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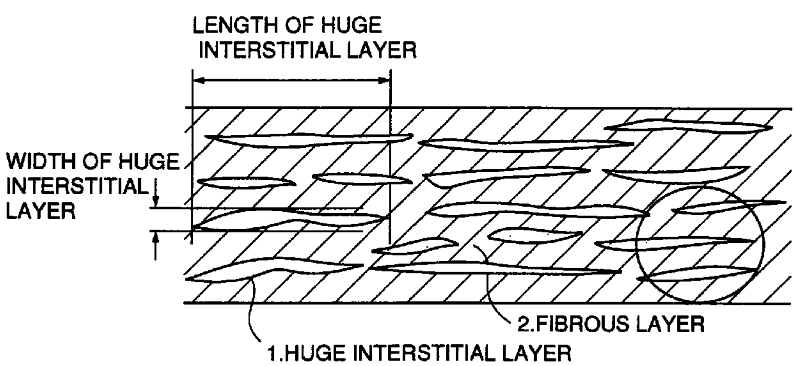
(54) Bulky nonwoven fabric

(57) An object of the invention to provide a melt-blown nonwoven fabric having superior bulkiness and flexibility attained by means of a nonwoven fabric consisting of thermoplastic fine fibers having a fiber diameter of 20 µm or less spun by a melt-blowing method, characterized in that huge interstitial layers having a width of 30 to 200 µm and a length of 50 to 30000 µm which contain no fiber present or which are mostly occupied by spaces if fiber(s) being present are distributed as plural layers in a cross-section of the nonwoven fabric, and that the said interstitial layers occupy 10 to 85% of a total area in an optional positional cross-sectional area having a cross-sectional area of at least 0.25cm^2 in the nonwoven fabric.

FIG.1

CROSS-SECTIONAL VIEW OF MELT-BLOWN NONWOVEN FABRIC



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Description

This invention relates to a bulky nonwoven fabric having superior flexibility and a composite nonwoven fabric with use thereof.

Nonwoven fabrics spun by a melt-blowing method (hereinafter abbreviated as melt-blown nonwoven fabrics) consisting of thermoplastic fine fibers having a fibrous diameter of 20 µm or less have hitherto been much used as filtrating materials of filters such as air filters and filters for liquid, surface materials for hygiene materials, clothings as well as carpet materials, or as basic fabrics for synthetic leathers. The reasons why the melt-blown fabrics being used in these applications are considered variously according to the respective applications, but a soft touch, a small fibrous diameter, a small hole diameter and a high open-hole rate are common to all.

Although melt-blown nonwoven fabrics have such many advantages, the said melt-blown nonwoven fabrics have too small fibrous diameter of constituting fibers and low bulkiness so that their applications may be much limited.

For example, the reason for using the melt-blown nonwoven fabrics in filter applications is a decreased mean flow pore size of the nonwoven fabrics, which make filters having good accuracy owing to much crossed fine fibers. Furthermore, it is easy to make a nonwoven fabric having a specified hole diameter, since a fibrous diameter can be controlled relatively freely according to preparation conditions. However, since it is difficult to increase a bulkiness of nonwoven fabrics in the conventional melt-blowing techniques, there is a disadvantage of increased loss in pressure.

Furthermore, melt-blowing nonwoven fabrics are much used as surface materials for hygiene materials, since they have proper touch properties. However, if the fibrous diameter becomes fine in order to make its touch better, the mean flow pore size becomes too small and the fabric becomes water repellent, wherein required water permeability may not be obtained in some cases. Furthermore, if the diameter of constituting fibers is made large to increase the mean flow pore size in order to increase the water permeability, flexibility becomes poor and also touch of nonwoven fabrics becomes bad, that is, they become unsuitable as surface materials for hygiene materials.

Furthermore, since melt-blown nonwoven fabrics have such properties that steam being easily permeable and water in a liquid form being difficultly permeable, they can be made to clean and comfortable products in which moisture being not filled and water being not permeated from outside when used in carpet materials and clothings. However, the conventional melt-blown nonwoven fabrics have certain levels of flexibility and touch but have low bulkiness, so that they are not always satisfactory.

Thus, even though melt-blown nonwoven fabrics have many characteristics, they have been used in limited applications owing to low bulkiness. It is desired in many fields to increase bulkiness of melt-blown nonwoven fabrics, but melt-blowing methods are highly special techniques and so it is difficult to increase bulkiness by the conventional techniques. Therefore, there were not so many propositions in order to solve this problem.

Some examples may be mentioned amongst of them, that is, a nonwoven fabric having a latent shrinkage property can be made by changing right and left lip air temperatures of melt-blowing dies in Japanese Patent Application Laid-open No. Hei 4-34061. However, in order to realize three-dimensional shrinkage in the said method, it is necessary to prepare fibers having a certain higher thickness, which may lose inherent advantages of the melt-blown nonwoven fabric, i.e. advantages owing to fine fibers. Furthermore, there has been proposed in Japanese Patent Publication No. Sho 61-30065 a method to prepare a fibrous web by mixing fine fibers with staple fibers having a shrinkage property. However, in this method a preparation cost increases owing to mixed fibers made by two different spinning methods, and also the prepared web has lost a soft touch of a fine fibrous nonwoven fabric, which being not preferable.

An object of the invention is to provide a fine fibrous nonwoven fabric having a high bulkiness not obtained by the conventional melt-blowing methods and a soft touch economically without changing a diameter of constituting fibers or fibrous raw materials in the nonwoven fabric.

This invention has the following constitutions in order to solve the above-mentioned problems.

(1) A nonwoven fabric consisting of thermoplastic fine fibers having a fiber diameter of 20 µm or less spun by a melt-blowing method, characterized in that huge interstitial layers having a width of 30 to 200 µm and a length of 50 to 30000 µm which contain no fiber present or which are mostly occupied by spaces if fiber(s) being present are distributed as plural layers in a cross-section of the nonwoven fabric, and that the said interstitial layers occupy 10 to 85% of a total area in an optional positional cross-section area having a cross-sectional area of at least 0.25cm^2 in the nonwoven fabric.

(2) A nonwoven fabric according to the above-mentioned item (1), wherein the thermoplastic fine fibers are at least one kind of fibers selected from polyolefin fibers and polyester fibers.

(3) A nonwoven fabric according to any of the above-mentioned item (1) or (2), wherein the thermoplastic fine fibers are composite thermoplastic fine fibers consisting of a low-melting resin and a high-melting resins having a temperature difference of 15°C or more.

(4) A nonwoven fabric according to any of the above-mentioned items (1) to (3), wherein the nonwoven fabric has a compressibility of 10% to 40% at a load of 25g/cm^2.

(5) A composite nonwoven fabric in which the nonwoven fabric according to any of the above-mentioned items (1) to (4) and at least one selected from films, nonwovens, knitted textiles and paper products are laminated.

Brief Description of Drawings

Fig. 1 is a cross-sectional view of a melt-blown nonwoven fabric according to the invention.

Fig. 2 is a partly enlarged view of the melt-blown nonwoven fabric in Fig. 1.

Fig. 3 is a graph to show a relationship between fibrous diameters and bulkinesses of the melt-blown nonwoven fabrics in Examples 1 to 4 and Comparative Examples 1 to 4.

This invention is illustrated in detail as follows.

As raw materials for the nonwoven fabric according to the invention, all thermoplastic resins spinnable by the general melt-blowing method can be used. As the said raw materials, there are mentioned thermoplastic resins, for example, polyolefin resins such as polypropylene, polyethylene, propylene copolymers (for example, propylene-based copolymers with at lead one of comonomer selected from ethylene, butene-1 and 4-methylpentene-1 etc.), polyester resins such as polyester and low-melting copolyesters, polyamides, polystyrene, polyurethane elastomers, polyester elastomers, polyphenylene sulfide etc. In the case that the invention being used for throwaway applications such as filters or hygiene materials etc., polyolefin resins and polyester resins are particularly preferable owing to balanced price and performance aspects.

Furthermore, the nonwoven fabric according to the invention may be the nonwoven fabric consisting of two components, that is, a low-melting resin and a high-melting resin having a melting point difference of 15°C or more, or multicomponent thermoplastic composite fibers. As combinations of these resins, there may be mentioned for example polyethylene/polypropylene, propylene copolymer/polypropylene, low-melting copolyester/polyester and polyethylene/polyester. Amongst of them, combinations of propylene copolymer/polypropylene and low-melting copolyester/polyester are particularly preferable, since they have a high bonding strength of each fibers by heat treatment so as to obtain a strong nonwoven fabric.

An average fibrous diameter of the melt-blown nonwoven fabric according to the invention may be any optional value between 0.3 to 20 μm, preferably 0.3 to 10 μm depending on selection of spinning conditions in the melt-blowing method. If the average fibrous diameter becomes more than 20 μm, flexibility may become poor and touch of the fabric may become worse, which are not preferable. Furthermore, it is difficult technically to make the said value less than 0.3 μm. Furthermore, a basis weight of the nonwoven fabric can be 4 to 700g/m^2.

The melt-blown nonwoven fabric according to the invention is characterized in that when the said nonwoven fabric is cut and an optional area having a cross-sectional area of more than 0.25cm^2 is selected, plural huge interstitial layers are contained in the said area. Furthermore, individual huge interstitial layers are characterized by having such sizes that a width being 30 to 200 μm and a length being 50 to 30000 μm. Model drawings of their cross-sectional constitutions are shown in Fig. 1 and Fig. 2. Huge interstitial layers 1 are distributed in fibrous layer 2 as plural band-like layers. These can be observed clearly by means of an electronic microscopy. And, a total cross-sectional area of the huge interstitial layers is characterized in that the area occupies 10 to 85% of the optionally selected cross-sectional area having more than 0.25cm^2.

The reason to limit the optionally selected area of 0.25cm^2 or more herein is as follows: since the cross-sectional constitution of the melt-blown nonwoven fabric according to the invention is divided into the huge interstitial layers and others, either of the huge interstitial layers or others is only contained in a small cross-sectional area of less than 0.25cm^2 and the above-mentioned condition, i.e., that the proportion of the huge interstitial layers should be 10 to 85%, may not be satisfied. Furthermore, if the total cross-sectional area of the huge interstitial layers being less than 10% of the optionally selected area having 0.25cm^2 or more, bulkiness, the characteristic of the invention, is lost. Furthermore, if it being more than 85%, the nonwoven fabric becomes very weak by an external force, which is not preferable.

It is denied that any fiber cannot be completely present in the huge interstitial layers, and sometimes one to several fiber(s) may be contained. This phenomenon may occur, because constitutional fibers of the melt-blown fabric are oriented in random directions and several fibers thereof may be accidentally mixed into the huge interstitial layers.

Since the huge interstitial layers 1 of the nonwoven fabric according to the invention are distributed in fibrous layer 2 as plural band-like layers as seen from the above-mentioned Fig. 1 and Fig. 2, the layers contribute much to improve bulkiness and simultaneously flexibility of the nonwoven fabric.

Additionally, the nonwoven fabric according to the invention has no touch resistance owing to a superior free deformation property against an external power owing to the presence of the huge interstitial layers, and also the fabric has both of bulkiness and soft touch different from the conventional melt-blown nonwoven fabrics owing to a superior recovering property. That is, the nonwoven fabric according to the invention has an extremely flexible and soft touch which cannot be obtained by the conventional melt-blown nonwoven fabrics at all. Therefore, useful developments can be expected in applications of absorbing products such as paper diapers, a clothing field in which fitting and draping properties being required, as well as in applications for wiping cloths used for polishing/cleaning etc.

Furthermore, the nonwoven fabric according to the invention has characteristics such as an eminently superior gas permeability and a warmth keeping property, since the total cross-sectional area of the huge interstitial layers occupies a large proportion such as 10 to 85% at the cross-sectional area of more than 0.25cm^2 in the nonwoven fabric so that air is present in the said huge interstitial layers.

Furthermore, the nonwoven fabric according to the invention has such a characteristic that a compressibility relative to the original thickness of the nonwoven fabric being 10% to 40% at a load of 25g/cm^2. The nonwoven fabric according to the invention is superior in its free deformation property against an external power, since the fabric has such high shrinkage. If the said shrinkage being less than 10%, there is no difference from the conventional melt-blown nonwoven fabric, and the characteristic of free deformation property against an external power is lost, which being not preferable for the object. Furthermore, it is technically difficult to increase the said shrinkage more than 40%.

The nonwoven fabric according to the invention can be laminated with a film, nonwovens, a knitted textile or a paper product, to obtain a composite nonwoven fabric. As raw materials for the nonwoven films, all thermoplastic resins spinnable by the general melt-blowing method can be used, for example, polyolefin resins such as polypropylene and polyethylene, polyester resins such as polyester and low-melting copolymerized esters, polyamides, polystyrene, polyurethane elastomers, polyester elastomers, polyphenylene sulfide and polytetrafluoroethylene etc. As the said films, all films can be used including uniaxial stretched films, biaxial stretched films and porous films made by mixing and stretching liquid paraffin. Furthermore, as non-fibrous assemblies, there are mentioned short-fibrous nonwoven fabrics such as carding processed nonwoven fabrics, needle punch processed nonwoven fabrics, water needle punch processed nonwoven fabrics and air-laid nonwoven fabrics, melt-blown nonwoven fabrics, nonwoven fabrics made by nonweeving of molten resins directly such as spun bonded nonwoven fabrics, as well as glass fibrous nonwoven fabrics.

In order to laminate the nonwoven fabric according to the invention with the above-mentioned film, nonwovens, knitted textile or paper product and to make a composite nonwoven fabric, all or one part of the nonwoven fabric may be adhered by heat and/or pressure by using a calender roll or an embossing roll, or may be adhered by using a binder such as a hot-melting agent or an adhesive. In the case that the fabrics according to the invention are used for applications contacting directly with human body such as clothing materials or hygiene materials, it is desirable to adhere by means of an emboss roll from view points of touch and hygiene aspects.

As one method to arrange such huge interstitial layers in the melt-blown nonwoven fabric, there is mentioned a method in which a blowing air stream of melt-blowing is made as a strong turbulent flow state just below holes of a nozzle by devising a constitution of a melt-blowing die or controlling forcedly an accompanying stream just below the nozzle. When the melt-blown nonwoven fabric is made by this method, such huge interstitial layers can be arranged in the melt-blown nonwoven fabric during a spinning procedure, which being very superior in quality stability and cost of the product.

A method to make a blowing air stream of melt-blowing as a turbulent state just below holes of a nozzle is not limited particularly, but a method for controlling an accompanying stream forcedly just below a nozzle is illustrated as one example thereof. In the melt-blowing method, polymer discharged from the nozzle is finely divided by blowing it with hot air. In the general melt-blowing method, an air stream just below the nozzle is oriented in a specified direction since an air stream speed is very fast such as several hundred meters per minute. However, if hot air is jetted against a nozzle by means of another hot air jetting device, the stream conflicts with the hot air from the nozzle and becomes a strong turbulent state.

Generally the temperature of the hot air jetted against the nozzle at that time is desirably the similar temperature to the temperature of the blowing air stream jetted from the nozzle, depending on the direction of jetting and stream speed. If the said temperature is extremely lower than the temperature of the blowing air stream, the discharged resin may solidify before fibers being sufficiently finely divided, so that they may not become sufficiently fine fibers. Conversely, if the said temperature is extremely higher than the temperature of the blowing air stream, obtained fibers extruded from the nozzle may be melt-adhered, which being not preferable. Furthermore, a speed for jetting hot air is not particularly limited, but if the air speed is too fast, the discharged resin may be unpreferably scattered, and conversely if the air speed is too slow, a sufficient turbulent stream may not be produced.

The reason why the melt-blown nonwoven fabric becomes the above mentioned constitution containing the huge interstitial layers by the said turbulent stream is not completely clarified, but can be explained as follows. When the blowing air stream is made as a strong turbulent state just below a nozzle, change of an air speed may not necessarily completely random, but it is considered to be changed according to a certain regulation at a very short intermittent period. Therefore, it is considered that the dispersed state of the finely divided fibers changes delicately, thus to form dense parts and sparse parts of fibers within the nonwoven fabric and form fibrous layers from the dense parts and huge interstitial layers from the sparse parts. By such mechanism, these constitutions can be made in one procedure.

Examples

The invention is illustrated by Examples as follows, but the invention is not limited to them. Definitions and determination methods of physical properties of fibers etc. in the present Examples are as follows.

[Basis weight]

A nonwoven fabric is cut into a size of length 25cm × width 25cm, and weight thereof (g) is determined. Then, a basis weight of the nonwoven fabric is calculated from the following equation:

$$\text{basis weight (g/m}^2) = \text{weight of nonwoven fabric (g)} \times 16,$$

wherein n=20.

[Thickness]

As to the twenty nonwoven fabrics used in determination of a basis weight, a thickness (μm) under a load of 2gf/cm^2 is determined at five points per one piece of the nonwoven fabrics. Then, an average value of three points is calculated after excluding maximum and minimum values of the five points, and the similar operations are carried out as to other nonwoven fabrics, from which an average value of twenty data obtained from these twenty nonwoven fabrics is calculated and the said average value is used as a thickness (μm) of the nonwoven fabric.

[Air permeability]

An air permeability (cc/cm^2/sec) of the central part of the nonwoven fabric used for determination of a basis weight is calculated according to JIS L 1096-A method. (n=20)

[Compressibility]

Compression is carried out using a handy compression tester KES-G5 made by Katotech Co. Ltd. under such conditions that a compression speed being 0.01cm/second and maximum load being 25gf/cm^2, and a thickness is determined at a load of 25gf/cm^2. Then, compressibility (%) is calculated from the following equation by using the said thickness and the thickness obtained by the above-mentioned method at 2gf/cm^2:

$$\text{Compressibility (\%)} = 100\ [1-\{\text{thickness at load of 25gf/cm}^2(\mu\text{m})/\text{thickness at load of 2gf/cm}^2(\mu\text{m})\}].$$

[Mean flow pore size]

A mean flow pore size (μm) of the central part of the nonwoven fabric used for determination of a basis weight is calculated according to ASTM F316-86 method. (n=20)

[Melt flow rate (MFR)]

It is measured according to JIS K 7120 method. Herein, there are used such conditions that a test temperature being 230°C and a test load being 2.16kgf. (n=3)

[Average fibrous diameter]

100 constitutional fibers of the nonwoven fabric are selected randomly with observing by an electronic microscope, and an average value Σ (di)/100 of their diameters di (μm) is defined as an average fibrous diameter (μm).

[Bulkiness]

The respective bulkiness (cc/g) is calculated from the following equation by using the basis weight and the thickness of the nonwoven fabric cut into length of 25cm × width of 25cm determined by the above-mentioned methods:

$$\text{Bulkiness (cc/g)} = \text{thickness } (\mu\text{m})/\text{basis weight (g/m}^2).$$

[Width and length of huge interstitial layers as well as rate of total area]

The nonwoven fabric is cut to make small pieces, which pieces are frozen in liquid nitrogen and divided by means of a razor. The cut cross-sections are observed by an electronic microscope and images of 0.5cm × 0.5cm selected randomly are photographed. (n=3). In these photographs, spaces having a width of more than 10 μm and a length of more than 20 μm are defined as huge interstitial layers, and then the length, the width and the area of all huge interstitial layers in photographs are determined by an image analysing machine. And, average values of the length and the width of the respective huge interstitial layers are defined as the length and the width of huge interstitial layers in the nonwoven fabric. Furthermore, a value obtained by adding the areas of the respective huge interstitial layers and dividing by $0.25cm^2$, i.e. the area of the image photograph, is defined as an interstitiality relative to the total area of the nonwoven fabric at a cross-sectional area of $0.25cm^2$.

Examples 1 to 4

As a melt-blowing die, there was used a die having a total hole number of 501 which has a resin discharging hole with a hole diameter of 0.3mm and in which spinning holes are arranged in one line. A distance between hot-air jetting slits was set at 0.3mm. Polypropylene having MFR of 80g/10 minutes and a melting point of 165°C was used as a raw material and spun under such conditions that a spinning temperature being 280°C, a discharging amount being 120g/minute and a temperature of a blowing air stream being 350°C. Then, hot-air was jetted from an oblique lower part of a nozzle against the nozzle at a temperature of 350°C and a wind velocity of 10m/second, and a finely divided resin was blown onto a conveyer net equipped with a suction device, to obtain a fine melt-blown nonwoven fabric having a basis weight of $30.0g/m^2$. By changing pressure of the blowing air stream at $0.82kgf/cm^2 \cdot G$ (Example 1), $1.25kgf/cm^2 \cdot G$ (Example 2), $1.45kgf/cm^2 \cdot G$ (Example 3) and $1.55kgf/cm^2 \cdot G$ (Example 4) respectively, spinning operations were carried out. Results thereof are shown in Table 1 and Figure 3. Amongst of them, the melt-blown nonwoven fabric in Example 4 has such a bulkiness not obtained by the conventional melt-blown nonwoven fabrics, and has a proper water permeability when used as a surface material for a hygiene material.

Example 5

Spinning was carried out by the same method as in Example 4 to obtain a fine melt-blown nonwoven fabric having a basis weight of $30.0g/m^2$, except that polyester having a inherent viscosity of 0.61 and a melting point of 253°C was used as a raw material, that a spinning temperature was 300°C and that a pressure of blowing air stream was $1.8kgf/cm^2 \cdot G$. The results thereof are shown in Table 1. While the said nonwoven fabric had the same degree of bulkiness as in Example 4, it had less thermal shrinkage and more superior thermal stability than in Example 4.

Example 6

Spinning was carried out by the same method as in Example 4 to obtain a fine melt-blown nonwoven fabric having a basis weight of $30.0g/m^2$, except that a temperature of hot-air jetted from an oblique lower part of a nozzle against the nozzle was 350°C and that a wind velocity was 13m/second. The results thereof are shown in Table 1. The said nonwoven fabric had more superior bulkiness than in Example 4.

Example 7

Spinning was carried out by the same method as in Example 4 to obtain a fine melt-blown nonwoven fabric having a basis weight of $30.0g/m^2$, except that a temperature of hot-air jetted from an oblique lower part of a nozzle against the nozzle was 350°C and that a wind velocity was 15m/second. The results thereof are shown in Table 1. The said nonwoven fabric had more superior bulkiness than in Example 4.

Examples 8

As a melt-blow die, there was used a side-by-side type melt-blowing die having a total hole number of 501 which has a resin discharging hole with a hole diameter of 0.3mm and in which spinning holes are arranged in one line. Spinning was carried out by the same method as in Example 4 to obtain a fine melt-blown nonwoven fabric having a basis weight of $30.0g/m^2$, except that there were used polypropylene having MFR of 80g/10 minutes and a melting point of 165°C as a high-melting component as well as propylene ethylene-butene-1 random copolymer having MFR of 65g/10 minutes and a melting point of 138°C as a low-melting component and that the respective components were extruded at 60g/minute. Results thereof are shown in Table 1. While the said nonwoven fabric had the same degrees of basis weight, thickness and water permeability as in Example 4, it is heat-sealable at a low temperature, so that it was suitable for a hygiene material.

Example 9

The melt-blown fabric obtained in Example 4 was adhered to a spun-bonded nonwoven fabric made of polypropylene having a fibrous diameter of 6 denier and a basis weight of $4g/cm^2$, to obtain a composite nonwoven fabric made of polypropylene having a total basis weight of $34g/cm^2$. While the said nonwoven fabric had a superior size stability, it had the same superior water permeability and mean flow pore size as in Example 4.

Example 10

First, sheath-core type composite fibers (the sheath part being propylene-ethylene-butene-1 random terpolymer and the core part being propylene homopolymer) having a fiber diameter of 6 denier and a fiber length of 32mm were passed through a carding machine, to obtain a heat adhesive carding web having a basis weight of $10g/cm^2$. The said web and the melt-blown nonwoven fabric obtained in Example 4 were adhered by means of an embossing roll, to obtain a composite fabric made of polypropylene having a total basis weight of $40g/cm^2$. While the said nonwoven fabric had a superior size stability, it had the same superior water permeability and mean flow pore size as in Example 4.

Comparative Examples 1 to 4

Spinning operations were carried out with the similar raw materials and conditions to Example 1 to obtain fine melt-blown nonwoven fabrics having a basis weight of $30.0g/m^2$, except that hot-air was not jetted from an oblique lower part of a nozzle against the nozzle and that pressures of blowing air stream were $0.81kgf/cm^2 \cdot G$ (Comparative Examples 1), $1.39kgf/cm^2 \cdot G$ (Comparative Examples 2), $1.45kgf/cm^2 \cdot G$ (Comparative Examples 3) and $1.57kgf/cm^2 \cdot G$ (Comparative Examples 4). Results thereof are shown in Table 1 and Figure 3.

TABLE 1

	PRESSURE OF BLOWING AIR STREAM (kg/cm²)	WIND VELOCITY OF HOT AIR FROM THE LOWER PART (m/sec.)	BASIS WEIGHT (g/m²)	THICKNESS (μm)	HUGE INTERSTITIAL LAYER			AIR PERMEA-BILITY (cc/cm²/sec)	COMPRESS-IBILITY (%)	MEAN FLOW PORE SIZE (μm)	AVERAGE FIBROUS DIAMETER (μm)	BULKI-NESS (cc/g)
					WIDTH (μm)	LENGTH (μm)	PROPORTION TO TOTAL AREA (%)					
EXAMPLE1	0.82	10	30	840	65	417	17	81.2	15	57	2.9	28
EXAMPLE2	1.25	10	30	950	88	564	23	82.3	17	58	2.6	32
EXAMPLE3	1.45	10	30	980	96	613	25	81.7	17	57	2.5	33
EXAMPLE4	1.55	10	30	1050	107	687	28	70.0	18	49	2.0	35
EXAMPLE5	1.80	10	30	1030	103	662	27	69.5	18	49	2.0	34
EXAMPLE6	1.55	13	30	1160	130	834	34	82.0	20	57	2.0	39
EXAMPLE7	1.55	15	30	1165	132	833	34	90.0	20	63	2.0	39
EXAMPLE8	1.55	10	30	1020	92	589	24	69.5	17	48	2.0	34
EXAMPLE9	1.55	10	34	1060	84	540	22	68.5	16	48	2.0	31
EXAMPLE10	1.55	10	40	1070	84	540	22	68.0	16	48	2.0	31
COMPARA. EXAMPLE1	0.81	-	30	480	-	-	-	48.0	8	34	3.0	16
COMPARA. EXAMPLE2	1.39	-	30	540	-	-	-	43.2	9	30	2.4	18
COMPARA. EXAMPLE3	1.45	-	30	550	-	-	-	42.2	10	30	2.3	18
COMPARA. EXAMPLE4	1.57	-	30	570	-	-	-	39.9	10	28	2.1	19

As clear from Figure 3, amongst of the nonwoven fabrics according to the invention, the melt-blown nonwoven fabrics in Examples 1 to 4 had about 2.1 times of bulkiness compared with the melt-blown nonwoven fabrics in Comparative Examples 1 to 4 having the same fibrous diameters. In particular, the fabric in Example 4 had the water permeability hitherto not attained in the melt-blown nonwoven fabric having a fibrous diameter of 2 μm or less.

The nonwoven fabric according to the invention has both of a superior bulkiness and a soft touch which have not been attained in the conventional melt-blown nonwoven fabrics, since there are present huge interstitial layers which contain no fiber present or which are mostly occupied by spaces if fiber(s) being present. Furthermore, in addition to the said bulkiness and soft touch, a water permeability and a warmth keeping property are superior, so that wide useful developments can be expected in a hygiene field such as absorbing products and a clothing field in which a fitting property and a draping property being required, as well as expected as wiping cloths for polishing and cleaning etc.

Claims

1. A nonwoven fabric consisting of thermoplastic fine fibers having a fiber diameter of 20 μm or less spun by a melt-blowing method, characterized in that huge interstitial layers having a width of 30 to 200 μm and a length of 50 to 30000 μm which contain no fiber present or which are mostly occupied by spaces if fiber(s) being present are distributed as plural layers in a cross-section of the nonwoven fabric, and that the said interstitial layers occupy 10 to 85% of a total area in an optional positional cross-section area having a cross-sectional area of at least $0.25cm^2$ in the nonwoven fabric.

2. A nonwoven fabric according to Claim 1, wherein the thermoplastic fine fibers are at least one kind of fibers selected from polyolefin fibers and polyester fibers.

3. A nonwoven fabric according to any of Claim 1 or 2, wherein the thermoplastic fine fibers are composite thermoplastic fine fibers consisting of a low-melting resin and a high-melting resins having a temperature difference of 15°C or more.

4. A nonwoven fabric according to any of Claims 1 to 3, wherein the nonwoven fabric has a compressibility of 10% to 40% at a load of $25g/cm^2$.

5. A composite nonwoven fabric in which the nonwoven fabric according to any of Claims 1 to 4 and at least one selected from films, nonwovens, knitted textiles and paper products are laminated.

FIG.1

CROSS-SECTIONAL VIEW OF MELT-BLOWN NONWOVEN FABRIC

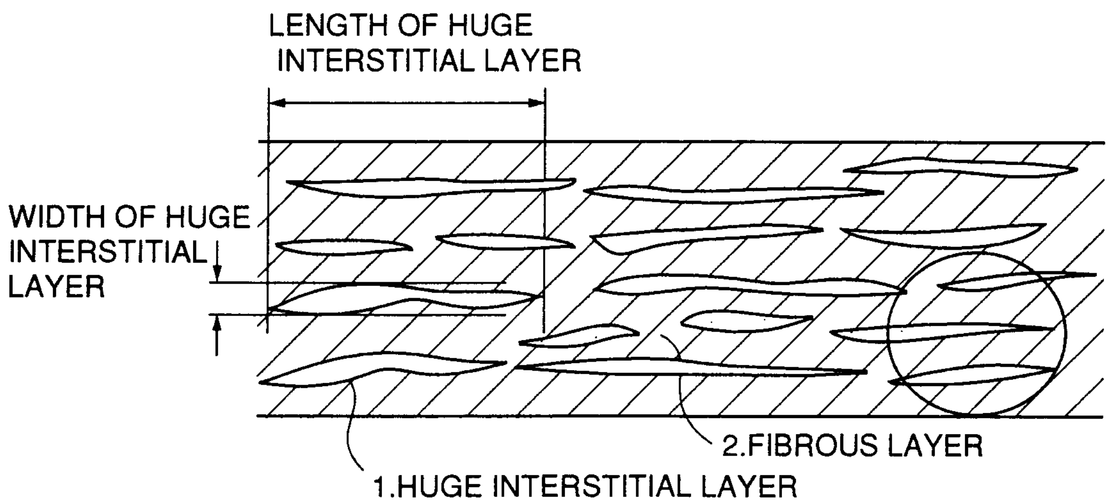
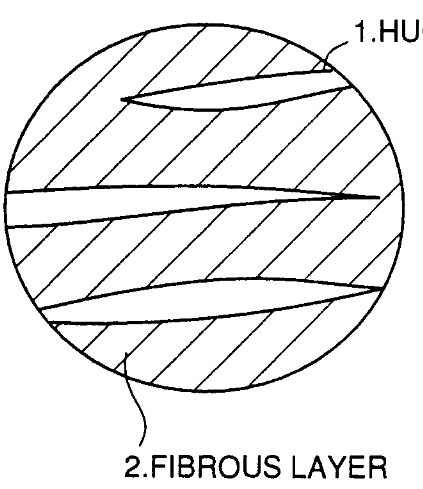


FIG.2

ENLARGED VIEW OF FIG.1,A PART



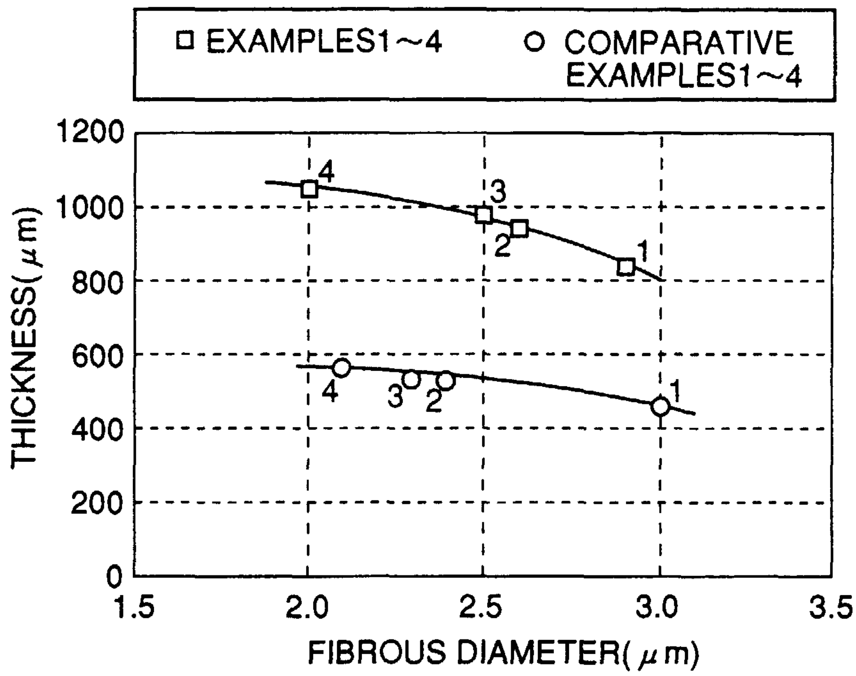
a. TOTAL CROSS-SECTIONAL AREAS OF HUGE INTERSTITIAL LAYERS
  ··· TOTAL AREAS OF □ PARTS IN THE ABOVE-MENTIONED FIGURE

b. OPTIONALLY SELECTED AREA OF MORE THAN 0.25 SQUARE CENTIMETER
  ··· TOTAL AREA WITHIN THE CIRCLE IN THE ABOVE-MENTIONED FIGURE

c. PROPORTION OF TOTAL CROSS-SECTIONAL AREAS OF HUGE INTERSTITIAL LAYERS TO OPTIONALLY SELECTED AREAS OF MORE THAN 0.25 SQUARE CENTIMETER
  ···a/b × 100%

FIG.3

RELATIONSHIP BETWEEN FIBROUS DIAMETER AND THICKNESS



NUMBERS IN THE GRAPH SHOW EXAMPLE OR COMPARATIVE EXAMPLE NUMBERS

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 4181

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	GB 1 579 568 A (MINNESOTA MINING & MFG) 19 November 1980 * the whole document * ---	1	D04H1/56 D04H1/72 D04H3/03
D,A	DATABASE WPI Section Ch, Week 9212 Derwent Publications Ltd., London, GB; Class A32, AN 92-091816 XP002070720 & JP 04 034 061 A (TOYOBO KK) * abstract * ---	1	
P,A	US 5 667 749 A (LAU JARK CHONG ET AL) 16 September 1997 * the whole document * ---	1-5	
P,A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 010, 31 October 1997 & JP 09 170150 A (TOYOBO CO LTD), 30 June 1997, * abstract * ---	1-5	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
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A	US 4 409 282 A (FUJII SHIGEO ET AL) 11 October 1983 * the whole document * ---	1	
A	DATABASE WPI Section Ch, Week 8849 Derwent Publications Ltd., London, GB; Class A88, AN 88-351059 XP002070732 & JP 63 264 073 A (TOYOBO KK) * abstract * -----	1-5	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 July 1998	Barathe, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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