidants), antibacterial agents, deodorants, fragrances, colorants (dyes and pigments), fillers, antistatic agents, flame retardants, plasticizers, lubricants, and crystallization speed retardants. These additives may be used singly, or in combination of two or more kinds thereof. The additives may be supported on the fiber surface or may be contained in the fibers.

[Method for manufacturing fiber structure]

[0075] A method for manufacturing the fiber structure according to the present invention includes: 1) forming a fiber into a web (hereinafter also referred to as a "web formation step"); 2) entangling part of the web by spraying or injection of water to form the entangled parts (B) (hereinafter also referred to as an "entangling step 1"); and 3) heating the web with high-temperature steam to form the entangled part (A) (hereinafter also referred to as an "entangling step 2").

[0076] As a method of forming the web in the web formation step, it is possible to use a commonly used method, such as a direct method including a spunbond method and a melt-blow method, a carding method using melt-blown fibers, staple fibers, or the like, or a dry method such as an air-lay method. Among these methods, a carding method using melt-blown fibers or staple fibers, particularly, a carding method using staple fibers is commonly used. Examples of the web obtained by using staple fibers include a random web, a semi-random web, a parallel web, and a cross-wrap web.

[0077] Next, in the entangling step 1, part of the obtained fibrous web is entangled by spraying or injection of water to form the entangled parts (B). Although the water to be sprayed or injected may be blown from one or both sides of the fibrous web, it is preferable to blow water from both sides from the viewpoint of efficiently performing strong entanglement. The portion blown with water turns into the entangled parts (B), and the portion not blown with water turns into the entangled part (A) in the subsequent entangling step 2.

[0078] Examples of a method of forming the entangled parts (B) include a method of injecting water with a spray nozzle or the like through a plate-like object (porous plate, slit plate, or the like) or a drum (porous drum, slit drum, or the like) having a regular spray area or spray pattern formed with a plurality of holes, a method of forming the entangled parts (B) by switching on and off of the injection of water from the spray nozzle, and a combination method of these. These methods can be performed by appropriately selecting a manner of continuously or periodically moving the spray nozzle, a manner of continuously or periodically transferring the fibrous web using a belt conveyor such as an endless conveyor, or a combination manner of these in accordance with the shape and size of the fibrous web, the shape and arrangement pattern of the entangled parts (B) to be formed, and the like. The entangled parts (B) can be continuously formed, for example, by installing a spray nozzle in the above-described drum, and rotating the drum to transfer the fibrous web while injecting water. The material constituting the plate-like object or the drum may be, for example, metals, plastics, or wood.

[0079] When a border pattern in which the entangled part (A) and the entangled parts (B) are alternately arranged in the machine direction is to be formed, the entangled parts (B) can be formed, for example, by injecting water to the fibrous web using a spray nozzle through a plate-like object or a drum having slits of a specific width in a direction perpendicular to the machine direction. The slit width may be, for example, 0.5 to 30 mm, and is preferably 1 to 20 mm, more preferably 2 to 10 mm, still more preferably 3 to 8 mm. The pitch of the slits is, for example, greater than or equal to 2.5 mm, preferably greater than or equal to 3 mm, more preferably greater than or equal to 3.5 mm. Meanwhile, the pitch of the slits may be, for example, less than or equal to 20 mm, and is preferably less than 20 mm, more preferably less than or equal to 15 mm, still more preferably less than or equal to 10 mm.

[0080] In the case of forming the border pattern, the entangled parts (B) can also be formed, for example, by injecting water from spray nozzles arranged linearly in the machine direction by switching on/off of the spray nozzles while continuously moving the fibrous web.

[0081] When a plane lattice pattern in which the entangled parts (B) having a specific shape are regularly arranged is to be formed, the entangled parts (B) can, for example, be formed by injecting water from a spray nozzle onto the fibrous web through a plate-like object or a drum having a plurality of regularly formed holes.

[0082] The shape of the hole is not particularly limited, but may be, for example, an oval shape, an elliptical shape, a circular shape, a square shape, or a rectangular shape, and is preferably an oval shape. When the hole has an oval shape, the length in the major axis direction is, for example, 1 to 80 mm, and is preferably 5 to 60 mm, more preferably 10 to 40 mm, and the length in the minor axis direction is, for example, 1 to 80 mm, and is preferably 3 to 50 mm, more preferably 5 to 30 mm. The plurality of holes can be arranged in a plane lattice pattern, for example, a square lattice pattern, an orthorhombic lattice pattern, or a rectangular lattice pattern. The pitch of the holes may be, for example, greater than or equal to 2.5 mm, and is preferably greater than or equal to 3 mm, more preferably greater than or equal to 3.5 mm. Meanwhile, the pitch of the holes may be, for example, less than or equal to 20 mm, and is preferably less than 20 mm, more preferably less than or equal to 15 mm, still more preferably less than or equal to 10 mm.

[0083] The jetting pressure of water may be, for example, greater than or equal to 4 MPa, and is preferably 8 MPa, more preferably greater than or equal to 10 MPa, still more preferably greater than or equal to 15 MPa, particularly preferably greater than 15 MPa. When the jetting pressure of water is greater than or equal to the above-described lower limit, the fibers come into a state of being packed, and even if a steam jet is applied to the fibers in the subsequent entangling step 2, the fibers are fixed and do not move and hardly express coil-shaped crimps, so that the entangled parts (B) tend to be easily formed. Meanwhile, the upper limit of the jetting pressure of water may be, for example, less than or equal to 20 MPa.

[0084] The temperature of water is preferably 5 to 50°C, more preferably 10 to 40°C, still more preferably 15 to 35°C (normal temperature).

[0085] As a method of spraying or injecting water, preferred is a method of injecting water with use a nozzle or the like having a regular spray area or spray pattern, from the viewpoint of convenience and the like. Specifically, water can be injected onto a fibrous web transferred by a belt conveyor such as an endless conveyor, while the fibrous web is placed on a conveyor belt. The conveyor belt may be water-permeable, and water may pass through the water-permeable conveyor belt from the back side of the fibrous web to be injected onto the fibrous web. When water is injected also from the back side of the fibrous web, it is preferable to inject water onto the fibrous web through a plate-like object or a drum having a spray area or a spray pattern also on the back side of the fibrous web. In order to suppress scattering of fibers due to water injecting, the fibrous web may be wetted with a small amount of water in advance. When the fibrous web is transferred by a conveyor, the transfer speed may be, for example, 5 to 40 m/minute, and is preferably 10 to 20 m/minute.

[0086] As the nozzle for spraying or injecting water, it is possible to use a plate or die having predetermined orifices successively arranged in the width direction thereof in accordance with the pattern of the entangled parts (B) to be formed. The plate or die may be disposed to arrange the orifices in the width direction of the fibrous web to be conveyed. The number of orifice lines may be at least one, and a plurality of orifice lines may be arranged in parallel. A plurality of nozzle dies each having one orifice line may be installed in parallel. The nozzle pitch may be, for example, 1.0 to 2.5 mm. The nozzle diameter may be, for example, 0.2 to 0.5 mm.

[0087] In the entangling step 2, the fibrous web is heated with high-temperature steam, and a portion of the conjugated fiber not blown with water in the above-described entangling step is crimped into a coil shape to form the entangled part (A). In the method of treating the fibrous web with high-temperature steam, the fibrous web is exposed to a high-temperature or superheated steam (high-pressure steam) flow, whereby coil-shaped crimps are formed in the conjugated fibers (latently crimped fibers). The fibrous web has air permeability. Accordingly, high-temperature steam permeates into the fibrous web even in treatment from one direction, substantially uniform crimps are expressed in the thickness direction, and the fibers are uniformly entangled with each other. The temperature of the high-temperature steam may be, for example, 50 to 150°C, and is preferably 40 to 130°C, more preferably 60 to 120°C.

[0088] The portion of the conjugated fiber not blown with water in the entangling step 1 of the fibrous web shrinks simultaneously with the high-temperature steam treatment. Accordingly, it is desirable that the fibrous web to be supplied is overfed according to the area shrinkage rate of an intended fiber structure immediately before the fibrous web is exposed to high-temperature steam. The rate of overfeeding is preferably 110 to 250% based on the length of the intended fiber structure.

[0089] In order to supply the fibrous web with steam, a commonly used steam injecting apparatus may be used. The steam injecting apparatus is preferably an apparatus capable of generally uniformly blowing steam over the whole width of the fibrous web with a desired pressure and amount. The steam injecting apparatus may be provided only on one surface side of the fibrous web, or in order to treat the front and back of the fibrous web with steam at a time, the steam injecting apparatus may be further provided on the other surface side.

[0090] Since the high-temperature steam injected from the steam injecting apparatus is a gas flow, the high-temperature steam enters inside the fibrous web without significantly moving the fibers in the fibrous web, unlike the water flow entanglement treatment and the needle punching treatment. By virtue of the entry action of the steam flow into the fibrous web, the steam flow efficiently covers a surface of each fiber existing in the fibrous web, and enables uniform thermal crimping. Since heat can be satisfactorily conducted inside the fibrous web, as compared with the dry heat treatment, the degree of crimping is almost uniform in the plane direction and the thickness direction.

[0091] Similarly to the nozzle for water flow entanglement, as a nozzle for injecting high-temperature steam, a plate or die having predetermined orifices successively arranged in a width direction thereof is used, and the plate or die may be disposed to arrange the orifices in the width direction of the fibrous web to be conveyed. The number of orifice lines may be at least one, and a plurality of orifice lines may be arranged in parallel. A plurality of nozzle dies each having one orifice line may be installed in parallel.

[0092] The pressure of the high-temperature steam to be used can be selected from the range of 0.1 to 2 MPa (for example, 0.2 to 1.5 MPa). If the pressure of the steam is too high, the fibers forming the fibrous web may move more than required to cause disturbance of the texture, or the fibers may be entangled more than required. When the pressure is too weak, it becomes impossible to give the quantity of heat required for expression of crimps of the fibers to the fibrous web, or the steam cannot penetrate the fibrous web and expression of crimps of the fibers in the thickness direction tends to be nonuniform. Although depending on materials of the fibers and the like, the temperature of the high-temperature steam can be selected from the range of 70 to 180°C (for example, 80 to 150°C). The treatment speed with high-temperature steam can be selected from the range of less than or equal to 200 m/minute (for example, 0.1 to 100 m/minute).

[0093] After thus causing expression of crimps of the conjugated fiber in the fibrous web, there may be a case where water remains in the fiber structure, and therefore, a drying step of drying the fiber structure may be provided as necessary. Examples of the drying method may include a method using a drying apparatus such as a cylinder dryer or a tenter; a non-contact method such as far infrared ray irradiation, microwave irradiation, or electron beam irradiation; and a method of blowing hot air or passing the fiber structure through hot air.

[0094] The fiber structure according to the present invention is excellent in the initial conformity, can be tightly wound, does not contain a pressure-sensitive adhesive, and has self-adhesiveness. Therefore, the fiber structure is suitable for applications in contact with the human body, for example, tapes such as bandages and supporters used in the medical and sports fields. Another gist of the present invention is a bandage including the fiber structure.

[0095] Hereinafter, the present invention will be described more specifically with reference to examples, but the present invention is not limited by these examples.

EXAMPLES

[0096] Physical property values of fiber structures obtained in Examples and Comparative Examples were measured by the following methods.

(1) Apparent average fiber length
The apparent average fiber length was obtained by observing a surface of the fiber structure with an electron microscope, measuring the apparent fiber lengths of 100 fibers arbitrarily selected from the coil-shaped crimped fibers (a) present per any 1 cm^2 of a surface of the entangled part (A) of the fiber structure, and calculating the average of the apparent fiber lengths.
(2) Number of crimps
The number of crimps was evaluated in accordance with JIS L 1015 "Chemical fiber staple test method" (8.12.1).
(3) Basis weight
The basis weight was measured in accordance with the "Test methods for nonwovens" specified in JIS L 1913.
(4) Thickness (T_A) of entangled part (A) (height of protrusion)
The thickness was measured in accordance with the "Test methods for nonwovens" specified in JIS L 1913.
(5) Thickness (T_B) of entangled parts (B) (base height)
The thickness was measured in accordance with the "Test methods for nonwovens" specified in JIS L 1913.

(6) Density of entangled part (A)
The density was calculated from the basis weight measured in the item (3) and the thickness measured in the item (4).
(7) Density of entangled parts (B)
The density was calculated from the basis weight measured in the item (3) and the thickness measured in the item (5).
(8) Area rate of entangled part (A)
The area rate of the entangled part (A) present per 0.5 cm^2 of the fiber structure was determined as follows. A surface of the fiber structure was observed over 0.5 cm^2 at a magnification of 300 using an electron microscope. As for one visual field observed with the electron microscope, a case where only crimped fibers were visible was defined as "1", a case where crimped fibers and other fibers were mixed was defined as "0.5", and a case where no crimped fibers were present was defined as "0". The total of the scores was determined, and the rate of the calculated total to the number of observed visual fields was defined as the area rate of the entangled part (A).
(9) As a method of measuring the distance between the entangled parts (B), a ruler was used to measure the distance between two points that were farthest from each other at the center of the entangled parts.
(10) Recovery rate after 50% extension
The recovery rate after 50% extension was measured in accordance with the "Test methods for woven and knitted fabrics" specified in JIS L 1096. In the evaluation in the present invention, however, the recovery rate was uniformly defined as that after 50% extension, and after the fiber structure returned to its original position subsequent to the 50% extension, the next operation was performed without any standby time. Note that the measurement was performed in the machine (MD) direction of the fiber structure. AG-IS manufactured by Shimadzu Corporation was used as a constant rate extension tensile tester.
(11) Stress at extension
The stress at extension was measured in accordance with the "Test methods for woven and knitted fabrics" specified in JIS L 1096. Stresses at 50% extension and at 80% extension were measured. AG-IS manufactured by Shimadzu Corporation was used as a constant rate extension tensile tester.
(12) Self-adhesiveness
The curved surface sliding stress (N/50 mm) was measured by the following method. When the curved surface sliding stress was greater than or equal to 1 N/50 mm, it was determined that the fiber structure has self-adhesiveness.

[0097] First, a fibrous sheet was cut into a size of 50 mm in width and 600 mm in length so that the MD direction was the length direction, to obtain a sample 5. Then, as shown in Fig. 2(a), one end of sample 5 was fixed to a winding core 7 (a pipe roll formed of a polypropylene resin and having an outer diameter of 30 mm and a length of 150 mm) with a single-sided adhesive tape 6. Then, with use of an alligator clip 8 (the gripping width was 50 mm, and a rubber sheet having a thickness of 0.5 mm had been fixed on the inside of the clip with a double-sided adhesive tape before use), a weight 9 of 150 g was attached to the other end of sample 5 to apply the load to the whole width of sample 5 evenly.

[0098] Then, while winding core 7 to which sample 5 was fixed was lifted up such that sample 5 and weight 9 were suspended, winding core 7 was rotated for five rounds so that weight 9 did not significantly swing, to wind up sample 5 and thus to lift up weight 9 (see Fig. 2(b)). In this state, a contact between a cylindrical portion at an outermost peripheral portion of sample 5 wrapped around winding core 7 and a planar portion of sample 5 not wrapped around winding core 7 was defined as a base point 10 (the contact was a border line between an area of sample 5 wrapped around winding core 7 and an area of sample 5 rendered vertical by the gravity of weight 9), and alligator clip 8 and weight 9 were slowly removed so as not to move and shift base point 10. Then, the outermost peripheral portion of sample 5 wound around winding core 7 was cut with a razor at a point 11 that was located a half-circle away (180°) from base point 10 along sample 5, paying attention to avoid cutting underlying sample 5, to provide a cut 12 (see Fig. 3).

[0099] A curved surface sliding stress between an outermost layer portion of sample 5 and an inner layer portion placed under the outermost layer portion (inner layer) and wrapped around winding core 7 was measured. For this measurement, a tensile tester ("Autograph" manufactured by Shimadzu Corporation) was used. Winding core 7 was fixed on a jig 13 installed on a chuck base on a fixed side of the tensile tester (see Fig. 4), and the end of sample 5 (the end to which alligator clip 8 had been attached) was gripped by a chuck 14 on a load cell side to stretch sample 5 at a tensile speed of 200 mm/minute. When sample 5 was removed (separated) at cut 12, the measured value (tensile strength) was regarded as the curved surface sliding stress.

<Example 1>

[0100] As a latently crimpable fiber, a side-by-side type composite staple fiber ["Sofit PN780" manufactured by Kuraray Co., Ltd., 1.7 dtex × 51 mm long, number of mechanical crimps: 29 crimps/25 mm, number of crimps after heat treatment at 130°C for 1 minute: 29 crimps/25 mm] was prepared that was constituted of a polyethylene terephthalate resin having an intrinsic viscosity of 0.65 [component (A)] and a modified polyethylene terephthalate resin [component (B)] in which 20 mol% of isophthalic acid is copolymerized with 5 mol% of diethylene glycol. Using 100% by mass of this side-by-side type composite staple fiber, a carded web having a basis weight of 30 g/m^2 was provided by a carding method.

(Entangling step 1)

[0101] This carded web was moved on a conveyor net, and allowed to pass between the conveyor net and a porous drum with pores (oval shape) having a major axis dimension of 50 mm, a minor axis dimension of 5 mm, and a pitch of 15 mm and being arranged in an orthorhombic lattice pattern. Through the porous drum, a water flow was injected in a spray form at 10 MPa toward the web and the conveyor net, and thus an entangling step of fibers was conducted.
[0102] Then, the carded web was transferred to an entangling step 2 while the web was overfed at about 200% so as not to prevent shrinkage in the subsequent entangling step 2 performed by steam.

(Entangling step 2)

[0103] Then, the carded web was introduced to a steam injecting apparatus provided in a belt conveyor, and steam at 0.5 MPa and a temperature of about 160°C was ejected to the carded web perpendicularly from the steam injecting apparatus to treat the web with steam, so that coil-shaped crimps of the latently crimped fibers were expressed, and at the same time, the fibers were entangled. In this steam injecting apparatus, nozzles were installed in one of the conveyors so as to blow steam toward the carded web through the conveyor belt. Each of the steam injecting nozzles had a pore diameter of 0.3 mm, and an apparatus in which the nozzles were arranged in a line at a pitch of 2 mm in the width direction of the conveyor was used. The processing speed was 8.5 m/minute, and the distance between each nozzle and the conveyor belt on a suction side was 7.5 mm. Finally, the web was dried with hot air at 120°C for 1 minute to obtain stretchable sheet-shaped fiber structure 1.
[0104] Obtained fiber structure 1 was subjected to various measurements. The results are shown in Table 1. An outline diagram of an arrangement pattern of entangled parts (B) 2 in a machine direction of obtained fiber structure 1 is shown in Fig. 1.

<Example 2>

[0105] A fiber structure was produced in the same manner as in Example 1 except that in the entangling step 1, a water flow was injected at a water pressure of 20 MPa. The evaluation results are shown in Table 1.

<Example 3>

[0106] A fiber structure was produced in the same manner as in Example 1 except that in the entangling step 1, the carded web was allowed to pass between the conveyor net and a porous drum with pores (oval shape) having a major axis dimension of 50 mm, a minor axis dimension of 10 mm, and a pitch of 10 mm and being arranged in an orthorhombic lattice pattern. The evaluation results are shown in Table 1.

<Example 4>

[0107] A fiber structure was produced in the same manner as in Example 1 except that in the entangling step 1, the carded web was allowed to pass between the conveyor net and a porous drum with pores having a major axis dimension of 400 mm, a minor axis dimension of 5 mm, and a pitch of 15 mm and being arranged in a border pattern. The evaluation results are shown in Table 1.

<Comparative Example 1>

[0108] A fiber structure was produced in the same manner as in Example 1 except that the entangling step 1 was not conducted. The evaluation results are shown in Table 1.

<Comparative Example 2>

[0109] A fiber structure was produced in the same manner as in Example 1 except that instead of the entangling step 1, the carded web was moved on a conveyor net, and allowed to pass between the conveyor net and a porous drum with pores (circular shape) having a diameter of 2 mmφ and a pitch of 2 mm and being arranged in an orthorhombic lattice pattern, that a water flow was injected in a spray form at 0.8 MPa from the inside of the porous drum toward the web and the conveyor net, and thus an uneven distribution step of periodically forming a low-density region and a high-density region of fibers was conducted, and that then water was injected at a water pressure of 4 MPa while the web was transferred to a belt conveyor equipped with a 76 mesh, 500 mm width resin endless belt, using a nozzle having orifices having a diameter of 0.1 mm arranged in a line at 0.6 mm intervals in the width direction of the web. The evaluation results are shown in Table 1.

[Table 1]

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Average fineness (dtex)	1.7	1.7	1.7	1.7	1.7	1.7
Average fiber length (mm)	51	51	51	51	51	51
Apparent average fiber length (mm)	17	17	17	17	17	17
Number of mechanical crimps (crimps)	29	29	29	29	29	29
Basis weight (g/m^2)	138.6	142.8	147.0	140.4	90.0	88.5
Thickness (T_B) of entangled parts (B) [Base height] (mm)	0.77	0.78	0.75	0.77	-	-
Thickness (T_A) of entangled part (A) [Height of protrusion] (mm)	2.8	2.79	2.81	2.80	-	-
T_A/T_B	3.64	3.58	3.75	3.64	-	-
Density of entangled part (A) (g/cm^3)	0.05	0.05	0.06	0.05	0.06	0.11
Density of entangled parts (B) (g/cm^3)	0.18	0.18	0.20	0.18		
Area rate of entangled area (A) (%)	81	68	55	77	100	100
Distance between entangled parts (B) [mm]	7.5	5.0	3.5	7.5	-	-
Rate of distances between entangled parts (B) that are less than apparent average fiber length (%)	100	100	100	100	-	-
Stress at 50% extension (N/50 mm)	7.5	9.4	11.8	7.7	4.2	19.0
Stress at 80% extension (N/50 mm)	31.5	34.0	38.0	32.1	8.5	48.6
Stress at 80% extension/stress at 50% extension	4.2	3.6	3.2	4.2	2.0	2.6
Recovery rate after 50% extension (%)	93.8	94.6	95.3	93.1	93.9	96.4
Self-adhesiveness	Yes	Yes	Yes	Yes	Yes	Yes

[0110] The fiber structures of Examples 1 to 3 were smaller in stress at 50% extension, excellent in the initial conformity, and excellent in the recovery rate after 50% extension compared to the fiber structure of Comparative Example 2. Further, the fiber structures of Examples 1 to 3 had higher stress at 80% extension than the fiber structure of Comparative Example 1 did, and can be tightly wound. That is, the fiber structures of Examples 1 to 3 had the performance required at low extension and at high extension in a balanced manner as compared with Comparative Examples 1 and 2.

REFERENCE SIGNS LIST

[0111] 1: fiber structure, 2: entangled part (B), 3: entangled part (A), 4: distance between entangled parts (B), 5: sample, 6: single-sided adhesive tape, 7: winding core, 8: alligator clip, 9: weight, 10: base point, 11: point located half-circle away from base point, 12: cut, 13: jig, 14: chuck

Claims

1. A fiber structure comprising coil-shaped crimped fibers (a) and non-coil-shaped crimped fibers (b), the fiber structure having an entangled part (A) including the coil-shaped crimped fibers (a) and two or more entangled parts (B) including the non-coil-shaped crimped fibers (b), at least one distance between the entangled parts (B) in a machine direction of the fiber structure being less than an apparent average fiber length of the coil-shaped crimped fibers (a).

2. The fiber structure according to claim 1, wherein, in a surface of the fiber structure, an area rate of the entangled part (A) to a surface area of the fiber structure is 20 to 85%.

3. The fiber structure according to claim 1 or 2, wherein a thickness (T_A) of the entangled part (A) and a thickness (T_B) of the entangled parts (B) have a ratio of T_A/T_B = 1.1 to 10.

4. The fiber structure according to any one of claims 1 to 3, having, in the machine direction of the fiber structure, a stress at 50% extension of less than or equal to 15 N/5 cm, and a stress at 80% extension of greater than or equal to 20 N/5 cm.

5. The fiber structure according to any one of claims 1 to 4, having, in the machine direction of the fiber structure, a ratio between a stress at 50% extension and a stress at 80% extension, that is, stress at 80% extension/stress at 50% extension of greater than or equal to 2.7.

6. The fiber structure according to any one of claims 1 to 5, wherein the coil-shaped crimped fibers (a) include a conjugated fiber in which a plurality of resins having different thermal shrinkage factors or thermal expansion coefficients form a phase structure.

7. The fiber structure according to any one of claims 1 to 6, having a basis weight of 50 to 200 g/m^2.

8. A bandage comprising the fiber structure according to any one of claims 1 to 7.

9. A method for manufacturing the fiber structure according to any one of claims 1 to 8, the method comprising:

   1) forming a fiber into a web;
   2) entangling part of the web by spraying or injection of water to form the entangled parts (B); and
   3) heating the web with high-temperature steam to form the entangled part (A).

FIG.1

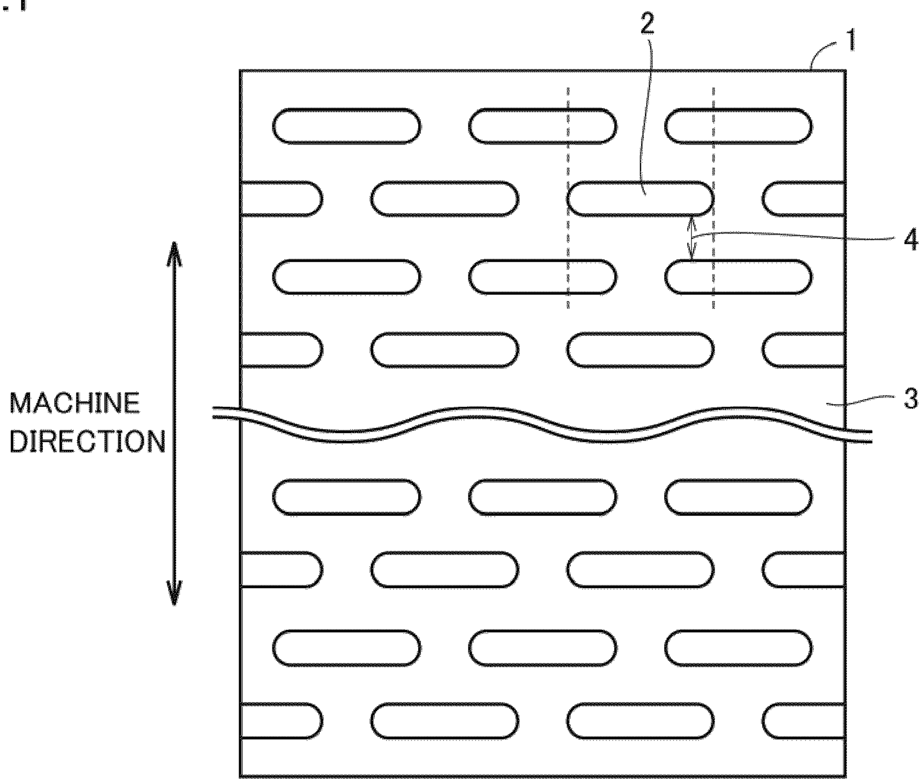


FIG.2

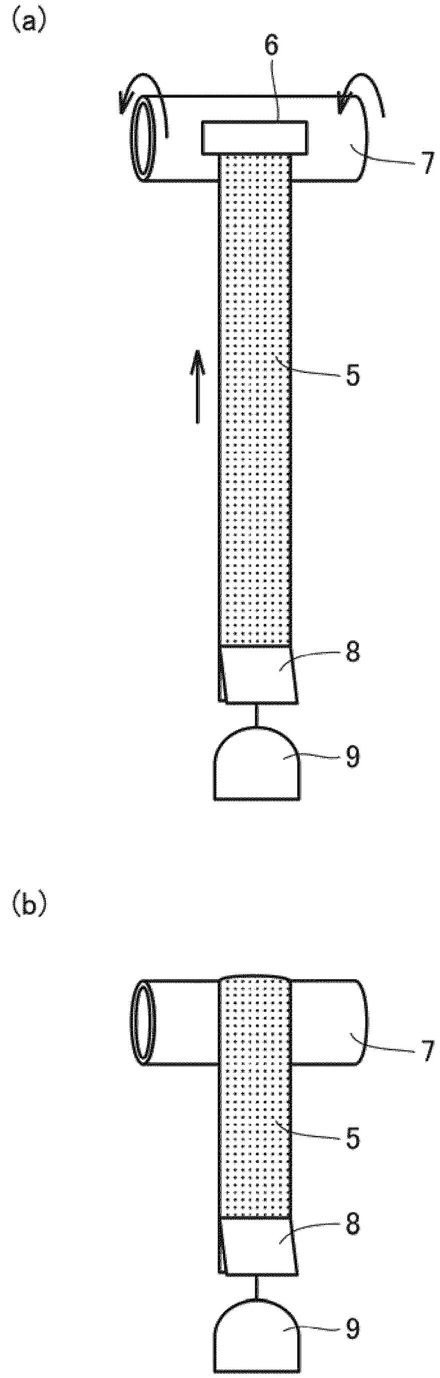


FIG.3

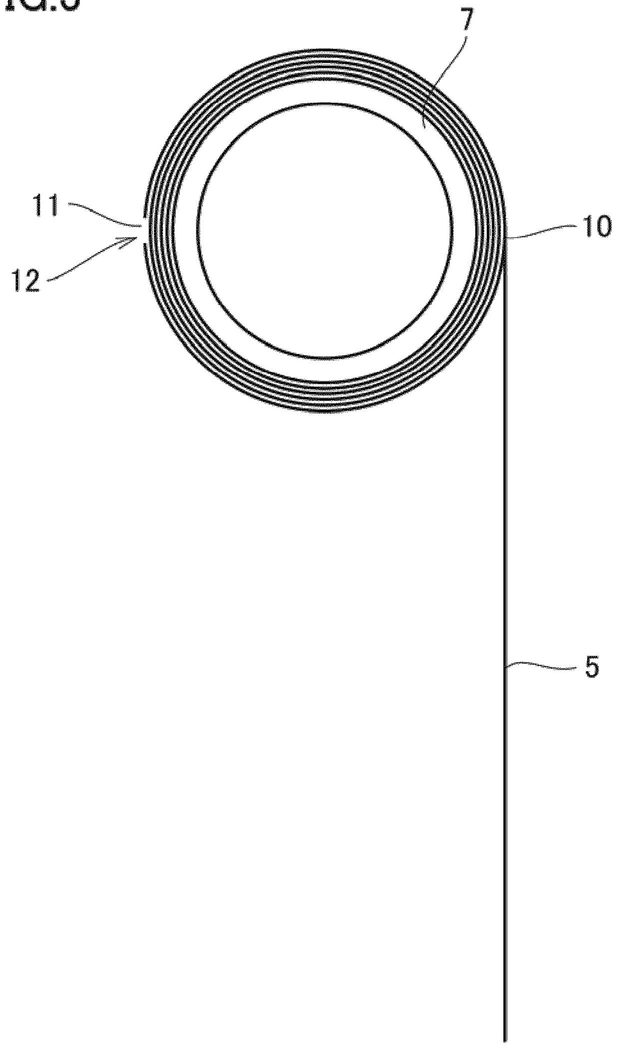
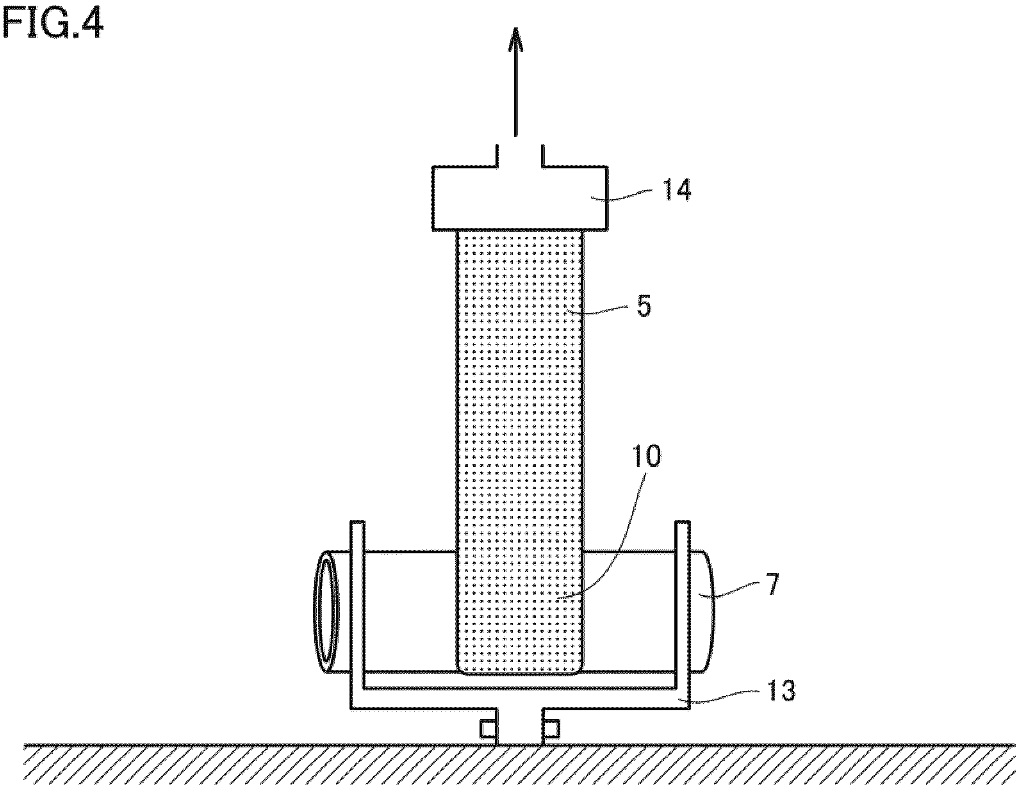


FIG.4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/041010

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. D04H1/4391(2012.01)i, D04H1/4382(2012.01)i, D04H1/492(2012.01)i, D04H1/50(2012.01)i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. B32B1/00-43/00, 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	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2012-102437 A (JAPAN VILENE COMPANY, LTD.) 31 May 2012, paragraph [0025], examples (Family: none)	1, 2, 6, 7, 9 3-5, 8
A	WO 2016/104795 A1 (KURARAY CO., LTD.) 30 June 2016 & US 2017/0370038 A1 & CN 107109736 A & KR 10-2017-0098276 A	1-9
A	JP 2012-012758 A (KURARAY KURAFLEX CO., LTD.) 19 January 2012 (Family: none)	1-9
A	JP 09-087950 A (DAIWABO CO., LTD.) 31 March 1997 (Family: none)	1-9

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

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/	Authorized officer
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