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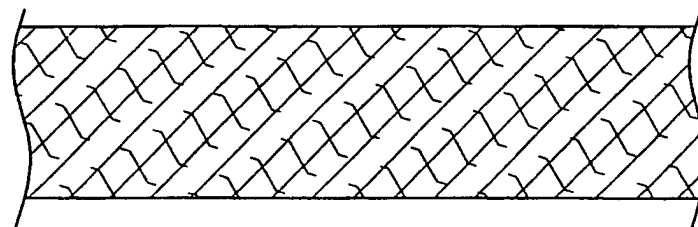
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(54) **NON-WOVEN FABRIC AND,LAMINATE AND STRING USING THE SAME**

(57) A non-woven fabric of the present invention is composed primarily of entangled fluoropolymer fibers. In addition, the non-woven fabric of the present inven-

tion may be pressure and heat treated, or may be subject to elongation. This provides the non-woven fabric with superior mechanical characteristics.

Fig. 1



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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a non-woven fabric made primarily from a fluoropolymer, as well as a laminate and braided material using the same.

BACKGROUND ART

10 **[0002]** Fluoropolymers have excellent chemical resistance, excellent heat resistance, excellent insulating abilities, and an extremely low coefficient of friction. However, it has been difficult to produce a non-woven fabric from fluoropolymers that has excellent mechanical strength because of this extremely low coefficient of friction. In particular, using short fluoropolymer fibers to produce a non-woven fabric has thus far been impossible.

15 **[0003]** Thus for example, in situations in which mechanical strength is required, a fluoropolymer non-woven fabric having a foundation cloth is conventionally employed in which fluoropolymer staple fibers in textiles and the like are laminated and entangled. Thus, it is well known to use fluoropolymer staple fibers in textiles and felt that have been laminated and entangled as a fluoropolymer non-woven fabric having a foundation cloth. On the other hand, a cloth-like material that does not have a foundation cloth and which is composed primarily of a fluoropolymer has been proposed, and is a web produced by cutting a fluoropolymer film into fibers and then laminating those fibers. In addition, International Patent Publication No. WO96/10668 discloses technology for improving both the ability of fibers to be entangled and the strength of a non-woven fabric by mixing fluoropolymer fibers with non-fluoropolymer fibers.

20 **[0004]** However, there are problems with providing this type of non-woven cloth having a foundation cloth with a homogeneous porosity, air permeability, and elasticity because it is difficult to reduce the thickness of the foundation cloth.

25 **[0005]** In addition, the aforementioned conventional web is merely formed into a laminate in the thickness direction, and thus it will be difficult to obtain a web having excellent tensile strength and elasticity even if pressure is applied to it with a nip roller. Thus, there will be problems with tearing of the web during processing, even when the web is wound up into a roll with low tension.

30 **[0006]** In addition, in situations in which the web is joined to another member with an adhesive or the like, the surface layer of the web will easily peel off of the adhesive layer because the web is merely laminated in the thickness direction.

[0007] On the other hand, with non-woven fabric in which other fibers have been mixed therein, the excellent characteristics provided by the fluoropolymer will be lost as the ratio of other fibers therein increases.

DISCLOSURE OF THE INVENTION

35 **[0008]** Thus, an object of the present invention is to improve the mechanical strength of a non-woven fabric that does not have a foundation cloth and which is composed primarily of fluoropolymer fibers. In addition, another object of the present invention is to make it possible to use this type of non-woven fabric in variety of applications.

40 **[0009]** The non-woven fabric disclosed in claim 1 does not have a foundation cloth, is composed primarily of fluoropolymer fibers, and the fibers therein are entangled.

[0010] Because this non-woven fabric is primarily composed of a fluoropolymer, it has superior characteristics, such as a strong resistance to chemicals, a strong resistance to heat, strong insulating abilities, and an extremely low coefficient of friction.

45 **[0011]** This non-woven fabric does not have a foundation cloth, and thus its thickness can be reduced. In addition, a homogeneous porosity, air permeability, and elasticity can be obtained.

[0012] A web composed primarily of fluoropolymer fibers may be one which is composed entirely of fluoropolymer fibers, or may also be one which includes other fibers so long as the aforementioned superior characteristics of the fluoropolymer has not been substantially and completely lost. The ratio of fluoropolymer in the non-woven fabric is normally 50% or more, preferably 70% or more, more preferably 90% or more, and even more preferably 95% or more. As used in the present specification, the symbol "%" refers to weight % unless otherwise noted.

50 **[0013]** The non-woven fabric disclosed in claim 2 is the non-woven fabric disclosed in claim 1, in which the average fiber length of the fluoropolymer fibers is approximately 5 to approximately 50 mm. This type of non-woven fabric is not known in the prior art. Conventionally, these fibers were not used in the production of non-woven fabrics and were discarded. This non-woven fabric has the advantage of being inexpensive to produce.

55 **[0014]** The non-woven fabric disclosed in claim 3 is the non-woven fabric disclosed in claim 1 or claim 2, in which water jet needle punching is performed on a web that is primarily composed of branched chain fluoropolymer fibers, and in which the apparent density thereof is between 0.2 g/cm³ or greater and 1.5 g/cm³ or lower.

[0015] By performing water jet needle punching on the fluoropolymer fibers, this non-woven fabric will have superior

web tensile strength and elasticity because the fibers will be intertwined. In addition, because the fluoropolymer fibers have branched chains, the fibers can be more strongly intertwined and the mechanical strength thereof will be even better.

5 [0016] There is a strong correlation between the apparent density of this non-woven fabric and the strength thereof. When the density of the non-woven fabric is high, the strength thereof will be high as well. Because this non-woven fabric has an apparent density of 0.2 g/cm³ or greater, it will have sufficient mechanical strength even at low basis weights of 300 g/m² or less, 200 g/m² or less, or 100 g/m² or less. Thus, the non-woven fabric does not need to have a foundation cloth. As for strength, the apparent density of the non-woven fabric is preferably 0.7 g/cm³ or greater, more preferably 0.8 g/cm³ or greater, and even more preferably 1.0 g/cm³ or greater. On the other hand, the special characteristics of the non-woven fabric will be lost if the apparent density thereof exceeds 1.5 g/cm³.

10 [0017] The non-woven fabric has a high degree of strength due to these factors. Thus, it is possible to reduce the basis weight of the fabric. For example, a fluoropolymer fiber non-woven fabric can be provided that has a basis weight of 300 g/m² or less, 200 g/m² or less, or 100 g/m² or less. In production tests performed by the inventors, a fluoropolymer fiber non-woven fabric having a basis weight of approximately 30 g/m² could be obtained.

15 [0018] Furthermore, the apparent density of this non-woven fabric will be reduced as a result of water jet needle punching, but here the apparent density produced will be within the desired range if the workability thereof when other members are laminated thereon is taken into consideration.

20 [0019] In addition, this non-woven fabric can control peeling that occurs between the surface layer of the web and the adhesive layer, even if other members are adhered thereto with an adhesive or the like, because the strength of this non-woven fabric is improved in the thickness direction by means of water jet needle punching. Thus, the non-woven fabric of the present invention can have a variety of members laminated thereon, and a laminated product capable of being used in a variety of applications such as a sliding material, sealing material, or the like can be obtained thereby.

25 [0020] The non-woven fabric disclosed in claim 4 is the non-woven fabric disclosed in any of claims 1 to 3, in which the non-woven fabric is treated with pressure and heat at a temperature below the melting point of the fluoropolymer.

[0021] The strength of this non-woven fabric is increased by treating it with pressure and heat. In addition, this treatment controls napping and fiber loss, and stabilizes the non-woven fabric in its proper form. In addition, this pressure and heat treatment is conducted below the melting point of the fluoropolymer fibers.

[0022] The strength of this non-woven fabric will be increased thereby, but will be soft to the touch.

30 [0023] The non-woven fabric disclosed in claim 5 is the non-woven fabric disclosed in any of claims 1 to 3, in which a portion of the fluoropolymer fibers are fused together. Distinguishing the fused fibers can be performed visually with the use of a microscope. Tweezers or the like are used to disentangle the non-fused fibers from the short fibers, but the fused fibers can be easily distinguished because they cannot be disentangled.

35 [0024] This type of non-woven fabric, e.g., a non-woven fabric in which fluoropolymer fibers are entangled together, is obtained by pressure and heat treating at least a portion of the fluoropolymer fibers at a temperature that is at or above the melting point thereof.

40 [0025] With this non-woven fabric, the mechanical properties of the non-woven fabric as a whole are improved, the tensile strength is increased, and the tensile strain is reduced, because a portion of the fluoropolymer fibers in the non-woven fabric are fused together and strongly linked. On the other hand, with this non-woven fabric, air permeability is maintained because the fibers are fused in the thickness direction (the direction in which pressure is applied) but not in the longitudinal direction.

[0026] Thus, non-woven fabrics having these qualities are used, for example, in filters or filter support members for filtering devices in which a large filter pressure is applied, in air permeable sheets, and the like.

45 [0027] In addition, this non-woven fabric can be used, for example, as a sliding material because napping of the surface fibers is controlled.

[0028] Note that heat contraction will occur if the fluoropolymer fibers on both surfaces of non-woven fabric are fused. Thus, fusing only a portion of the fluoropolymer fibers on one surface of the non-woven fabric is preferred from the standpoint of controlling deformation.

50 [0029] The non-woven fabric disclosed in claim 6 is the non-woven fabric disclosed in claims 1 to 5, in which the fluoropolymer fibers are obtained primarily by cutting a uniaxially drawn fluoropolymer film into fibers. The fibers that make up the non-woven fabric of the present invention have branched chains and thus have a superior ability to be entangled. However, fibers having branched chains are often obtained by means of this method. Thus here, a non-woven fabric in which the fluoropolymer fibers therein are primarily obtained by means of this method is particularly desirable.

55 [0030] The non-woven fabric disclosed in claim 7 is the non-woven fabric disclosed in any of claims 1 to 6, in which the fluoropolymer is polytetrafluoroethylene (hereinafter referred to as PTFE).

[0031] Amongst various fluoropolymers, PTFE in particular has low frictionality and low dielectric properties, and has qualities that make it easy to form fibers by means of this processing method. Thus here, it is particularly desirable to

use sintered or semi-sintered PTFE as the fluoropolymer fibers. From amongst these, semi-sintered PTFE is preferred because it is easy to produce the web therefrom and the secondary processing thereof is easy.

[0032] Semi-sintered PTFE is a substance which displays both the heat absorbance of unsintered PTFE (approximately 615° K) and the heat absorbance of sintered PTFE (approximately 600° K) during DSC (differential scanning calorimetry). DSC can be performed by means of a commercially available DSC device.

[0033] Note that it is more preferable that the apparent density of the non-woven fabric immediately after entanglement has been completed is between 0.4 g/cm³ and 0.9 g/cm³.

[0034] The non-woven fabric disclosed in claim 8 is the non-woven fabric disclosed in any of claims 1 to 6, in which the fluoropolymer is ethylene-tetrafluoroethylene copolymer (hereinafter referred to as ETFE).

[0035] Like PTFE, ETFE has low frictionality and low dielectric properties, and has qualities that make it easy to form fibers by means of this processing method. Thus here, it is particularly desirable to use ETFE materials as the fluoropolymer fibers.

[0036] Note that it is more preferable that the apparent density of this non-woven fabric immediately after entanglement has been completed is between 0.3 g/cm³ and 0.8 g/cm³.

[0037] The non-woven fabric disclosed in claim 9 is the non-woven fabric disclosed in any of claims 1 to 8, in which the non-woven fabric includes one or more types fibers selected from the group consisting of polypropylene (hereinafter referred to as PP) fibers, polyethylene (hereinafter referred to as PE) fibers, polyethylene terephthalate (hereinafter referred to as PET) fibers, aramid fibers, nylon fibers, poly-para-phenylene benzobisoxazole (hereinafter referred to as PBO) fibers, polyimide fibers, carbon fibers, glass fibers, alumina fibers, stainless steel fibers, and compound fibers used for splitting.

[0038] By mixing these fibers together in ratios in which the superior properties provided by fluoropolymers are not substantially and completely lost, this non-woven fabric will have both the superior properties provided by fluoropolymers and the superior properties provided by the other fibers.

[0039] The non-woven fabric disclosed in claim 10 is the non-woven fabric disclosed in any of claims 1 to 8, in which the non-woven fabric includes compound fibers used for splitting, and in which the compound fibers therein are split. The splitting is performed simultaneously by means of water jet needle punching when the web is water jet needle punched to obtain the non-woven fabric.

[0040] The compound fibers are split into ultra fine fibers. Thus, this non-woven fabric possesses both the superior properties provided by fluoropolymers and the superior properties provided by the ultra fine fibers. In addition, the ultra fine fibers contribute to the ability of the other fibers to become entangled.

[0041] The non-woven fabric disclosed in claim 11 is the non-woven fabric disclosed in any of claims 1 to 10, in which the non-woven fabric is elongated below its maximum degree of elongation.

[0042] This non-woven fabric is the non-woven fabric of any of claims 1 to 10, and elongated below its maximum degree of elongation in one or two axes. This process controls elongation, and improves tensile strength (maximum point load). In addition, the fabric density can be adjusted by elongation.

[0043] The laminated material disclosed in claim 12 is comprised of a non-woven fabric and a support material. The non-woven cloth is that disclosed in any of claims 1 to 11. The support material is laminated on the non-woven fabric.

[0044] The non-woven fabric disclosed in any of claims 1 to 11 has sufficient strength in and of itself, but its mechanical strength is increased by laminating it with a suitable material. In addition, the non-woven fabric disclosed in any of claims 1 to 11 has a high degree of strength in the thickness direction, and thus problems are unlikely to occur when a portion of the fibers that make up the non-woven fabric are left on the surface of the support material when the non-woven fabric is peeled away. This laminate can be used in a variety of applications, such as a sliding material, an insulating material, a sealing material, or a filter, because it has superior characteristics such as low frictionality, a low dielectric constant, and the like provided by the fluoropolymer.

[0045] The braided material disclosed in claim 13 is produced by twisting the non-woven fabric of any of claims 1 to 11. The non-woven fabric is cut into tape-shaped portions and then into long and narrow strips, and one or a plurality of these long and narrow strips are twisted in order to obtain the aforementioned braided material. In addition, the aforementioned braided material can be twisted together to obtain the braided material disclosed in claim 13.

[0046] According to claim 14, a method of strengthening a non-woven fabric comprised primarily of a fluoropolymer is comprised of the step of applying pressure and heat to the non-woven fabric.

[0047] The term "strengthen" here is defined as increasing the tensile strength and/or the strength in the thickness direction.

[0048] The non-woven fabric of claim 15 is strengthened by means of the method disclosed in claim 14.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049]

5 Fig. 1 is a cross section in the thickness direction of a non-woven fabric which employs an embodiment of the present invention.

Fig. 2 is a cross section in the thickness direction of a laminated material which employs an embodiment of the present invention.

10 BEST MODE FOR CARRYING OUT THE INVENTION

[0050] Preferred embodiments of the present invention will be described below.

[Non-woven fabric]

15

First Embodiment

[0051] Fig. 1 shows a non-woven fabric which employs a first embodiment of the present invention.

20 **[0052]** The non-woven fabric 1 is composed primarily of semi-sintered PTFE fibers, and these fibers have a branched structure.

[0053] In the present embodiment, PTFE is used as a fluoropolymer, but the PTFE may instead be a homopolymer of tetrafluoroethylene (hereinafter referred to as TFE), or may be a PTFE modified by polymerizing a small amount of perfluorovinyl ether with TFE. Note that in the present invention, the term PTFE also includes this modified PTFE unless otherwise noted.

25 **[0054]** In addition, PTFE may be substituted with a fluoropolymer capable of being melt processed, such as a copolymer of TFE and hexafluoropropylene (FEP), a copolymer of ethylene and TFE (ETFE), or a copolymer of TFE and perfluoroalkyl vinyl ether (PFA). These fluoropolymers may be used independently or in combinations of two or more types. These fluoropolymers have excellent chemical resistance, low frictionality, wear resistance, non-cohesiveness, and heat resistance, as well as excellent water and oil repellency.

30 **[0055]** From amongst the aforementioned fluoropolymers, PTFE is preferred due to its superior chemical resistance and mechanical strength, and semi-sintered PTFE is particularly preferred due to the ease with which it is formed into a web and the ease with which it undergoes secondary processing.

35 **[0056]** Semi-sintered PTFE film is obtained by heat processing a PTFE film obtained by forming a paste from PTFE fine powder obtained with an emulsion polymerization method, or heat processing a PTFE film obtained by applying pressure to a PTFE powder obtained by a suspension polymerization method, at a temperature between the melting point of sintered PTFE (approximately 327°C) and the melting point of a non-sintered PTFE (approximately 337°C to 347°C).

[0057] Sintered PTFE is obtained by heat processing non-sintered PTFE or semi-sintered PTFE at a temperature at or above the melting point of non-sintered PTFE.

40 **[0058]** In the present embodiment, the web used in the production of the non-woven fabric of the present invention is comprised only of a fluoropolymer. However, fibers other than fluoropolymer fibers may be used therewith in the web. These types of fibers include organic fibers such as PP fibers, PE fibers, PET fibers, aramid fibers, nylon fibers, PBO fibers, and polyimide fibers, inorganic fibers such as glass fibers, carbon fibers, and alumina fibers, metal fibers such as stainless steel fibers, and compound fibers that are used for splitting. These fibers may be used independently, or may be used in combinations of two or more.

45 **[0059]** The aforementioned compound fibers used for splitting can be those well known in the art that are obtained by spinning a plurality of resin types. Preferably, the aforementioned compound fibers used for splitting are split at the same time that the fibers of the web are entangled by means of water jet needle punching, and are formed into ultra fine fibers thereby. The aforementioned plurality of different resin types include polyester/nylon, polyester/polypropylene, and the like.

50 **[0060]** The ratio of fibers other than the fluoropolymer fibers is not particularly limited so long as the aforementioned superior properties of fluoropolymers are not substantially and completely lost. However, the properties provided by fluoropolymers will be harmed as the ratio of the fluoropolymer fibers used decreases. The ratio of fluoropolymer in the web used in the non-woven fabric of the present invention is normally 50% or more, preferably 70% or more, more preferably 90% or more, and even more preferably 95% or more.

55 **[0061]** In addition, the branched monofilament, staple fibers, and multifilament disclosed in, for example, WO94/23098, WO96/00807, WO96/10662, and the like are preferably used as webs. Each individual fiber of these webs is obtained by mechanically cutting PTFE that has been uniaxially drawn and processed into a film (PTFE film),

and then cutting this film into fibers. These fibers have a branched structure.

[0062] In the non-woven fabric of the present invention, fluoropolymer fibers that are not used conventionally and which are comparatively short may be used in a non-woven fabric composed primarily of fluoropolymer fibers.

More specifically, fluoropolymer fibers can be used that are 5 to 50 mm in length, and preferably 10 to 20 mm in length.

[0063] The length of the fluoropolymer fibers are not required to be uniform. Extremely short fluoropolymer fibers may be within a fixed ratio. More specifically, less than 40% of the fibers may be 5 mm or less in length, preferably less than 10%, and more preferably less than 5%. On the other hand, the ratio of long fluoropolymer fibers is not particularly limited. Surprisingly, an ideal non-woven fabric could be produced even when, for example, 20% or less, 10% or less, 5% or less, or 2% or less of the fibers were 25 mm or less in length. In addition, an ideal non-woven fabric can be produced even when less than 1% or substantially 0% of the fibers therein are 50 mm or greater in length. The symbol "%" refers to a number relating to the length of the fibers.

[0064] The length of the fibers is determined by removing 100 fibers from the non-woven fabric and measuring them by standard methods. If a fiber is branched, it is measured in such a way that the length thereof is maximized.

[0065] A web that includes fluoropolymer fibers and fibers other than fluoropolymer fibers can be obtained by overlaying a fluoropolymer film with a polymer film other than a fluoropolymer, and mechanically cutting the films and forming fibers therefrom. Or, these fibers can simply be mixed together mechanically.

<Water Jet Needle Punching>

[0066] The web of the present embodiment is subjected to water jet needle punching. Here, a preferred example will be described, but the present embodiment is not limited thereto.

[0067] Note that here, a PTFE web will be described in detail.

[0068] In water jet needle punching, a web is mounted on a 70 mesh or higher net that supports the web, a nozzle having a nozzle diameter of approximately 1 mm and a nozzle pitch of approximately 1 mm is employed, pre-needle punching is first carried out at a water pressure of 5 MPa or greater, and then a main needle punching is carried out at a maximum water pressure of 10 MPa. Air and water discharge ports that are connected to a vacuum pump or a blower are provided below the transport net that is directly below the nozzle, and the water used to needle punch the web is swiftly discharged thereby.

[0069] Note that it is preferred that the net that is used as a support material for the web during needle punching be approximately 100 mesh so that the web fibers do not become entangled with the net and that the amount of web (fluoropolymer loss) that remains on the net when it is peeled away is reduced. There will be a large degree of entanglement between the web and the net with a 70 mesh or lower. Furthermore, if the eyes are rough, there will be large variations in the degree to which the web encroaches into the eyes of the net, a net pattern will be transferred to the surface of the web, and through holes will be formed in the web by means of the water jets. In addition, if felt is used as a support member for the web, the flow of water reflected by the interface between the web and the felt during water jet needle punching will be lower than when a net having small eyes therein is employed, and thus the entanglement will tend to be weaker.

[0070] When entanglement begins, the density of the web will be reduced to 0.3 to 0.7 g/cm³, thus making it easier for the water jet to flow therethrough. At this time, if the pore size of the support material increases, the energy of the water jet will not be applied to the entanglement of the web but rather will be dissipated from the support material. However, by reducing the pore size thereof, the energy of the collision between the net and the water jet can be effectively used to entangle the web. In addition, a net which has been calendared may be used because if the surface thereof has been smoothed, the percentage of open holes in the support material will increase.

[0071] By performing water jet needle punching in this manner, the fibers will be moved in the thickness direction, the fibers will be entangled in the thickness direction, tensile strength (maximum point load) will increase, and elongation during this process will be controlled.

[0072] Note that if a web having a basis weight of 250 g/m² (a density of 860 kg/cm³) and supported by a 15 mesh net is processed with a dynamic force of 0.13kWh (a value calculated from experimental conditions), the tensile strength (maximum load point) thereof will be 5 to 6.5 N/cm.

[0073] On the other hand, if a web having a basis weight of 250 g/m² and supported by a 100 mesh net is processed with a dynamic force of 0.11 kWh per 1 kg of weight, the tensile strength thereof will be 6.5 to 8 N/cm.

[0074] In particular, if the openings in the net on which the web is mounted are large (e.g., 2 mm or larger), a non-woven fabric having a plurality of holes (e.g., 1 to 2 mm in diameter) that correspond to the positions of these openings can be obtained because the fibers that are positioned in the openings will come out therefrom. The shape of these openings is not particularly limited. In addition, the size of the openings that produce these types of holes will be different depending upon the conditions under which water jet needle punching is performed (water pressure, etc.). The term "hole" does not necessarily mean portions that are completely open, but rather includes portions comprised of spaces between separated fluoropolymer fibers.

<Pressure and heat treatment>

5 **[0075]** A non-woven fabric having a low density of entangled fibers will not have sufficient strength. There is a strong correlation between the apparent density of a non-woven fabric and the strength thereof. In addition, there will be problems in that, because there is significant napping on the surface of this type of non-woven fabric, the fibers thereon will easily peel away and scatter, and creases will remain visible on the non-woven fabric when it is water jet needle punched.

10 **[0076]** Accordingly, in this embodiment, the apparent density of a non-woven fabric that has napping will be increased and the surface thereof will be smoothed by applying heat and pressure thereto at a temperature that is below the melting temperature thereof after the fibers have been entangled. More specifically, a non-woven fabric can be continuously processed by passing a non-woven fabric whose fibers have been entangled between heated metal rollers or between a heated metal roller and a rubber roller. In addition, the non-woven fabric may be intermittently processed by means of a process involving a heat press device.

15 **[0077]** As for strength, the apparent density of the non-woven fabric is preferably 0.7 g/cm³ or greater, more preferably 0.8 g/cm³ or greater, and even more preferably 1.0 g/cm³ or greater. On the other hand, the special characteristics of the non-woven fabric will be lost if the apparent density thereof exceeds 1.5 g/cm³.

20 **[0078]** The apparent density thereof can be increased by increasing the pressure applied thereto. In order to increase the pressure applied to the non-woven fabric, the gap between the rollers may be narrowed if, as noted above, the method used to apply the pressure involves passing the non-woven fabric in between rollers. The gap between the rollers needed to obtain the desired apparent density will differ depending upon the thickness of the non-woven fabric being passed therethrough, the properties of the rollers, the temperature of the rollers, and other factors. However, the gap can be easily determined by changing the parameters and conducting a number of production tests.

25 **[0079]** The temperature used during heat treatment may be higher than room temperature (normally about 25°C), but with respect to the effects of this pressure and temperature treatment, a high processing temperature will tend to produce better results. However, in this embodiment, the upper limit of the processing temperature is set to be the melting point of the fluoropolymer fibers. In this way, a soft non-woven fabric having a high degree of strength will be obtained.

30 **[0080]** In particular, if the aforementioned non-woven fabric having a plurality of holes is heat and pressure treated, these plurality of holes will be maintained in that state, and the strength of the non-woven fabric can be increased. The non-woven fabric obtained in this manner is ideally used as a support member of a fluoropolymer membrane.

<Elongation>

35 **[0081]** If a non-woven fabric having a low density is water jet needle punched as is and a highly viscous adhesive is applied thereto, there will be problems in that the length and the width of the non-woven fabric can be easily deformed by external forces, the density thereof will not be uniform, and the size thereof will not be stable.

[0082] Accordingly, in the present embodiment, elongation is controlled and tensile strength (maximum point load) increased by elongating the non-woven fabric in one or two axial directions before water jet needle punching.

40 **[0083]** More specifically, the non-woven fabric can be continuously elongated in one axial direction by rolling the non-woven fabric up at a speed that is faster than the speed at which it is unrolled. In addition, the non-woven fabric can be elongated in two axes by using a horizontal elongation device (tenter) and elongating it in a direction that is perpendicular to the direction in which it is being unrolled.

<Twisting>

45 **[0084]** Conventionally, when a thread, braid, or rope is obtained from fluoropolymer fibers, either long fibers are braided together, or short fibers are braided together around a core of braided long fibers.

[0085] The present invention can easily obtain a cylindrically shaped braid having a high tensile strength by braiding a non-woven fabric that has been subject to elongation.

50 **[0086]** More specifically, a braided material is obtained by braiding one or a plurality of long and narrow shaped portions of non-woven fabric together. These braids can be formed into a rope by braiding the braids together.

Second Embodiment

55 **[0087]** The non-woven fabric according to a second embodiment of the present invention is identical to the non-woven fabric according to the first embodiment, except that a portion of the fluoropolymer fibers are fused together.

[0088] The non-woven fabric of the present embodiment is obtained by pressure and heat treating at least a portion of the fluoropolymer fibers of the non-woven fabric of the first embodiment at a temperature that is at or above the

melting point thereof. However, if the aforementioned temperature is too high, the fluoropolymer will break down to an excessive degree. For example, it is preferred that semi-sintered PTFE be processed at 340°C to 360°C. In addition, it is preferred that only one surface of this non-woven fabric be heat treated in order to control changes in the width of the non-woven fabric due to thermal contraction.

[0089] More specifically, for example, the non-woven fabric may be passed between a metal roller that has been heated to 340°C to 360°C and an unheated metal roller.

[0090] With this non-woven fabric, the mechanical properties of the non-woven fabric as a whole are improved, the tensile strength is increased, and the tensile strain is reduced, because the fibers on the surface of the web are fused together and strongly linked. On the other hand, with this non-woven fabric, the fibers in the portions of the web other than on the surface thereof are not fused, and the air permeability of the non-woven fabric is maintained due to the fusion of the fibers in the thickness direction.

[0091] In addition, this non-woven fabric controls napping of the fibers on the surface thereof.

[0092] Note that because wrinkles and the like are produced by shrinkage in the width direction during heat fusion of the non-woven fabric, it is preferable that the temperature and processing times be set such that the amount of contraction in the width is 25% or less.

[0093] In particular, if the aforementioned non-woven fabric having a plurality of holes is heat and pressure treated, these holes will be maintained in that state, and the strength of the non-woven fabric can be increased. The non-woven fabric obtained in this manner is ideally used as a support member of a fluoropolymer membrane.

[Non-woven fabric applications]

[0094] Fig. 2 shows a laminate 1 which employs an embodiment of the present invention.

[0095] The laminate 11 is comprised of the non-woven fabric 1 noted above, and a support member 3 that is laminated to the non-woven fabric 1.

[0096] The non-woven fabric 1 of the present invention is porous due to formation as a web, and other members can be easily affixed thereto by means of an adhesive. These characteristics can be utilized to obtain the laminate 11 shown in Fig. 2. In addition, the non-woven fabric alone can be used in a variety of applications.

<Various types of laminates (sliding members, sealing members, mold release members)>

[0097] If a metal, rubber, polymer, wood, ceramic, or other similar material is used as the support member 3, a sliding member having low frictionality, a sealing member having superior water repellency, or a non-cohesive mold release member can be obtained by affixing one of these materials to the non-woven fabric 1.

[0098] If polyvinyl chloride (hereinafter referred to as PVC) is used as the material used as the support member 3, the non-woven fabric 1 can be affixed on top thereof by applying a conventional adhesive used for PVC to the PVC member. A rubber adhesive can be used if the member is made from rubber. A general use vinyl acetate adhesive can be used if the member is made from wood. A thermosetting resin adhesive (e.g., an epoxy resin), a thermoplastic resin adhesive (e.g., a urethane adhesive), or the like can be used if the member is made from metal or ceramic.

[0099] In addition, the adhesive layer can be in combination with the support member. For example, an earthquake damping member for use with pipes can be made that has a PTFE web as the upper layer and rubber as the lower layer.

[0100] A mold release member is placed between a molded article in, for example, a hot press and the heated surface of the hot press, and allows the molded article to be easily released from the heated surface of the press. However, if rubber is used as the support member 3, a mold release member having superior cushionability is obtained.

[0101] If the support member is a metal or ceramic that is resistant to heat that is at or above the melting point of PTFE or the like, or if the support member is a polymer or the like that is assured of being heat resistant for a short period of time, then the upper layer of the web can be heat treated at a temperature at or higher than the melting temperature thereof if an adhesive having heat resistance, e.g., a polyimide varnish, is used to adhere the non-woven fabric 1 to the support member. This process can produce a laminate in which the surface thereof has been turned into a film. In this way, the non-woven fabric can be used in a variety of applications because the mechanical strength of the surface is increased, and its ability to act as a mold release is increased.

[0102] Likewise, a PTFE laminate film having superior adhesiveness can be produced by applying a heat resistant soluble polymer adhesive such as the aforementioned polyimide varnish to the non-woven fabric.

[0103] Note that the abrasion resistance of non-woven fabrics used in sliding applications can be improved by using one which has aramid fibers or carbon fibers mix spun therein.

<Non-cohesive belt>

[0104] A non-cohesive belt can be obtained by adhering the non-woven fabric 1 to the main body of an annular belt.

<Insulating tape>

5 [0105] A insulating tape for use in electric wires/electric circuits and which has superior insulating capabilities can be obtained by wrapping the conductive surface thereof with the non-woven fabric 1. More specifically, an insulating layer which has a water resistant layer on the outer circumference thereof can be easily produced by wrapping a standard conductive material with the non-woven fabric 1, and applying a thermosetting resin, a thermoplastic resin, or the like on the non-woven fabric 1 wrapped thereon. This insulating layer has a low dielectric constant, a low dielectric dissipation factor, and a high degree of porosity, and thus a layer that is suitable as an insulating material for a high frequency electric circuit/electric wire can be obtained.

10 [0106] In addition, because the non-woven fabric 1 of the present invention is flexible, its ability to be wrapped around an object is superior to that of conventional drawn tape and has superior dielectric capabilities, even if it is comparatively thick. Note that from the point of view of workability, the non-woven fabric 1 preferably has a thickness of 0.05 mm or greater.

15 [0107] In particular, a low basis weight non-woven fabric having an approximate thickness of 0.1 mm and a porosity of 50% or greater is needed when used as a wrapping tape to insulate high frequency electric wires. In this type of application, changes in the width of the tape and tape breakage during wrapping can be controlled, even if wrapped under a high degree of tension, by using a non-woven fabric whose thickness has been adjusted after one side thereof has been heat fused. This also allows an insulated electric wire having stable quality to be obtained.

20 <Printed circuit board>

[0108] A printed circuit board can be obtained by using the non-woven fabric 1 as a base material, impregnating it with a thermosetting resin or a thermoplastic resin, and then adhering copper foil to the surface thereof. This printed circuit board can be used as a substrate for high frequency circuits due to the low dielectric constant, the low dielectric dissipation factor, and the like that fluoropolymers have.

25 [0109] A conventional fluoropolymer web has low tensile strength because an entangling process is not performed, and because of this, the sheet will be easily damaged when it is handled during fabrication. Thus, it is difficult for a conventional fluoropolymer web to be used in this type of printed circuit board. However, if the non-woven fabric 1 of the present invention is employed, this type of application will become possible because an entangling process is performed and tensile strength is improved.

30 [0110] An epoxy resin can be used as the thermosetting resin. A substrate having even more superior heat resistance can be obtained when a heat resistant polyimide resin is employed as the thermoplastic resin.

35 <Various membranes (gas-liquid/solid-liquid separation membranes, total heat exchange membranes)>

[0111] By using the non-woven fabric 1 as a boundary membrane, a gas-liquid/solid-liquid separation membrane that is resistant to ozone and other chemicals can be obtained. It is easier to process this membrane into various shapes than compared to a fluoropolymer drawn membrane, because its adhesive workability is superior.

40 [0112] In addition, by forming the non-woven fabric 1 into a heat exchange membrane for an element in a heat exchanger, it can be used as a total heat exchanger because it is air permeable.

<Surface decoration>

45 [0113] A surface decoration that is transparent, air permeable, and fire-proof can be obtained by using the non-woven fabric 1 as a surface decoration for indoor walls and fittings (such as shoji screens and the like), thereby providing a comfortable living space.

<Felt material>

50 [0114] A felt material that has a smooth surface and a low friction sliding functionality can be obtained by adhering the non-woven fabric 1 to, for example, a felt surface that is composed of elastic fibers made from other polymers. This felt material can be used as a support material for supporting the window glass of an automobile when it slides with respect to the door, or as a wiper for cleaning the rollers inside office equipment.

55 <Tubular member>

[0115] A tubular member having the desired length in the axial direction can be obtained by forming the non-woven fabric 1 into oblong strips and then, for example, wrapping it in a spiral pattern around a cylindrical member while

adhering the boundary portions of the spiral (the portions of the non-woven fabric that lie on top of each other). This tubular material can be used in the gasification of liquid fuels or solvents, when bubbling ozone gas, oxygen or the like, or in filters, because it can be formed with small diameters of approximately ϕ 2 mm.

5 <Braided material>

[0116] A non-woven fabric having a low degree of elongation and a high degree of tensile strength can be obtained by elongating the non-woven fabric. A tape made from this is easily wrapped around the outer circumference of fiber optic cable or power/signal cable, and the task of placing this cable in a protective tube of a conduit tube or the like is thereby made easier.

10 [0117] A braided material having a high degree of strength, a superior sliding ability, and low elongation can be obtained by twisting this tape-shaped non-woven fabric. This can be used as a binding material in environments that require these materials to be resistant to chemicals, and as a buffer material in between electric communication cables or optical communication cables.

15 <Filter material or filter support material for cake-type filter devices>

[0118] A non-woven fabric according to a second embodiment can be used as a filter or a filter support material for cake-type filter devices.

20 [0119] In cake-type filter devices, a filter having a high degree of strength is needed because, in order to conduct filtering through a cake layer produced by the filtering, a large amount of filter pressure is required, and that large filter pressure is applied to the filter material. This non-woven fabric is ideal for this application because the air permeability is maintained as is, and the strength thereof is improved.

25 <Sliding material>

[0120] The non-woven fabric of the second embodiment can be used as a sliding member, such as by adhering it to a variety of sliding surfaces, because the strength thereof is improved, it has low frictionality, and napping on the surface thereof is controlled.

30 <Air permeable sheet>

[0121] The non-woven fabric of the second embodiment can be used as an air permeable sheet because it is permeable to air, and because it is water repellant due to the fluoropolymer.

35 <Support member>

[0122] The non-woven fabric of the first or second embodiment can be ideally used as a support member for a fluoropolymer membrane because the non-woven fabric has a plurality of 1 to 2 mm holes therein and has an extremely high air permeability.

40 Examples

[0123] Examples and comparative examples are provided below that describe the present invention in greater detail. However, the present invention is not limited to these examples.

Example 1 [Strengthening a non-woven fabric by applying pressure and heat thereto]

50 [0124] A web comprised of branched fluoropolymer fibers was obtained by means of the method disclosed in International Patent Publication No. WO94/23098. More specifically, after uniaxially drawing a semi-sintered PTFE film (thickness 120 micrometers, width 165 mm, crystal conversion ratio 0.45) 25 times, a roller having needle cutters was used to cut the film into fibers. Note that the crystalline conversion ratio was calculated by means of the method disclosed in International Patent Publication No. WO94/23098.

55 [0125] The web obtained thereby (apparent density 0.86 g/cm³, basis weight 250 g/m²) was water jet needle punched by means of a horizontal belt type of water jet needle entangling device under the following conditions, and a non-woven fabric was obtained thereby.

[0126] The strength of the web produced thereby is shown in Table 1 in terms of the average tensile strength of a sample having a width of 2 cm and a distance of 4 cm between the chucks holding the same.

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Table 1

Vertical direction		Horizontal direction	
Maximum point load (N)	Elongation (%)	Maximum point load (N)	Elongation (%)
1.5	2.6	1.2	5.0

Entangling conditions

[0127]

Nozzle used: Inlet hole diameter ϕ 0.2 mm, outlet hole diameter ϕ 0.1 mm, nozzle pitch 1 mm

Web support material: polyethylene net (100 mesh)

Preliminary entanglement: two times on the front side at 3 MPa water pressure

Main entanglement: two times on the front side at 6 MPa water pressure, then the web was reversed and entanglement was conducted two times from the rear side

[0128] As a result of this entanglement, the apparent density of the web was 0.3 to 0.7 g/cm³.

[0129] In addition, the strength of the water jet entangled product obtained thereby is shown in Table 2 in terms of the average tensile strength of a sample having a width of 2 cm and a distance of 4 cm between the chucks holding the same.

Table 2

Vertical direction		Horizontal direction	
Maximum point load (N)	Elongation (%)	Maximum point load (N)	Elongation (%)
16.0	82.0	13.3	80.9

[0130] Next, the aforementioned water jet needle punched web was processed between metal/rubber rollers. More specifically, nip rollers constructed of a ϕ 80 mm metal roller having a surface temperature of 250°C and a ϕ 80 mm rubber lined pressure roller were used to apply heat and pressure at a line pressure of 4 kg/cm and a line speed of 1.5 m/min to obtain a non-woven fabric having the following characteristics.

Apparent density: 1.1 g/cm³

Air permeability: 0.13 to 0.26 cm/s/mm Aq

[0131] In addition, the strength of the non-woven fabric obtained by applying pressure and heat thereto is shown in Table 3 in terms of the average tensile strength of a sample having a width of 2 cm and a distance of 4 cm between the chucks holding the same.

Table 3

Vertical direction		Horizontal direction	
Maximum point load (N)	Elongation (%)	Maximum point load (N)	Elongation (%)
34.8	84.7	27.0	111.5

Example 2 [Strengthening a non-woven fabric by elongation]

[0132] A water jet needle punched non-woven fabric obtained in the same manner as in Example 1 was elongated in one axis. Before elongation, the non-woven fabric had a length of 250 mm, a width of 20 mm, a thickness of 0.38 mm, and an apparent density of 0.65 g/cm³, and was elongated 60% in one axis to obtain a elongated article having a total length of 400 mm, a width of 8 mm, and a thickness of approximately 0.4 mm. The strength thereof was improved as shown below.

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Tensile strength before processing (test piece 20 mm wide and 0.38 mm thick)
 Maximum point load: 15N, maximum point elongation 82%
 Tensile strength after processing (test piece 8 mm wide and 0.4 mm thick)
 Maximum point load: 30N, maximum point elongation 22%

Example 3 [braided material]

[0133] The elongated article obtained in Example 2 having a width of 8 mm and a thickness of 0.4 mm was twisted one turn/cm in the lengthwise direction to form a braided material having an outer diameter of approximately 1.3 mm and a total length of 400 mm.

[0134] This article had the strength shown below.

Tensile strength before twisting (test piece 8 mm wide and 0.4 mm thick)
 Maximum point load: 30N, maximum point elongation 22%
 Tensile strength after twisting (test piece having an outer diameter of approximately 1.3 mm)
 Maximum point load: 60N, maximum point elongation 25%

[0135] By twisting the non-woven fabric into a braided material, a braided material having a high tensile strength per unit of weight can be obtained.

[0136] In addition, frayed fibers in the braided material can be repaired by sintering the braided material, and thus a braided material having an even higher tensile strength can be obtained.

[0137] By sintering the aforementioned braided material at 370°C, the maximum point load can be increased from 60N to 175N.

Example 4 [Strengthening a non-woven fabric by partial fusion (basis weight of 200 g/m²)]

[0138] A web having a basis weight of 200g/m² was water jet needle punched under the conditions shown in Example 1, and a non-woven fabric was obtained.

[0139] The strength of the 200g/m² basis weight non-woven fabric had the following values per 2 cm of width.

Table 4

Vertical direction MD		Horizontal direction TD	
Maximum point load (N)	Elongation (%)	Maximum point load (N)	Elongation (%)
14.6	65.1	11.8	89.3

[0140] The 200g/m² basis weight non-woven fabric was heat and pressure treated at a speed of 3 m/min. by rollers set such that the lower roller had a temperature of 300°C, the upper roller had a temperature of 360°C, and the gap between both rollers was 0.2 mm. The strength of the heat fused non-woven fabric obtained in this manner had the following values per 2 cm of width. The non-woven fabric was viewed under a microscope after being pressure and heat treated, and a portion of the fibers on one surface thereof were observed to be heat fused.

Table 5

Vertical direction MD		Horizontal direction TD	
Maximum point load (N)	Elongation (%)	Maximum point load (N)	Elongation (%)
123.5	22.0	40.2	70.0

Example 5 - 7 [Strengthening a non-woven fabric by partial fusion (basis weight of 75 g/m²)]

[0141] A web having a basis weight of 75 g/m² was water jet needle punched under the conditions shown in Example 4, and then pressure and heat treated by a calendar roller. The treatment took place at a rate of 2 m/min. and the gap between the rollers was adjusted to 0.075 mm. In Examples 5 to 7, the roller temperature was set as shown in Table 6.

[0142] As shown in Table 6, a non-woven fabric in which one side thereof was fused at a temperature at or above the melting point of the fluoropolymer had an improved degree of strength compared to a non-woven fabric not subject to calendaring (referred to as "unprocessed" in the table). The non-woven fabrics of Examples 5 to 7 were viewed under a microscope after being pressure and heat treated, and a portion of the fibers on one surface of each of them were observed to be heat fused.

Table 6

	Roller temperature		Basis weight	Thickness	Density	Vertical direction MD		Horizontal direction TD	
	Upper roller	Lower roller				Maximum point load	Elongation	Maximum point load	Elongation
	°C	°C	g/m ²	mm		N/cm	%	N/cm	%
Unprocessed	—	—	71.8	0.16	0.45	0.6	74.2	0.5	78.4
Example 5	340	300	66.0	0.18	0.36	3.6	15.9	2.2	58.5
Example 6	350	300	83.3	0.20	0.42	6.3	18.2	3.3	45.8
Example 7	360	300	90.0	0.19	0.48	12.9	15.3	6.2	58.8

Example 8

[0143] Branched fluoropolymer fibers were obtained by means of the method disclosed in International Patent Application No. WO94/23098. More specifically, after uniaxially drawing a semi-sintered PTFE film (thickness 120 micrometers, width 165 mm, crystal conversion ratio 0.45) 25 times, a roller having needle cutters was used to form the film into fibers, and 5 types of webs were prepared in which the lengths of the branches of the fibers were different.

[0144] Each web was pressure treated with nip rollers in order to continuously supply each to a water jet needle punch device, and then each was water jet needle punched under the same conditions as in Example 1. The strength of the non-woven fabrics obtained thereby were tested. The results are shown in Table 7. As shown in Table 7, non-woven fabrics having a sufficient degree of strength were obtained even if short fibers were used (i.e., fibers having an average fiber length of 20 mm or less). However, when the average fiber length was 3.9 mm, high strength was not obtained.

Table 7

Test sample	Number of fiber branches					Average fiber length (mm)	Maximum point load (g/cm ³)	
	Below 5 mm	Below 10 mm	25 mm or higher	50 mm or higher	Total number measured		MD	TD
1	85	98	0	0	305	3.9	78	65
2	0	10	20	1	327	18.3	259	227
3	1	40	4	0	324	11.9	258	216
4	0	35	10	1	338	16.0	180	146
5	1	50	1	0	317	10.1	337	372

Comparative Example

[0145] A mixture of a PTFE polymer powder and viscose was spun into thread, and the PTFE staple fiber (Torofluon 201 produced by Toray Fine Chemical Corp, fiber length 100 mm, thickness 6.7 denier, crimping present) produced thereby was cut to obtain PTFE staple fibers that were approximately 25 mm in length. 2% by weight of a static electricity prevention agent (Erimina, produced by Maurzen Sekiyu) was sprayed on the PTFE staple fibers, and then an attempt at producing a web by means of a carding machine was made. The gap from the portion in which the fibers exit the machine (doffer) to the drum was set to be 10 mm, but a web could not be continuously produced. Because of this, paper was placed below the doffer, the staple fibers were placed on top thereof, and a web was obtained thereby (width 250 mm, length 500 mm, 50 g/m²).

[0146] The web was then pressure treated with nip rollers, but a web having sufficient strength could not be obtained and could not be continuously fed into a horizontal belt type of water jet needle entangling device. Because of this, the web was placed on the belt of this device by hand and was then water jet needle punched. However, the fibers scattered, and a non-woven fabric could not be obtained.

INDUSTRIAL APPLICABILITY

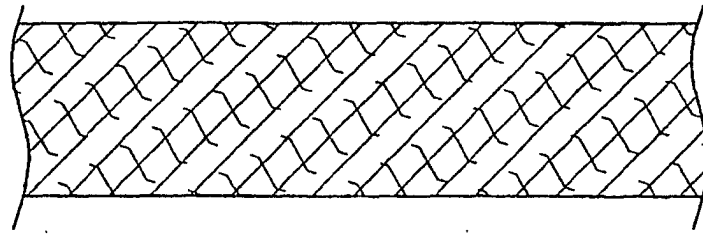
[0147] According to the present invention, a non-woven fabric having improved mechanical characteristics such as tensile strength and tensile strain can be obtained because the fibers of the web are strongly entangled by means of water jet need punching. In addition, because the non-woven fabric of the present invention has fluoropolymer characteristics, and superior adhesive properties due to the porosity of the web, a laminate that can be used in a variety of applications can be obtained by adhering other members to the non-woven fabric.

[0148] Furthermore, a braided material having superior sliding abilities can be easily obtained by twisting the non-woven fabric.

Claims

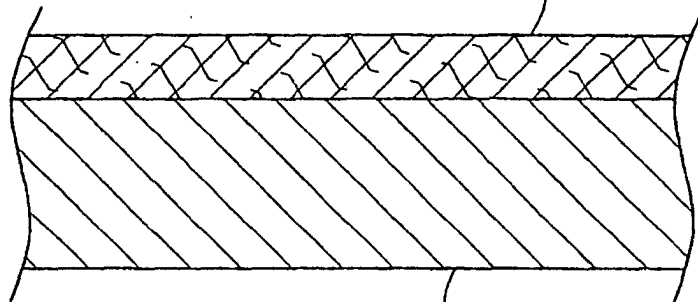
- 5
1. A non-woven fabric composed primarily of fluoropolymer fibers, wherein the fibers are entangled and the non-woven fabric does not have a foundation cloth.
2. The non-woven fabric set forth in claim 1, wherein the average length of the fluoropolymer fibers is 5 to 50 mm.
3. The non-woven fabric set forth in claim 1 or claim 2, wherein water jet needle punching is performed on a web that is primarily composed of branched fluoropolymer fibers, and the apparent density of the non-woven fabric is between 0.2 g/cm³ or greater and 1.5 g/cm³ or lower.
- 10
4. The non-woven fabric set forth in any of claims 1 to 3, wherein the non-woven fabric is pressure and heat treated at a temperature at or below the melting point of polytetrafluoroethylene.
- 15
5. The non-woven fabric set forth in any of claims 1 to 3, wherein a portion of the fluoropolymer fibers are fused together.
6. The non-woven fabric set forth in any of claims 1 to 5, wherein the fluoropolymer fibers are obtained by uniaxially drawing a fluoropolymer film and then cutting the drawn fluoropolymer film into fibers.
- 20
7. The non-woven fabric set forth in any of claims 1 to 6, wherein the fluoropolymer is sintered or semi-sintered polytetrafluoroethylene.
8. The non-woven fabric set forth in any of claims 1 to 6, wherein the fluoropolymer is a ethylene-tetrafluoroethylene copolymer.
- 25
9. The non-woven fabric set forth in any of claims 1 to 8, wherein the web further includes one or more types of fibers selected from the group consisting of polypropylene fibers, polyethylene fibers, polyethylene terephthalate fibers, aramid fibers, nylon fibers, poly-para-phenylene benzobisoxazole fibers, polyimide fibers, carbon fibers, glass fibers, alumina fibers, stainless steel fibers, and compound fibers used for splitting.
- 30
10. The non-woven fabric set forth in any of claims 1 to 8, wherein the web includes compound fibers used for splitting, and the compound fibers are split.
- 35
11. The non-woven fabric set forth in any of claims 1 to 10, wherein the non-woven fabric is elongated to a point at or below the maximum degree of elongation thereof.
- 40
12. A laminate comprising the non-woven fabric set forth in any of claims 1 to 11; and a support member laminated onto the non-woven fabric.
13. A braided material obtained by twisting the non-woven fabric set forth in any of claims 1 to 11.
- 45
14. A method of strengthening a non-woven fabric primarily composed of fluoropolymer fibers, comprising the step of applying pressure and heat to the non-woven fabric.
- 50
15. A non-woven fabric strengthened by means of the method set forth in claim 14.
- 55

Fig. 1



1

Fig. 2



1

3

11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/06028

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ D04H1/42		
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 ⁷ D04H1/00-18/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2002 Kokai Jitsuyo Shinan Koho 1971-2002 Jitsuyo Shinan Toroku Koho 1996-2002		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPII D04H1/42, D04H1/46, D04H1/54		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 96/10668 A1 (Daikin Industries, Ltd.), 11 April, 1996 (11.04.96), Full text & EP 785302 A & US 5912077 A	1-15
Y	WO 94/23098 A1 (Daikin Industries, Ltd.), 13 October, 1994 (13.10.94), Full text & EP 648870 A & US 5562986 A	6, 7
A	WO 96/10662 A1 (Daikin Industries, Ltd.), 11 April, 1996 (11.04.96), Full text & EP 790336 A & US 5807633 A	1-15
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* "A" "E" "L" "O" "P"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance earlier document but published on or after the international filing date document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) document referring to an oral disclosure, use, exhibition or other means document published prior to the international filing date but later than the priority date claimed	"T" "X" "Y" "&"
Date of the actual completion of the international search 21 August, 2002 (21.08.02)	Date of mailing of the international search report 03 September, 2002 (03.09.02)	
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer	
Facsimile No.	Telephone No.	

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/06028

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2000-42126 A (Daikin Industries, Ltd.), 15 February, 2000 (15.02.00), Full text (Family: none)	1-15
A	JP 9-13258 A (Toray Fin Chemicals Kabushiki Kaisha), 14 January, 1997 (14.01.97), Full text (Family: none)	1-15

Form PCT/ISA/210 (continuation of second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP02/06028

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1 to 13 relate to a non-woven fabric which comprises fluoro-resin fibers as a primary component and has no base cloth, wherein the fibers are intermingled with one another.

Claims 14 and 15 relate to a method for enhancing the strength of a non-woven fabric comprising fluoro-resin fibers as a primary component, which comprises pressurizing and heating the non-woven fabric.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest** The additional search fees were accompanied by the applicant's protest.
 No protest accompanied the payment of additional search fees.