

DESCRIPTION**SPUNBOND NONWOVEN CLOTH****5 Technical Field**

[0001]

The present invention relates to a spunbond nonwoven cloth subjected to an embossing process.

Background Art

10 [0002]

Hitherto, a nonwoven cloth has been used as a sheet member configuring, for example, an absorptive article such as a disposable diaper or a urine absorbing pad.

Since the nonwoven cloth constituting a disposable diaper or the like is, for example, an article which comes in direct contact with the skin of a baby, the nonwoven cloth

15 particularly needs excellent flexibility and texture.

[0003]

In this regard, a fiber diameter of a fiber constituting the nonwoven cloth or a weight of the nonwoven cloth is generally known as a factor deciding the flexibility of the nonwoven cloth. Further, it is known that, although nonwoven clothes have the same fiber diameter or the same weight, the flexibility of the nonwoven cloth is improved by performing an embossing process on the nonwoven cloth (for example, Patent Literature 1). In general, the embossing process means a process in which a nonwoven cloth is introduced between an embossing roll having a plurality of embossments (protrusions) on the surface thereof and an anvil roll having a smooth surface, and asperities are imparted to the nonwoven cloth by press pressure of both

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rolls. When the embossing process is performed, the linking between fibers constituting the nonwoven cloth is broken or the surface area, which comes in direct contact with the skin of a wearer, of the nonwoven cloth becomes small. Therefore, it is possible to achieve a sensory evaluation result that flexibility of the nonwoven cloth is improved.

Citation List

Patent Literature

[0004]

10 Patent Literature 1: WO 2007/091444 A1

Summary of Invention

Technical Problem

[0005]

15 However, although flexibility can be imparted to some extent by performing the embossing process on the nonwoven cloth, stiffness or elasticity of the nonwoven cloth is reduced or fuzz is prominent on the surface of the nonwoven cloth. As a result, drape is poor. In this regard, even in a case where a disposable diaper is formed by such a nonwoven cloth, good wearing feeling cannot be provided. For these reasons, 20 the nonwoven cloth needs to maintain favorable drape in comprehensive consideration of stiffness, elasticity, fuzz, or the like as well as flexibility.

[0006]

Here, in general, it is known that the stiffness of the nonwoven cloth depends on the bend stiffness of the nonwoven cloth and the elasticity of the nonwoven cloth is 25 influenced by compression characteristics of the nonwoven cloth. However, when the

bend stiffness of the nonwoven cloth is enhanced by adjusting the fiber diameter or weight of the constituent fibers of the nonwoven cloth in order to impart favorable stiffness to the nonwoven cloth, the compression characteristics of the nonwoven cloth are deteriorated instead. As a result, there is a problem in that the elasticity of the nonwoven cloth is impaired. On the other hand, when the compression characteristics of the nonwoven cloth are enhanced in order to impart favorable elasticity to the nonwoven cloth, there is a problem in that the bend stiffness of the nonwoven cloth is reduced and thus the stiffness of the nonwoven cloth is deteriorated. As described above, in the related art, it is difficult to set both of the bend stiffness and the compression characteristics of the nonwoven cloth to appropriate ranges.

[0007]

In this regard, a technical object of the invention is to overcome the above-described problems in the related art and to provide a spunbond nonwoven cloth subjected to an embossing process, the nonwoven cloth exhibiting appropriate performance such as flexibility, stiffness, or elasticity, and being excellent in drape.

Solution to Problem

[0008]

The present inventors conducted intensive studies on a means for solving the above-described technical problem, and as a result, found that, by adjusting physical configurations of embossments to be imparted to the nonwoven cloth or chemical configurations of the constituent fibers of the nonwoven cloth, it was possible to obtain a nonwoven cloth having recovery relative to compression regardless of high stiffness relative to bending. That is, although the bend stiffness was higher than that of a spunbond nonwoven cloth in the related art, in a case where the compression

characteristics were within a specific range, it was possible to obtain a spunbond nonwoven cloth evaluated to have excellent drape by sensory evaluation as compared to the spunbond nonwoven cloth of the related art. Thus, the present inventors perceived that the technical problems in the related art could be solved based on the above findings and completed the invention.

Specifically, the invention has the following configurations.

[0009]

The invention relates to a spunbond nonwoven cloth. The spunbond nonwoven cloth of the present invention is obtained by spinning and accumulating a thermoplastic resin into continuous fibers, after which spaces between the fibers are heated and compressed using an embossing roll provided with a plurality of embossments aligned in the flow direction of the fibers and a perpendicular direction thereof.

Here, an embossing area ratio of embossment to be imparted to the nonwoven cloth is 5 to 12%.

In addition, a minimum distance between adjacent embossments is 1.5 to 3 mm.

Further, a bend stiffness index (bend stiffness $[g/cm^2/cm]/weight [g/m^2] \times 10^4$ using a KES bend stiffness test machine) is 5 to 15 cm^{-1} .

Furthermore, a compression resilience (RC%) using a KES compression characteristic test machine is 60 to 75%.

[0010]

As in the above configuration, although the spunbond nonwoven cloth has a relatively high bend stiffness index, when compression characteristics (compression resilience) are maintained within the above-described predetermined range, contrary to expectations, it is possible to achieve a sensory evaluation result of excellent drape

compared to a spunbond nonwoven cloth in the related art. In the above configuration, physical characteristics of embossments to be imparted to the nonwoven cloth are specified as a factor for maintaining the compression characteristics within the predetermined range. That is, as in the above configuration, the configuration in which the embossing area ratio is set to be relatively small and the minimum distance between adjacent embossments is set to be relatively large causes that the bend stiffness index of the spunbond nonwoven cloth is relatively increased and the compression resilience is adjusted to a relatively high value. In this way, when embossments are imparted to the spunbond nonwoven cloth and the bend stiffness index and the compression resilience are set within the range of values unique to the invention, it is possible to provide a nonwoven cloth exhibiting appropriate performance such as flexibility, stiffness, or elasticity and being excellent in drape.

[0011]

Subsequently, the chemical configurations of the fiber constituting the spunbond nonwoven cloth of the present invention will be described. When the constituent fibers have the chemical configurations which will be described below, the bend stiffness index and the compression resilience can be adjusted within the range of values unique to the invention.

[0012]

That is, it is preferable that the thermoplastic resin forming the spunbond nonwoven cloth is a polypropylene resin.

In addition, it is preferable that the polypropylene resin includes low crystalline polypropylene and high crystalline polypropylene.

Here, it is preferable that the content of the low crystalline polypropylene is 5 to 50 wt% based on the total value of the contents of the low crystalline polypropylene

and the high crystalline polypropylene.

Further, it is preferable that a melt flow rate of the low crystalline polypropylene is 30 to 70 g/10 min.

Furthermore, it is preferable that a melt flow rate of the high crystalline polypropylene is 20 to 100 g/10 min.

[0013]

As described above, the spunbond nonwoven cloth of the present invention is produced by a polypropylene resin composition containing low crystalline polypropylene and high crystalline polypropylene. Incidentally, in the present invention, the low crystalline polypropylene indicates a crystalline polypropylene whose stereoregularity is moderately disturbed, and specifically, a polypropylene satisfying the following characteristics is used.

[0014]

That is, the low crystalline polypropylene to be used in the present invention has a meso pentad fraction [mmmm] of 30 to 80 mol%.

In addition, a racemic pentad fraction [rrrr] and $[1 - \text{mmmm}]$ satisfy a relation $[\text{rrrr}]/[1 - \text{mmmm}] \leq 0.1$.

Further, a racemic-meso-racemic-meso pentad fraction [rmmr] exceeds 2.5 mol%.

Further, a mesotriad fraction [mm], a racemic triad fraction [rr], and a triad fraction [mr] satisfy the relation $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2 \leq 2.0$.

Further, a weight-average molecular weight (M_w) is 10,000 to 200,000.

Further, a molecular weight distribution (M_w/M_n) is less than 4.

Furthermore, an amount of components extractable with boiling diethyl ether is 0 to 10 wt%.

[0015]

In addition, a fiber diameter of the constituent fiber is exemplified as a factor for adjusting the bend stiffness index and the compression resilience within the range of values unique to the invention. Specifically, a fiber diameter of the constituent fiber of the spunbond nonwoven cloth of the present invention is preferably 0.5 to 1 dtex.

[0016]

Further, it is preferable that the spunbond nonwoven cloth of the present invention contain a lubricant in a fiber layer forming at least one surface of the front surface and the rear surface of the nonwoven cloth.

Advantageous Effects of Invention

[0017]

The present invention can provide a spunbond nonwoven cloth subjected to an embossing process, the nonwoven cloth exhibiting appropriate performance such as flexibility, stiffness, or elasticity, and being excellent in drape.

Brief Description of Drawings

[0018]

Fig. 1 is a schematic perspective view illustrating an example of embossment.

Fig. 2 is a schematic plan view illustrating an example of an embossment pattern.

Figs. 3(a) to 3(c) are schematic plan views illustrating an example of a dot-shaped embossment pattern.

Figs. 4(a) and 4(b) are schematic plan views illustrating an example of a linear embossment pattern.

Figs. 5(a) and 5(b) are schematic plan views illustrating the arrangement of embossment patterns used in Examples.

Description of Embodiments

5 [0019]

Hereinafter, an embodiment for carrying out the invention will be described by means of the drawings. The invention is not limited to an embodiment to be described below and encompasses modifications conceived by a person skilled in the art based on the following embodiment with a self-evident range.

10 Incidentally, in the present specification, the expression "A to B" means "A or more but B or less" unless otherwise specified.

[0020]

(1. Spunbond Nonwoven Cloth)

A spunbond nonwoven cloth of the present invention is obtained by spinning
15 and accumulating a thermoplastic resin into a continuous fiber, after which the spaces between the fibers are heated and compressed using an embossing roll provided with a plurality of embossments aligned in the flow direction of the fiber and the perpendicular direction thereof. For example, the spunbond nonwoven cloth is produced in such a manner that a group of long fibers discharged from a melt spinneret is first introduced
20 into an air sucker or the like, drawn and opened, and collected on a conveyer, thereby obtaining a fibrous web. Thereafter, the spaces between the groups of long fibers forming the fibrous web are bonded to each other by an appropriate unit, thereby producing the spunbond nonwoven cloth. In particular, the spunbond nonwoven cloth of the present invention is produced in such a manner that asperities regularly aligned in
25 the flow direction of the conveyor and the perpendicular direction thereof are imparted

by an embossing process and the spaces between the groups of long fibers forming the fibrous web are thermally bonded to each other. Since a binder is not used for fixation of the spaces between long fibers, the spunbond nonwoven cloth obtained by the embossing process has less stimulus to skin and has an advantage of excellent flexibility as compared to a spunbond nonwoven cloth obtained by hot-air heating. The nonwoven cloth of the present invention is obtained in such a manner that a fibrous web is introduced between a heated embossing roll having protruding embossments and an anvil roll having a smooth surface, the fibrous web is heated and compressed by press pressure of both rolls, and the spaces between groups of long fibers are thermally fused at portions corresponding to the protrusions of the embossing roll.

[0021]

In the spunbond nonwoven cloth of the present invention, physical configurations of the embossment to be imparted to the nonwoven cloth and chemical configurations of the constituent fibers of the nonwoven cloth are adjusted such that the bend stiffness index and the compression resilience (compression recovery ratio) are within a predetermined range.

[0022]

[Bend Stiffness Index]

The spunbond nonwoven cloth of the present invention has a bend stiffness index of 5 to 15 cm^{-1} . In the present specification, the bend stiffness index is expressed by the formula: bend stiffness $[\text{g}/\text{cm}^2/\text{cm}]/\text{weight} [\text{g}/\text{m}^2] \times 10^4$, obtained by using a KES bend stiffness test machine. That is, the bend stiffness index is defined as the range of the amount obtained by standardizing, with weight $[\text{g}/\text{m}^2]$, the bend stiffness $[\text{g}/\text{cm}^2/\text{cm}]$ (which can be measured by the KES bend stiffness test machine) of the spunbond nonwoven cloth. The bend stiffness index $[\text{cm}^{-1}]$ is an indicator mainly

representing stiffness or resilience of the spunbond nonwoven cloth. When the bend stiffness index is 5 cm^{-1} , stiffness is not generated in the spunbond nonwoven cloth, and feeling during contact of the skin is deteriorated. Accordingly, the drape of the nonwoven cloth is impaired. On the other hand, when the bend stiffness index exceeds 15 cm^{-1} , the texture of the spunbond nonwoven cloth becomes hard and thus the drape of the nonwoven cloth is poor. For these reasons, the bend stiffness index of the spunbond nonwoven cloth of the present invention is preferably 5 to 15 cm^{-1} , may be 6 to 14 cm^{-1} or 7 to 13 cm^{-1} , and particularly preferably 6 to 10 cm^{-1} . Here, the spunbond nonwoven cloth of the invention exhibits a bend stiffness index of 5 to 15 cm^{-1} , that is, has a relatively high bend stiffness index. When the spunbond nonwoven cloth exhibits the bend stiffness index as described in the present invention, in general, there is a tendency that the texture becomes hard and the drape is impaired. However, in the spunbond nonwoven cloth of the present invention, as described below, the compression resilience (compression recovery ratio) can be maintained to a relatively high value. Therefore, the spunbond nonwoven cloth of the invention becomes a nonwoven cloth having sufficient elasticity regardless of strong stiffness, and it is possible to achieve an excellent drape evaluation result by sensory evaluation as compared to a spunbond nonwoven cloth in the related art.

[0023]

[Compression Resilience]

The spunbond nonwoven cloth of the present invention has a compression resilience (RC%) of 60 to 75%. A case where the value of the compression resilience (RC%) is close to 100% means that the recovery property relative to compression is favorable, and the compression resilience is an indicator mainly representing the elasticity of the spunbond nonwoven cloth. Although the spunbond nonwoven cloth of

the present invention has relatively high bend stiffness, by maintaining the compression resilience within the above-described specific range, the spunbond nonwoven cloth can achieve an evaluation result of excellent drape as compared to a spunbond nonwoven cloth in the related art. That is, since the bend stiffness index of the spunbond nonwoven cloth of the present invention is relatively high, that is, 5 to 15 cm⁻¹, when the compression resilience (RC%) is less than 60%, elasticity of the nonwoven cloth is not generated and hard texture is directly transmitted to the skin. Accordingly, drape is impaired. On the other hand, since the bend stiffness of the spunbond nonwoven cloth of the present invention is relatively high, when the compression resilience (RC%) exceeds 75%, the texture becomes hard and elasticity is too strong. For example, when a disposable diaper is produced by such a nonwoven cloth, there is a problem in that the fitting property of the nonwoven cloth to the skin is deteriorated. For these reasons, the compression resilience (RC%) of the spunbond nonwoven cloth of the present invention is preferably 60 to 75%, may be 62 to 74%, 63 to 73%, or 65 to 72%, and particularly preferably 66 to 72%.

[0024]

As described above, when the spunbond nonwoven cloth of the invention has a bend stiffness index within the range of 5 to 15 cm⁻¹ and a compression resilience (RC%) within the range of 60 to 75%, the spunbond nonwoven cloth becomes a nonwoven cloth having the recovery relative to compression regardless of high stiffness relative to bending. According to this, the spunbond nonwoven cloth of the present invention can achieve an excellent drape evaluation result by sensory evaluation as compared to a spunbond nonwoven cloth in the related art. In order to set the bend stiffness index and the compression resilience of the spunbond nonwoven cloth to the above ranges, physical configurations of the embossment to be imparted to the

nonwoven cloth and chemical configurations of the constituent fibers of the nonwoven cloth may be adjusted to be appropriate configurations. In this regard, hereinafter, the physical configurations of the embossment to be imparted to the spunbond nonwoven cloth of the invention and the chemical configurations of the fiber constituting the spunbond nonwoven cloth of the present invention will be described.

[0025]

(2. Embossment)

The spunbond nonwoven cloth of the present invention is obtained in such a manner that a fibrous web is introduced between an embossing roll provided with a plurality of embossments aligned in the flow direction of the fiber and the perpendicular direction thereof and an anvil roll having a smooth surface and the spaces between the fibers are heated and compressed. For example, Fig. 1 is a perspective view illustrating the outline of a plurality of embossments formed on the surface of the embossing roll. Fig. 1 illustrates an example of general embossments formed in a dot shape. Further, Fig. 2 is a plan view illustrating the outline of the embossments formed on the surface of the embossment. As illustrated in Fig. 1 and Fig. 2, it is preferable that the plurality of embossments provided in the embossing roll is aligned at a regular interval in the flow direction of the fiber constituting the nonwoven cloth and the perpendicular direction thereof. Further, Fig. 1 and Fig. 2 illustrate a vertex portion of each embossment with oblique lines.

[0026]

In the present invention, the embossing area ratio of the embossment heating and compressing the spaces between the fibers is 5 to 12%. The embossing area ratio described herein means a ratio of the total planar area of a plurality of embossments to the entire planar area of the circumferential face of the embossing roll including the

total planar area of the plurality of embossments and the non-embossed portion. As illustrated in Fig. 1, a vertex portion 11 of each embossment 10 has a planar face. When heating and compressing is performed between the vertex portion 11 (planar face) of each embossment 10 and the smooth face of the anvil roll, the spaces between the fibers are boned to each other so as to form a plurality of concave portions in the spunbond nonwoven cloth. For this reason, when the ratio of the total planar area of embossments to the entire planar area of the circumferential face of the embossing roll is obtained, it is possible to obtain an actual ratio of the total area of the concave portions engraved on the spunbond nonwoven cloth to the entire area on which the embossing process is performed.

[0027]

This embossing area ratio can generally be obtained by the following calculation formula.

Calculation formula: $(S1/S2) \times 100 (\%)$

Definition: S1 = total planar area of whole embossed protrusions

S2 = entire area of embossing roll

[0028]

Further, the embossing area ratio can also be obtained from one embossment pattern as illustrated in Fig. 2. In a case where the embossing area ratio is obtained from one embossment pattern, the following calculation formula may be used.

Calculation formula: $[(a \times b)/(P1 \times P2)] \times 100 (\%)$

Definition: $a \times b$ = planar area of embossed protrusions

$P1 \times P2$ = unit area including planar area of embossed protrusions and area of non-embossed portions

[0029]

As described above, when the embossing area ratio is within the range of 5 to 12%, it is possible to impart flexibility to the nonwoven cloth and this is one factor for adjusting the bend stiffness index and the compression resilience of the nonwoven cloth to the range of values unique to the present invention. That is, when the embossing area ratio is set to less than 5%, the bend stiffness index of the nonwoven cloth reduces to less than 5 cm^{-1} , and adequate elasticity does not occur so that the compression resilience (RC%) becomes less than 60%. Therefore, the drape of the nonwoven cloth that is unique to the present invention cannot be exerted. Similarly, when the embossing area ratio exceeds 12%, the bend stiffness index of the nonwoven cloth exceeds 15 cm^{-1} , and adequate elasticity does not occur so that the compression resilience (RC%) becomes less than 60%. Therefore, the drape of the nonwoven cloth that is unique to the present invention cannot be exerted. For these reasons, in the present invention, the embossing area ratio is preferably 5 to 12%, preferably 5.5 to 10%, 6 to 9%, or 7 to 8%, and particularly preferably 6.4 to 8.3%.

[0030]

In the present invention, the minimum distance between adjacent embossments is 1.5 to 3 mm. For example, in the embossment pattern illustrated in Fig. 2, the minimum distance between adjacent embossments is denoted as symbol SD. As illustrated in Fig. 2, the minimum distance SD between embossments may be obtained by measuring the distance between centers of planar vertex portions in adjacent embossments. When the minimum distance between adjacent embossments is set within the range of 1.5 to 3 mm, it is possible to impart flexibility to the nonwoven cloth and this is one factor for adjusting the bend stiffness index and the compression resilience of the nonwoven cloth to the range of values unique to the present invention. That is, when the minimum distance between adjacent embossments is less than 1.5 mm

or exceeds 3 mm, it is difficult to adjust the bend stiffness index of the nonwoven cloth to 5 to 15 cm⁻¹ and to adjust the compression resilience (RC%) to 60 to 75%. For these reasons, the minimum distance between embossments is preferably 1.5 to 3 mm, and may be 1.5 mm to 2 mm, or 1.5 mm to 1.7 mm.

5 [0031]

In the present invention, examples of the shape of the embossment include a triangular prism, a quadrangular prism, a column, a triangular pyramid, a quadrangular pyramid, a circular truncated cone, linear, oblique or square lattice, or a zigzag shape, and any shape may be employed as long as the embossing area ratio and the minimum
10 distance between embossments described above can be measured and the bend stiffness index and the compression resilience (RC%) of the spunbond nonwoven cloth can be maintained to the above-described values unique to the present invention. Further, a so-called rounding process or a chamfer process may be performed on a corner at the vertex portion side of the embossment.

15 [0032]

For example, in examples illustrated in Fig. 1 and Fig. 2, the shape of each embossment 10 is a quadrangular pyramid and the vertex portion 11 of the embossment 10 has a square shape. In addition, in examples illustrated in Fig. 1 and Fig. 2, the embossments 10 are arranged such that the direction in which one diagonal line of the
20 square shape forming the vertex portion 11 of the embossment 10 extends is coincident with the flow direction (horizontal direction in Fig. 2) of the fiber constituting the spunbond nonwoven cloth and the direction in which the other diagonal line of the square shape extends is coincident with the direction (vertical direction in Fig. 2) perpendicular to the flow direction. In the present invention, the shape of the
25 embossment may be a dot shape as illustrated in Fig. 1 and Fig. 2.

[0033]

Further, Figs. 3(a) to 3(c) and Figs. 4(a) and 4(b) illustrate examples of the embossment pattern different from the patterns illustrated in Fig. 1 and Fig. 2. In addition, in each pattern illustrated in Figs. 3(a) to 3(c) and Figs. 4(a) and 4(b), the minimum distance between embossments is denoted as symbol SD. The present invention can also employ the embossment patterns illustrated in Figs. 3(a) to 3(c) and Figs. 4(a) and 4(b).

[0034]

First, in the example illustrated in Fig. 3(a), the shape of each embossment is a quadrangular pyramid. In the example illustrated in Fig. 3(a), the embossments are arranged such that the directions in which two diagonal lines of the square shape forming the vertex portion of the embossment extend are respectively inclined by about 45 degrees relative to the flow direction (horizontal direction in Fig. 2) of the fiber and the perpendicular direction thereof (vertical direction in Fig. 2) constituting the spunbond nonwoven cloth.

[0035]

Further, in the example illustrated in Fig. 3(b), a concave portion is formed at the central position of the vertex portion of each embossment and the shape of the vertex portion is a hollow square. Incidentally, in the case of the embossment pattern as illustrated in Fig. 3(b), the width of the concave portion formed in the vertex portion of each embossment is not measured as "the minimum distance SD between adjacent embossments," but the distance between embossments in which the vertex portion is formed in a hollow square is consistently measured as "the minimum distance SD between adjacent embossments."

[0036]

Further, in the example illustrated in Fig. 3(c), the shape of each embossment is a circular truncated cone.

[0037]

Fig. 4(a) and Fig. 4(b) illustrate linear embossment patterns.

Specifically, Fig. 4(a) illustrates an embossment pattern of a square lattice. In the present specification, the square lattice pattern means a pattern in which, as illustrated in Fig. 4(a), a plurality of linear embossments extending in parallel along the flow direction (horizontal direction in Fig. 4(a)) of the fiber constituting the spunbond nonwoven cloth and a plurality of linear embossments extending in parallel along the direction (vertical direction in Fig. 4(a)) perpendicular to the flow direction are intersected with each other so as to form a lattice shape and the spaces between lattices have a square shape. In the case of the square lattice embossment pattern, an interval between linear embossments extending in the flow direction or the perpendicular direction thereof is measured as "the minimum distance SD between adjacent embossments."

[0038]

Fig. 4(b) illustrates a zigzag-shaped embossment pattern. In the present specification, the zigzag-shaped pattern means a pattern in which, as illustrated in Fig. 4(b), a plurality of linear embossments extending in parallel along a first direction and a plurality of linear embossments extending in parallel along a second direction are intersected with each other so as to form a lattice shape. Here, the first direction and the second direction are at least a direction different from the flow direction of the fiber and the perpendicular direction thereof. In particular, in the example illustrated in Fig. 4(b), the zigzag-shaped embossment pattern is a pattern in which the first direction is inclined by about 45 degrees relative to the flow direction of the fiber and the

perpendicular direction thereof and the second direction is intersected with the first direction and the spaces between lattices have a square shape. In the case of the zigzag-shaped embossment pattern, an interval between linear embossments extending in the first direction or the second direction is measured as "the minimum distance SD
5 between adjacent embossments."

[0039]

Fig. 5(a) illustrates a pattern of dot embossments arranged in a square lattice pattern. That is, in the pattern illustrated in Fig. 5(a), embossments each having a quadrangular pyramid shape are arranged at positions each corresponding to corners of
10 a plurality of square shapes that are continuous.

[0040]

Further, Fig. 5(b) illustrates a pattern of dot embossments arranged in a triangular lattice pattern. That is, in the pattern illustrated in Fig. 5(b), embossments each having a circular truncated cone shape are arranged at positions each
15 corresponding to corners of a plurality of equilateral triangle shapes that are continuous.

[0041]

(3. Chemical Configurations of Nonwoven Cloth)

It is preferable that the spunbond nonwoven cloth of the present invention be produced by using a polypropylene resin composition containing low crystalline
20 polypropylene and high crystalline polypropylene. The low crystalline polypropylene indicates a crystalline polypropylene whose stereoregularity is moderately disturbed, and specifically, a polypropylene satisfying the following characteristics (a) to (h). When the discrimination criterion for crystallinity is a melting point, a crystalline polypropylene having a melting point of 100°C or higher is called high crystalline
25 polypropylene and a crystalline polypropylene having a melting point of lower than

100°C is called low crystalline polypropylene.

[0042]

[Low Crystalline Polypropylene]

(a) Melt Flow Rate

5 The low crystalline polypropylene to be used in the present invention has a melt flow rate (MFR) of 30 to 70 g/10 min. Further, the melt flow rate of the low crystalline polypropylene is preferably 35 to 65 g/10 min, and particularly preferably 40 to 60 g/10 min.

[0043]

10 (b) [mmmm] = 30 to 80 mol%

 The low crystalline polypropylene to be used in the present invention has [mmmm] (meso pentad fraction) of 30 to 80 mol%. When [mmmm] is less than 30 mol%, solidification after melting is so slow that the fiber adheres to a winding roll to make continuous molding difficult. Further, when [mmmm] exceeds 80 mol%, a
15 degree of crystallinity is so high that end breakage easily occurs. From such a viewpoint, [mmmm] is preferably 30 to 80 mol% or 40 to 70 mol%, and particularly preferably 50 to 60 mol%.

[0044]

(c) $[rrrr]/(1 - [mmmm]) \leq 0.1$

20 The low crystalline polypropylene to be used in the present invention has $[rrrr]/(1 - [mmmm])$ of 0.1 or less. [rrrr] means the racemic pentad fraction. Therefore, $[rrrr]/(1 - [mmmm])$ is an indicator for the uniformity of the regularity distribution of the low crystalline polypropylene. When the value becomes large, a mixture of a high-stereoregularity polypropylene and an atactic polypropylene is
25 obtained as in the case of polypropylene produced by using an existing catalyst system,

and the mixture causes tack. From such a viewpoint, $[rrrr]/(1 - [mmmm])$ is preferably a positive number of 0.1 or less, and more preferably 0.05 or less or 0.04 or less.

[0045]

(d) $[rmm] > 2.5 \text{ mol\%}$

5 The low crystalline polypropylene to be used in the present invention has $[rmm]$ (racemic-meso-racemic-meso pentad fraction) exceeding 2.5 mol%. When $[rmm]$ is 2.5 mol% or less, the randomness of the low crystalline polypropylene reduces, the degree of crystallinity increases owing to crystallization by an isotactic polypropylene block chain, and end breakage easily occurs. From such a viewpoint,
10 $[rmm]$ is preferably 2.6 mol% or more, and more preferably 2.7 mol% or more. The upper limit thereof is typically about 10 mol%. That is, it is preferable that the low crystalline polypropylene have $10 \text{ mol\%} \geq [rmm] > 2.5 \text{ mol\%}$.

[0046]

(e) $[mm] \times [rr]/[mr]^2 \leq 2.0$

15 The low crystalline polypropylene to be used in the present invention has $[mm] \times [rr]/[mr]^2$ of 2.0 or less. Here, $[mm]$ means the mesotriad fraction. $[rr]$ means the racemic triad fraction. $[mr]$ means the triad fraction. Therefore, $[mm] \times [rr]/[mr]^2$ is an indicator for the randomness of the polymer. When the value becomes small, the randomness becomes high, and end breakage and tack are suppressed. From such a
20 viewpoint, $[mm] \times [rr]/[mr]^2$ is preferably 0.2 to 2.0, and particularly preferably 0.25 to 1.8 or 0.5 to 1.5.

[0047]

(f) Weight-Average Molecular Weight (M_w) = 10,000 to 200,000

25 The low crystalline polypropylene to be used in the present invention has a weight-average molecular weight (M_w) of 10,000 to 200,000. When the weight-

average molecular weight is 10,000 or more, the viscosity of the low crystalline polypropylene is not excessively low but moderate, and thus end breakage upon spinning is suppressed. Further, when the weight-average molecular weight is 200,000 or less, the viscosity of the low crystalline polypropylene is not excessively high and spinnability is improved. From such a viewpoint, the weight-average molecular weight is preferably 10,000 to 200,000, and particularly preferably 30,000 to 100,000 or 40,000 to 80,000.

[0048]

(g) Molecular Weight Distribution (M_w/M_n) < 4

In addition to the above-described chemical characteristics (a) to (g), it is preferable that the low crystalline polypropylene to be used in the present invention have a molecular weight distribution (M_w/M_n) of less than 4. When the molecular weight distribution is 0 or more and less than 4, the occurrence of tack in a fiber obtained by spinning is suppressed. This molecular weight distribution is preferably 3 or less or 2 or less.

[0049]

(h) Amount of Components Extractable with Boiling Diethyl Ether = 0 to 10 wt%

Regarding the low crystalline polypropylene to be used in the present invention, an amount of components extractable with boiling diethyl ether is 10,000 to 200,000.

The amount of components extractable with boiling diethyl ether is an indicator for a sticky component.

In terms of suppressing the bleeding of the sticky component on the surface of the nonwoven cloth, the amount of components extractable with boiling diethyl ether is preferably 0 to 10 wt%, and more preferably 0 to 5 wt%.

Further, the temperature-rising fractional chromatography (TREF) is also an

indicator for a sticky component. Regarding the TREF, the eluted amount at an elution temperature of 25°C or lower is preferably 0 to 20 wt%, and particularly preferably 0 to 10 wt% or 0 to 5 wt%.

[0050]

5 When the low crystalline polypropylene satisfying the above-described (a) to (h) is used together with the high crystalline polypropylene, the drawbacks of the high crystalline polypropylene are compensated and thus a raw material composition suitable for producing a target nonwoven cloth is obtained.

[0051]

10 As the method for producing the low crystalline polypropylene having the above-described chemical configurations, a method of using a metallocene catalyst is exemplified. As the metallocene catalyst, for example, a metallocene catalyst obtained by combining a transition metal compound having a crosslinked structure through two crosslinking groups, with a cocatalyst, may be used. As another method for producing
15 low crystalline polypropylene, for example, a method for producing polypropylene described in Japanese Patent No. 4242498 can be used as a reference.

[0052]

[High Crystalline Polypropylene]

 The kinds of the high crystalline polypropylene to be used in the present
20 invention is not particularly limited as long as high crystalline polypropylene can satisfy physical properties relating to the polypropylene resin composition which will be described later. Examples of the high crystalline polypropylene include a propylene homopolymer, a propylene random copolymer, and a propylene block copolymer. The melt flow rate (MFR) of the high crystalline polypropylene is 20 to 100 g/10 min. The
25 MFR of the high crystalline polypropylene is preferably 50 to 100 g/10 min, and more

preferably 70 to 100 g/10 min. The melting point of the high crystalline polypropylene is 100°C or higher, and may be 150 to 167°C or 155 to 165°C.

[0053]

[Polypropylene Resin]

5 The polypropylene resin to be used in the present invention is obtained by mixing the above-described low crystalline polypropylene and high crystalline polypropylene. The content of the low crystalline polypropylene in the polypropylene resin to be used in the present invention is 5 to 50 wt% based on the total of the low crystalline polypropylene and the high crystalline polypropylene. When the content of
10 the low crystalline polypropylene is less than 5 wt%, the drawbacks of the high crystalline polypropylene cannot be compensated, making it difficult to achieve reductions in denier values of the fibers without increasing the number of shots. Further, when the polypropylene resin is formed in such a manner that the low crystalline polypropylene is contained in a predetermined amount or more, the fiber is
15 less likely to be broken, and spinnability is improved. Therefore, it is possible to stably produce fibers with reductions in denier values. From such a viewpoint, the content of the low crystalline polypropylene is preferably 5 to 50 wt%, and particularly preferably 10 to 50% or 20 to 50 wt%.

[0054]

20 The melt flow rate (MFR) of the polypropylene resin to be used in the present invention is preferably 20 to 100 g/10 min. When the MFR of the polypropylene resin composition is less than 20 g/10 min, spinnability is deteriorated. On the other hand, when the MFR of the polypropylene resin composition exceeds 100 g/10 min, the compression resilience of the nonwoven cloth formed by the polypropylene resin is
25 deteriorated. Accordingly, the compression resilience (RC%) cannot be maintained

within an appropriate range, that is, the above-described range of 60 to 75%. Further, since the nonwoven cloth formed by the polypropylene resin of the present invention has a relatively high bend stiffness index, it is not possible to achieve an excellent result in sensory evaluation relating to the drape of the nonwoven cloth when the compression
5 resilience (RC%) is out of the range of 60 to 75%. For this reason, the MFR of the polypropylene resin composition is preferably 20 to 100 g/10 min, may be 20 to 90 g/10 min or 20 to 80 g/10 min, and is particularly preferably 20 to 70 g/10 min.

[0055]

The polypropylene resin to be used in the present invention may contain other
10 thermoplastic resins or additives as long as it satisfies the above-described physical properties.

Examples of the other thermoplastic resins include olefin polymers, and specific examples include polypropylene, a propylene-ethylene copolymer, a propylene-ethylene-diene copolymer, polyethylene, an ethylene/ α -olefin copolymer, an ethylene-
15 vinyl acetate copolymer, and a hydrogenated styrenic elastomer. One of them may be used alone or two or more kinds thereof may be used in combination.

[0056]

Further, as additives, conventionally known additives can be mixed, and examples of the additives include a lubricant, a foaming agent, a crystal nucleating
20 agent, a weatherability stabilizer, a UV absorbing agent, a light stabilizer, a heat resistance stabilizer, an antistatic agent, a mold releasing agent, a flame retardant, a synthetic oil, a wax, an electric-property-improving agent, a slip inhibitor, an anti-blocking agent, a viscosity modifier, a coloring inhibitor, a defogging agent, a pigment, a dye, a plasticizer, a softening agent, an age resistor, a hydrochloric-acid-absorbing
25 agent, a chlorine scavenger, an antioxidant, and an anti-tack agent.

[0057]

In order to achieve favorable drape of the nonwoven cloth formed by the polypropylene resin, it is preferable that the nonwoven cloth of the present invention contain a lubricant in a fiber layer forming at least one surface of the front surface and the rear surface thereof among the various additives described above. The lubricant may be applied to the nonwoven cloth or may be attached to the nonwoven cloth by spraying the lubricant. Examples of the lubricant may include fatty acid amide such as erucic acid amide, oleic acid amide, stearic acid amide, or behenic acid amide; butyl stearate; and silicone oil. The amount of the lubricant to be added can be appropriately adjusted, but may be set to, for example, 1,000 to 3,000 ppm, 1,500 to 2,500 ppm, or about 2,000 ppm.

Examples

[0058]

Resins 1 to 13 were produced as samples of the polypropylene resin by mixing high crystalline polypropylene and low crystalline polypropylene.

SA06 (product name, produced by Japan Polypropylene Corporation) was used as the high crystalline polypropylene. Further, L-MODU S901 (product name, produced by Idemitsu Kosan Co., Ltd.) was used as the low crystalline polypropylene. The above-described high crystalline polypropylene and low crystalline polypropylene each were mixed in a predetermined amount based on wt% to obtain the resins 1 to 13 as samples of the polypropylene resin. The resins 1 to 13 as samples of the polypropylene resin each exhibited characteristics shown in the following Table 1. Incidentally, erucic acid amide (product name: Fatty Acid Amide E, produced by Kao Corporation) was used as a lubricant.

[0059]

[Table 1]

Table 1	Low crystalline resin [wt%]	High crystalline resin MFR	Low crystalline resin MFR	Lubricant [ppm]	Spinnability	Formation Index	Fineness [dtex]	Weight [g/m ²]
Resin 1	5	40	60	2000	○	181	0.97	17.0
Resin 2	20	40	60	2000	◎	192	0.90	16.8
Resin 3	50	40	60	2000	◎	195	0.78	17.0
Resin 4	20	25	60	2000	○	190	0.92	17.2
Resin 5	20	80	60	2000	◎	182	0.91	17.0
Resin 6	20	40	40	2000	○	186	0.95	17.1
Resin 7	0	40	60	2000	○	193	1.44	17.2
Resin 8	70	40	60	2000	○	220	0.95	17.1
Resin 9	20	15	60	2000	△	198	1.28	17.1
Resin 10	20	120	60	2000	○	190	0.91	17.0
Resin 11	20	40	20	2000	△	197	1.33	17.1
Resin 12	20	40	80	2000	○	192	0.94	17.1
Resin 13	20	40	60	0	◎	192	0.90	17.0

[0060]

5 A fibrous web was obtained by melt-spinning various resins shown in Table 1 from a spinning nozzle and dispersing and accumulating the obtained filament on a dispersion plate through an air nozzle. The air nozzle is used for pulling the spun filament from the spinning nozzle and sending the filament toward the dispersion plate while the filament was carried on compressed airflow. The obtained fibrous web was

10 subjected to the embossing process while interposed between the embossing roll and a steel roll which had been heated, thereby obtaining a spunbond nonwoven cloth. The resins used in the production of the spunbond nonwoven cloth and the physical configurations (embossing area ratio, distance between embossments, and lattice shape) of the embossments used in the production of nonwoven cloth are shown in the

15 following Table 2. Further, regarding the pattern arrangement of the embossments, the arrangement illustrated in Fig. 5(a) was used as "the square lattice pattern," and the

arrangement illustrated in Fig. 5(b) was used as "the triangular lattice pattern." In addition, the bend stiffness index, the compression resilience (compression recovery ratio), the fuzz, and the drape of each of the obtained spunbond nonwoven clothes were measured and evaluated. The results of measurement and evaluation are shown in the

5 following Table 2.

[0061]

[Table 2]

Table 2	Used resin	Embossing area ratio [%]	Distance between embossments [mm]	Pattern arrangement	Bend stiffness index [cm-1]	Compression recovery ratio [%]	Fuzz	Drape evaluation
Example 1	Resin 2	6.4	1.5	Square lattice pattern	6	69	4	◎
Example 2	Resin 3	8.3	2	Square lattice pattern	8	72	5	◎
Example 3	Resin 5	7.4	1.5	Triangular lattice pattern	12	66	5	◎
Example 4	Resin 7	6.4	1.5	Square lattice pattern	13	61	4	○
Example 5	Resin 10	6.4	1.5	Square lattice pattern	9	72	4	○
Example 6	Resin 13	6.4	1.5	Square lattice pattern	6	66	4	○
Comparative Example 1	Resin 2	2.7	3.5	Square lattice pattern	3	63	2	○
Comparative Example 2	Resin 2	16.5	1.7	Square lattice pattern	28	32	5	×
Comparative Example 3	Resin 8	2.7	3.5	Square lattice pattern	3	52	1	○
Comparative Example 4	Resin 7	11.9	1.5	Square lattice pattern	24	45	5	×

[0062]

[Measurement and Evaluation Methods]

The measurement method and the evaluation method for deriving the measurement results and the evaluation results as shown in Table 1 and Table 2 described above were as follows.

5 [0063]

(1) Melt Flow Rate MFR [g/10 min]

The measurement was conducted in conformity with Table 1 in JIS-K7210 "Plastics-Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics" using a melt indexer (MELT INDEXER S-101
10 manufactured by Toyo Seiki Seisaku-sho, Ltd.) melt flow apparatus under the conditions at an orifice diameter of 2.095 mm, an orifice length of 0.8 mm, and a load 2160 g. The measurement was conducted at a measurement temperature of 230°C, and a discharge amount (g) of a molten polymer every 10 minutes from the time for discharging a certain volume integration was obtained through calculation.

15 [0064]

(2) Spinnability

Evaluation was conducted by visually observing the state of end breakage in a case where a polypropylene resin was spun by using a melt-spinning apparatus having a round spinneret with a hole diameter of $\phi 0.5$ mm and the hole number of 2675 in such a
20 manner that the molten resin was extruded from a nozzle under the conditions at a spinning temperature of 230°C and an output per hole of 0.45 g/min and the extruded molten resin was allowed to pass through an air jet (injector pressure: 0.24 MPa) provided at the position under the lower portion distant from 130 cm. The resin stably spun without end breakage was evaluated as "⊙," the resin in which there was a little
25 end breakage but the spinning state was favorable was evaluated as "○," and the resin

in which there were lots of end breakage and the spinning state was not favorable was evaluated as "△."

[0065]

(3) Formation Index

5 The formation index was measured by FMT-MIII (light-transmission variation method) manufactured by Nomura Shoji Co., Ltd. The shape of the sample was set to 20 × 20 cm, and the diaphragm (sensitivity) of a CCD camera being used was set to 12.

[0066]

(4) Fineness [dtex]

10 The produced nonwoven cloth was divided into about five equal parts in the width direction except for 10 cm in both ends of the nonwoven cloth, and a 1-cm square test piece was sampled. The diameter of the fiber was measured at 20 points by a microscope. The fineness was calculated from the average value thereof.

[0067]

15 (5) Weight [g/m²]

Five 20-cm long × 20-cm wide test pieces were arbitrarily sampled from the produced nonwoven cloth except for 10 cm in both ends of the nonwoven cloth, and the mass of each test piece was measured. The average value thereof was obtained in terms of weight per unit area.

20 [0068]

(6) Embossing Area Ratio

25 The produced nonwoven cloth was divided into about five equal parts in the width direction except for 10 cm in both ends of the nonwoven cloth, a 1-cm square test piece was sampled, and an enlarged image of the nonwoven cloth was captured by a microscope. The area ratio of the concave portion of the nonwoven cloth

corresponding to embossment was measured at 20 points by using an image processing program, and the average value was calculated.

The embossing area ratio was obtained by measuring the configuration of the concave portions formed in the nonwoven cloth by the embossing process. The
5 embossing area ratio was calculated by the following formula based on the vertex-portion area [mm^2] and the dot number density [$1/\text{mm}^2$] of the concave portion formed in the nonwoven cloth.

Embossing area ratio [%] = vertex-portion area [mm^2] $\times$ dot number density
[$1/\text{mm}^2$]

10

The vertex-portion area [mm^2] of Example 1 was 0.145 mm^2 , and the dot number density [$1/\text{mm}^2$] thereof was 0.444444.

The vertex-portion area [mm^2] of Example 2 was 0.332 mm^2 , and the dot number density thereof was 0.25.

15

The vertex-portion area [mm^2] of Example 3 was 0.145 mm^2 , and the dot number density thereof was 0.5132.

The vertex-portion area [mm^2] of Example 4 was 0.145 mm^2 , and the dot number density thereof was 0.444444.

20

The vertex-portion area [mm^2] of Example 5 was 0.145 mm^2 , and the dot number density thereof was 0.444444.

The vertex-portion area [mm^2] of Example 6 was 0.145 mm^2 , and the dot number density thereof was 0.444444.

The vertex-portion area [mm^2] of Comparative Example 1 was 0.332 mm^2 , and the dot number density thereof was 0.081633.

25

The vertex-portion area [mm^2] of Comparative Example 2 was 0.478 mm^2 , and

the dot number density thereof was 0.346021.

The vertex-portion area [mm²] of Comparative Example 3 was 0.332 mm², and the dot number density thereof was 0.081633.

The vertex-portion area [mm²] of Comparative Example 4 was 0.283 mm², and the dot number density thereof was 0.444444.

[0069]

(7) Distance between Embossments

The produced nonwoven cloth was divided into about five equal parts in the width direction except for 10 cm in both ends of the nonwoven cloth, a 1-cm square test piece was sampled, and an enlarged image of the nonwoven cloth was captured by a microscope. The distance between centers of the concave portions of the nonwoven cloth corresponding to embossments was measured at 20 points by using an image processing program, and the average value was calculated.

[0070]

(8) Bend Stiffness Index

Five 20-cm long × 20-cm wide test pieces were arbitrarily sampled from the produced nonwoven cloth except for 10 cm in both ends of the nonwoven cloth, and used as the samples for measurement. In each sample, measurement was conducted at three points in the flow direction of the fiber and the perpendicular direction thereof by using a KES system (FB-2), and the average value of five pieces was defined as the bend stiffness (B value) [g/cm²/cm]. The bend stiffness index was calculated by the following formula based on the obtained bend stiffness.

$$\text{Bend stiffness index [cm}^{-1}\text{]} = [\text{bend stiffness (B value) [g/cm}^2\text{/cm]}] / \text{weight [g/m}^2\text{]} \times 10,000$$

[0071]

(9) Compression Recovery Ratio

Five 20-cm long × 20-cm wide test pieces were arbitrarily sampled from the produced nonwoven cloth except for 10 cm in both ends of the nonwoven cloth, and used as the samples for measurement. In each sample, measurement was conducted at three points by using a KES system (FB-3) under the high sensitivity condition, that is, under the condition in which the maximum compression force was set to 10 gf/cm², and the average value of five pieces was defined as the compression recovery ratio (compression resilience).

[0072]

10 (10) Fuzz Evaluation

The measurement portions were determined at an interval of 10 cm in the width direction of the nonwoven cloth, and the fuzz of the nonwoven cloth was evaluated by using a loop film Hyper-KLL (manufactured by Sumitomo 3M Ltd). The visual evaluation was carried out, and the fuzz was ranked according to the following criteria for determination. Incidentally, a case where the fuzz evaluation is 4 or more was determined to be suitable for practical use.

1: Fibers were ripped off to an extent of damaging the sample.

2: Fibers were ripped off from the surface of the sample to a significant extent.

3: The floating of fibers was observed at a plurality of places, and fiber breakage was observed at some places.

4: The floating of fibers was observed at some places.

5: There was no fuzz.

[0073]

(11) Drape Evaluation

25 Five 20-cm long × 20-cm wide test pieces were arbitrarily sampled from the

produced nonwoven cloth except for 10 cm in both ends of the nonwoven cloth, and used as the samples for measurement. The sensory evaluation was conducted on the drape when a test subject touches the samples with hands.

The evaluation was conducted based on four grades of ranks "⊙," "○," "△,"

5 and "×."

[0074]

In addition, the measurement methods for the characteristics of the polypropylene resin itself were as follows.

[0075]

10 (12) Molecular Weight Distribution (Mw/Mn)

GPC Measuring Apparatus

Column: TOSO GMHHR-H(S)HT

Detector: RI detector for liquid chromatography, WATERS150C

Measurement Conditions

15 Solvent: 1,2,4-trichlorobenzene

Measurement temperature: 145°C

Flow rate: 1.0 ml/min

Sample concentration: 2.2 mg/ml

Injection rate: 160 µl

20 Detection line: Universal Calibration

Analysis program: HT-GPC (Ver. 1.0)

[0076]

(13) Temperature-Rising Fractional Chromatography (TREF)

Dissolution: To 60 mg of a sample was added 10 ml of o-dichlorobenzene and the

25 resultant was heated under stirring for 60 minutes in an aluminum block heater in which

the temperature was set to 150°C and which was equipped with a magnetic stirrer.

Analysis temperature-rising fraction: A sample solution was crystallized by cooling and then heated to measure the amount of an eluted sample under the following conditions.

The eluted-sample amount was plotted against temperature.

- 5 Column: Made of stainless steel, filled with Chromosorb P (30/60), size 4.2 mm ϕ $\times$ 150 mm

Amount of charged sample: 3 mg solvent (moving phase): o-dichlorobenzene (Wako special grade)

Crystallization: Temperature-dropping range 135°C $\rightarrow$ 0°C, temperature-dropping rate

- 10 5°C/hr, holding time at 0°C for 30 minutes

Elution: Temperature-rising range 0°C $\rightarrow$ 135°C, temperature-rising rate 40°C/hr, moving phase flow rate: 1.0 ml/min

Time for measuring 0°C eluted part: 20 minutes

Detector: IR (provided with a flow cell whose temperature could be raised), wavelength

- 15 3.41 μ m

[0077]

(14) Amount of Components Extractable with Boiling Diethyl Ether

The amount was measured under the following conditions by using a Soxhlet extractor.

- 20 Extracted sample: 5 to 6 g

Sample shape: Powder form (in the case of a sample in a pellet form, the sample is pulverized to be used in a powder form)

Extracting solvent: Diethyl ether

Extraction time: 10 hours

- 25 Number of times of extraction: 180 times or more

Calculation method of extracted amount: Calculation by using the following formula

$$\left[\frac{\text{Amount (g) of components extractable with diethyl ether}}{\text{Weight (g) of incorporated powder}} \right] \times 100$$

 [0078]

- 5 (15) Meso Pentad Fraction [mmmm], Racemic Pentad Fraction [rrrr], and Racemic-Meso-Racemic-Meso Pentad Fraction [rmrm]

Measurement of the ^{13}C -NMR spectrum was conducted by the following apparatus and conditions according to the peak assignments proposed by A. Zambelli, et al., in "Macromolecules, 8,687 (1975)."

- 10 Apparatus: ^{13}C -NMR spectrometer (model: JNM-EX400, manufactured by JEOL Ltd.)

Method: Proton complete decoupling

Concentration: 220 mg/ml

Solvent: Solvent mixture of 1,2,4-trichlorobenzene and hexadeuterobenzene (ratio by volume = 90 : 10)

- 15 Temperature: 130°C

Pulse width: 45°

Pulse repetition period: 4 seconds

Integration: 10,000 times

<Calculation Formulae>

- 20 $M = m/S \times 100$

$R = \gamma/S \times 100$

$S = P\beta\beta + P\alpha\beta + P\alpha\gamma$

S: Signal intensity of a side chain methyl carbon atom in the whole propylene units

$P\beta\beta$: 19.8 to 22.5 ppm

- 25 $P\alpha\beta$: 18.0 to 17.5 ppm

$P\alpha\gamma$: 17.5 to 17.1 ppm

γ : Racemic pentad chain: 20.7 to 20.3 ppm

m: Meso pentad chain: 21.7 to 22.5 ppm

[0079]

5 (16) Measurement of Melting Point (T_m) and Crystallization Temperature (T_c)

By using a differential scanning calorimeter (DSC-7 manufactured by PerkinElmer Co., Ltd.), 10 mg of the sample was melted in advance at 230°C for 3 minutes under a nitrogen atmosphere, and then the temperature of the sample was decreased to 0°C at 10°C/min. The crystallization temperature was determined as the
 10 peak top observed on the highest peak of a crystallization exothermic curve obtained at that time. In addition, the melting point was determined as the peak top observed on the highest peak of a melt endothermic curve obtained by further maintaining the sample at 0°C for 3 minutes and then increasing the temperature of the sample at 10°C/min.

15 [0080]

[Discussion]

Regarding the spunbond nonwoven clothes of Comparative Examples 1 to 4 shown in Table 2, by focusing on the bend stiffness index, it was found that the cases of having a high bend stiffness index (Comparative Example 2 and Comparative Example
 20 4) were inferior to the cases of having a low bend stiffness index (Comparative Example 1 and Comparative Example 3) in the determination on the drape evaluation. For this reason, it can be said that, as the bend stiffness index increases, the drape of the spunbond nonwoven cloth is impaired. On the other hand, it was found that, in the cases of having a low bend stiffness index (Comparative Example 1 and Comparative
 25 Example 3), lots of fuzz became prominent and there was a problem in practical uses as

compared to the cases of having a high bend stiffness index (Comparative Example 2 and Comparative Example 4). For this reason, it can be said that, in order to achieve a nonwoven cloth having practicality with little fuzz, it is necessary to maintain the bend stiffness index to some extent. Incidentally, as one factor causing the bend stiffness indexes of Comparative Example 2 and Comparative Example 4 to increase, an increase in embossing area ratio is considered. On the other hand, as one factor causing the bend stiffness indexes of Comparative Example 1 and Comparative Example 3 to decrease, a decrease in embossing area ratio is considered.

[0081]

Here, considering Examples 1 to 6 shown in Table 2, although all of the bend stiffness indexes were 6 or more and the spunbond nonwoven clothes of Examples 1 to 6 had a relatively high bend stiffness index, by maintaining the compression recovery ratio to a preferable range of 60 to 75%, it was determined that the spunbond nonwoven clothes of Examples 1 to 6 were no problematic level in practical uses on the fuzz evaluation and had relatively favorable drape on the drape evaluation. As in these Examples 1 to 6, it was found that, regardless of high stiffness relative to bending, by adjusting the recovery relative to the compression to a favorable level, it was possible to produce a spunbond nonwoven cloth having favorable drape without fuzz. As shown in Examples 1 to 6 and Comparative Examples 1 to 4, it can be said that the bend stiffness index and the compression recovery of the nonwoven cloth are considerably influenced by the embossing area ratio and the distance between embossments. As shown in Examples 1 to 6, in order to adjust the bend stiffness index and the compression recovery of the nonwoven cloth to appropriate ranges, it was preferable that the embossing area ratio was set to 6.4 to 8.3% and the distance between embossments was set to 1.5 to 2 mm.

[0082]

Further, the spunbond nonwoven clothes of Example 1 and Example 4 have the same embossing area ratio and the same distance between embossments, but used resins are different from each other. That is, in Example 1, the resin 2 (containing 20 wt% of low crystalline resin) was used, but in Example 4, the resin 7 (not containing low crystalline resin) was used. When Example 1 and Example 4 were compared with each other, the nonwoven cloth of Example 1 containing low crystalline resin exhibited a relatively low bend stiffness index and a relatively high compression recovery ratio and thus was determined that the drape evaluation was favorable. On the other hand, in the nonwoven cloth of Example 4 not containing low crystalline resin, the bend stiffness index was increased but the compression recovery ratio was reduced, and thus drape was impaired in some degree. In this regard, it was found that, even in the case of the same embossing area ratio of the embossments imparted to the nonwoven cloth and the same distance between embossments, differences in the bend stiffness index and the compression recovery ratio of the nonwoven cloth were generated depending on the amount of low crystalline resin contained in the resin forming the nonwoven cloth. That is, when the amount of low crystalline resin and chemical configurations thereof in the nonwoven cloth are adjusted to the preferable range of values as well as the embossing area ratio and the distance between embossments, the bend stiffness index and the compression recovery ratio of the nonwoven cloth become within a particularly preferable range of values, and the drape of the nonwoven cloth becomes more favorable.

Industrial Applicability

[0083]

The present invention relates to a spunbond nonwoven cloth to be used, for example, for an absorptive article such as a disposable diaper. Therefore, the present invention may be preferably used in the manufacturing industry for a disposable diaper or the like.

CLAIMS

1. A spunbond nonwoven cloth obtained by spinning and accumulating a thermoplastic resin into continuous fibers, after which spaces between the fibers are heated and compressed using an embossing roll provided with a plurality of embossments aligned in the flow direction of the fibers and a perpendicular direction thereof, wherein
 - an embossing area ratio is 5 to 12%,
 - a minimum distance between adjacent embossments is 1.5 to 3 mm,
 - a bend stiffness index (bend stiffness $[\text{g}/\text{cm}^2/\text{cm}]/\text{weight} [\text{g}/\text{m}^2] \times 10^4$ using a KES bend stiffness test machine) is 5 to 15 cm^{-1} , and
 - a compression resilience (RC%) using a KES compression characteristic test machine is 60 to 75%.
2. The spunbond nonwoven cloth according to claim 1, wherein
 - the thermoplastic resin is a polypropylene resin,
 - the polypropylene resin includes low crystalline polypropylene and high crystalline polypropylene,
 - the content of the low crystalline polypropylene is 5 to 50 wt% based on the total value of the contents of the low crystalline polypropylene and the high crystalline polypropylene,
 - a melt flow rate of the low crystalline polypropylene is 30 to 70 g/10 min, and
 - a melt flow rate of the high crystalline polypropylene is 20 to 100 g/10 min.
3. The spunbond nonwoven cloth according to claim 2, wherein

the low crystalline polypropylene is polypropylene in which

a meso pentad fraction [mmmm] is 30 to 80 mol%,

a racemic pentad fraction [rrrr] and $[1 - \text{mmmm}]$ satisfy a relation $[\text{rrrr}]/[1 - \text{mmmm}] \leq 0.1$,

5 a racemic-meso-racemic-meso pentad fraction [rmrm] exceeds 2.5 mol%,

a mesotriad fraction [mm], a racemic triad fraction [rr], and a triad fraction [mr] satisfy a relation $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2 \leq 2.0$,

a weight-average molecular weight (Mw) is 10,000 to 200,000,

a molecular weight distribution (Mw/Mn) is less than 4, and

10 an amount of components extractable with boiling diethyl ether is 0 to 10 wt%.

4. The spunbond nonwoven cloth according to any one of claims 1 to 3, wherein a melt flow rate of the polypropylene resin is 20 to 100 g/10 min.

15 5. The spunbond nonwoven cloth according to any one of claims 1 to 4, wherein a fiber diameter of the fiber is 1 dtex or less.

6. The spunbond nonwoven cloth according to any one of claims 1 to 5, wherein a lubricant is contained in a fiber layer of at least one surface of the nonwoven

20 cloth.