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(54) **FIBROUS NONWOVEN FABRIC**

(57) Provided is a fibrous nonwoven fabric including a resin composition (C) containing a high-crystalline polyolefin (A) and a low-crystalline polyolefin (B), wherein a half-crystallization time (t_c) of the resin composition (C) is 1.2 to 2.0 times a half-crystallization time (t_a) of the high-crystalline polyolefin (A).

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Description

Technical Field

5 **[0001]** The present invention relates to a fibrous nonwoven fabric using a polyolefin material.

Background Art

10 **[0002]** In recent years, polyolefin-based fibers and nonwoven fabrics are used for various applications, such as a disposable diaper, a sanitary product, a hygienic product, a clothing material, a bandage, a packaging material, etc. The fibers and nonwoven fabrics are often used for applications in which they come into direct contact with the body, and thus, in recent years, a required performance regarding good wear feeling to the body and hand touch feeling are being more increased. For this reason, with respect to the nonwoven fabrics, technological development related to an improvement of texture for good wear feeling, reduction in basis weight for weight reduction of products, and the like is demanded.

15 **[0003]** However, in producing a nonwoven fabric using a conventionally used polyolefin-based resin by a spunbond method, for the purpose of aiming to reduce fiber diameter, if a discharge amount per hole is decreased, or a spinning speed is increased, end breakage occurs frequently, so that stable spinnability is not obtained. When the end breakage occurs, the broken fiber catches up surrounding fibers to cause a roping phenomenon, or the nonwoven fabric in a part where the end breakage occurs or a part where the roped fiber falls leads to a defect or uneven basis weight, and
20 therefore, defective quality of the nonwoven fabric is brought. For this reason, it is desired to make both stable spinnability free from the occurrence of end breakage and reducing the fiber diameter compatible with each other.

Citation List

25 Patent Literature

[0004] PTL 1: WO2011/030893

Summary of Invention

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Technical Problem

[0005] Here, PTL 1 discloses a spunbonded nonwoven fabric using a resin composition containing a low-crystalline polypropylene and a high-crystalline polypropylene; however, from the viewpoint of providing a nonwoven fabric having
35 more excellent flexibility and higher strength, fibers constituting the nonwoven fabric are required to more reduce fiber diameter.

[0006] In view of the foregoing circumstances, the present invention has been made, and its object is to reduce fiber diameter of fibers constituting a fibrous nonwoven fabric using a polyolefin resin composition while preserving spinning stability.

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Solution to Problem

[0007] The present inventors made extensive and intensive investigations. As a result, it has been found that the above-described problem is solved by using a polyolefin resin composition having a specified crystallization rate.

45 **[0008]** Specifically, the present invention provides the following.

1. A fibrous nonwoven fabric including a resin composition (C) containing a high-crystalline polyolefin (A) and a low-crystalline polyolefin (B), the fibrous nonwoven fabric satisfying the following conditions (1) and (2):

50 (1) a half-crystallization time (t_a) of the high-crystalline polyolefin (A) and a half-crystallization time (t_b) of the low-crystalline polyolefin (B) satisfy a relation of $t_a < t_b$; and
(2) a half-crystallization time (t_c) of the resin composition (C) is 1.2 to 2.0 times the half-crystallization time (t_a) of the high-crystalline polyolefin (A).

55 2. The fibrous nonwoven fabric according to the above item 1, wherein a fineness of fibers constituting the fibrous nonwoven fabric is 0.2 to 1.3 deniers.

3. The fibrous nonwoven fabric according to the above item 2, wherein the fineness of fibers constituting the fibrous nonwoven fabric is 0.2 to 0.8 deniers.

4. The fibrous nonwoven fabric according to any one of the above items 1 to 3, wherein an initial elastic modulus of the high-crystalline polyolefin (A) is 500 to 2,000 MPa, and an initial elastic modulus of the low-crystalline polyolefin (B) is 5 MPa or more and less than 500 MPa.

5. The fibrous nonwoven fabric according to any one of the above items 1 to 4, wherein when molding the fibrous nonwoven fabric, molding is performed in a discharge amount per hole of 0.1 to 0.5 g/min.

6. A spunbonded nonwoven fabric constituted of fibers having a fineness of 0.2 to 1.0 denier.

Advantageous Effects of Invention

[0009] According to the present invention, in a fibrous nonwoven fabric using a polyolefin resin composition, the reduction of diameter of fibers constituting the nonwoven fabric can be achieved while preserving spinning stability.

Description of Embodiments

<First Invention>

[0010] A fibrous nonwoven fabric of a first invention is composed of a resin composition containing a high-crystalline polyolefin (A) and a low-crystalline polyolefin (B). It is to be noted that the low-crystalline polyolefin (B) as referred to in the present invention means a crystalline polyolefin having a longer half-crystallization time than the high-crystalline polyolefin (A). That is, a half-crystallization time (t_a) of the high-crystalline polyolefin (A) and a half-crystallization time (t_b) of the low-crystalline polyolefin (B) satisfy a relation of $t_a < t_b$.

[High-crystalline Polyolefin (A)]

[0011] The high-crystalline polyolefin (A) which is used in the first invention is not particularly limited in terms of a kind thereof so long as it satisfies a condition (2) regarding a resin composition (C) as described later. Examples thereof include polyethylene, a propylene homopolymer, an ethylene-propylene copolymer, an ethylene- α -olefin copolymer, a propylene- α -olefin copolymer, an α -olefin homopolymer, a copolymer of plural α -olefins, and the like. This α -olefin is preferably one having 4 to 24 carbon atoms, more preferably one having 4 to 12 carbon atoms, and especially preferably one having 4 to 8 carbon atoms.

[0012] As for the above-described high-crystalline polyolefin (A), its initial elastic modulus is preferably 500 to 2,000 MPa, more preferably 600 to 2,000 MPa, and still more preferably 700 to 1,800 MPa. The initial elastic modulus as referred to in this description is one measured by the following measuring method.

[Measuring Method of Initial Elastic Modulus]

[0013] A press sheet having a thickness of 1 mm was fabricated. A test piece was sampled from the resulting press sheet in conformity with JIS K7113 (2002) No. 2-1/2. Using a tensile tester (AUTOGRAPH AG-1, manufactured by Shimadzu Corporation), the test piece was set at an initial length L_0 of 40 mm, stretched at a tensile speed of 100 mm/min, and measured for a strain and a load in the stretching process, and the initial elastic modulus was calculated according to the following expression.

$$\text{Initial elastic modulus (N)} = (\text{Load (N) at a strain of 5\%}) / 0.05$$

[0014] It is to be noted that the half-crystallization time (t_a , t_b , and t_c) as referred to in this description means one measured by the following measuring method.

[Measuring Method of Half-crystallization Time]

[0015] The measurement is made using FLASH DSC (manufactured by Mettler-Toledo International Inc.) in the following method.

(1) A sample is melted by heating at 230°C for 2 minutes and then cooled to 25°C at a rate of 2,000°C/sec, and a time change of heating value in an isothermal crystallization process at 25°C is measured.

In the conventional DSC measurement, since the above-described abrupt cooling could not be performed, crystallization started in the cooling process, so that accurate evaluation of the isothermal crystallization in the neighborhood

of room temperature could not be achieved.

(2) When an integrated value of heating value from start of the isothermal crystallization to completion of the crystallization is defined as 100%, a time from start of the isothermal crystallization until the integrated value of heating value reaches 50% is defined as the half-crystallization time.

[Low-crystalline polyolefin (B)]

[0016] The above-described low-crystalline polyolefin (B) is not particularly limited in terms of a kind thereof so long as it has a longer half-crystallization time than the high-crystalline polyolefin (A) as described above. Examples thereof include polyethylene, a propylene homopolymer, an ethylene-propylene copolymer, a propylene- α -olefin copolymer, an α -olefin homopolymer, a copolymer of plural α -olefins, and the like. This α -olefin is preferably one having 4 to 24 carbon atoms, more preferably one having 4 to 12 carbon atoms, and especially preferably one having 4 to 8 carbon atoms.

[0017] As for the above-described low-crystalline polyolefin (B), its initial elastic modulus is preferably 5 MPa or more and less than 500 MPa, more preferably 10 to 400 MPa, and still more preferably 20 to 300 MPa. The initial elastic modulus of the low-crystalline polyolefin (B) can be measured in the same manner as that in the above-described high-crystalline polyolefin (A).

[0018] In the case where the high-crystalline polyolefin (A) is a general-purpose polypropylene, the low-crystalline polyolefin (B) is preferably a low-crystalline polypropylene satisfying the following condition (a), and more preferably a low-crystalline polypropylene satisfying all of the following conditions (a) to (f).

(a) [mmmm] = 20 to 60 mol%

[0019] As for the above-described low-crystalline polypropylene, its [mmmm] (mesopentad fraction) is 20 to 60 mol%. When the [mmmm] is 20 mol% or more, solidification after melting is fast, stickiness of the fibers is suppressed, and attachment onto a wind-up roll is hardly caused, and therefore, continuous molding becomes easy. In addition, when the [mmmm] is 60 mol% or less, a degree of crystallization is lowered, and therefore, end breakage is hardly caused, and furthermore, a nonwoven fabric having a soft touch feeling is obtained. From such viewpoints, the [mmmm] of the above-described low-crystalline polypropylene is more preferably 30 to 50 mol%, and still more preferably 40 to 50 mol%.

(b) $[\text{rrrr}]/(1 - [\text{mmmm}]) \leq 0.1$

[0020] As for the above-described low-crystalline polypropylene, its $[\text{rrrr}]/(1 - [\text{mmmm}])$ is preferably 0.1 or less. The $[\text{rrrr}]/(1 - [\text{mmmm}])$ is an index indicating the uniformity of regularity distribution of the low-crystalline polypropylene. When this value is small, the resultant does not become a mixture of a high-stereoregular polypropylene and an atactic polypropylene, as in the conventional polypropylene which is produced using an existent catalyst system, and stickiness is hardly caused. From such a viewpoint, the $[\text{rrrr}]/(1 - [\text{mmmm}])$ of the above-described low-crystalline polypropylene is more preferably 0.05 or less, and still more preferably 0.04 or less.

(c) [rmm] > 2.5 mol%

[0021] As for the above-described low-crystalline polypropylene, its [rmm] (racemic-meso-racemic-meso pentad fraction) is preferably more than 2.5 mol%. If the [rmm] is 2.5 mol% or less, random properties of the low-crystalline polypropylene are reduced, the degree of crystallization is increased due to crystallization by an isotactic polypropylene block chain, end breakage is caused, and furthermore, a soft touch feeling is not obtained in the resulting nonwoven fabric. The [rmm] of the above-described low-crystalline polypropylene is more preferably 2.6 mol% or more, and still more preferably 2.7 mol% or more. An upper limit thereof is usually about 10 mol%.

(d) $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2 \leq 2.0$

[0022] As for the above-described low-crystalline polypropylene, its $[\text{mm}]$ (mesotriad fraction) \times $[\text{rr}]$ (racemic triad fraction)/ $[\text{mr}]$ (meso-racemic triad fraction)² is preferably 2.0 or less. The $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2$ indicates an index of random properties of the polymer, and when the $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2$ is smaller, the random properties become higher, the frequency of end breakage is reduced, and a nonwoven fabric having a soft touch feeling is obtained. When this value is 2.0 or less, end breakage is not caused in fibers obtained by spinning, and a nonwoven fabric having a good soft touch feeling is obtained. From such a viewpoint, the $[\text{mm}] \times [\text{rr}]/[\text{mr}]^2$ of the above-described low-crystalline polypropylene is more preferably more than 0.25 and 1.8 or less, and still more preferably 0.5 to 1.5.

(e) Weight average molecular weight (M_w) = 10,000 to 200,000

[0023] As for the above-described low-crystalline polypropylene, its weight average molecular weight is preferably 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 is appropriate, and therefore, end breakage on the occasion of spinning is suppressed. In addition, 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 of the above-described low-crystalline polypropylene is more preferably 30,000 to 100,000, and still more preferably 40,000 to 80,000.

(f) Molecular weight distribution (M_w/M_n) < 4.0

[0024] As for the low-crystalline polypropylene which is used in the first invention, its molecular weight distribution (M_w/M_n) is preferably less than 4.0. When the molecular weight distribution is less than 4.0, the generation of stickiness in the fibers obtained by spinning is suppressed. The molecular weight distribution (M_w/M_n) of the above-described low-crystalline polypropylene is more preferably 3.0 or less, and still more preferably 2.5 or less.

[0025] By using the low-crystalline polypropylene satisfying the above-described conditions (a) to (f) together with the above-described general-purpose polypropylene, a raw material compensating disadvantages of the general-purpose polypropylene and suitable for the production of a target nonwoven fabric is obtained.

[0026] It is to be noted that the low-crystalline polypropylene satisfying the above-described condition (a) may also be a copolymer using other comonomer than propylene so long as it satisfies the condition (2) regarding the resin composition (C) as described later. In this case, the amount of the comonomer is usually 2% by mass or less. Examples of the comonomer include ethylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexene, 1-octene, 1-decene, 1-dodecene, 1-tetradecene, 1-hexadecene, 1-octadecene, 1-eicocene, and the like. In the present invention, one or two or more kinds of these monomers can be used.

[Resin Composition (C)]

[0027] The resin composition (C), which is a raw material of the fibrous nonwoven fabric of the first invention, contains the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B) as described above, and a half-crystallization time (t_c) of the resin composition (C) is 1.2 to 2.0 times the half-crystallization time (t_a) of the high-crystalline polyolefin (A).

[0028] If the half-crystallization time (t_c) is less than 1.2 times the half-crystallization time (t_a), the crystallization rate of the resin composition (C) is fast, and on the occasion of melt molding of fibers, and the molten resin discharged from a nozzle is immediately crystallized, and therefore, end breakage is liable to occur, reducing the fiber diameter is difficultly achieved, and the fiber diameter is limited to 1.7 deniers or more. Meanwhile, if the half-crystallization time (t_c) is more than 2.0 times the half-crystallization time (t_a), the fiber surface is sticky, roping (phenomenon in which the fibers stick to each other) is generated, and stable spinning cannot be achieved. In addition, the fibers become thick due to shrinkage, so that reducing the fiber diameter cannot be achieved, too.

[0029] From the above-described viewpoints, the half-crystallization time (t_c) is preferably 1.2 to 1.9 times, and more preferably 1.3 to 1.9 times the half-crystallization time (t_a).

[0030] Examples of a method of controlling the half-crystallization time (t_c) of the resin composition (C) to 1.2 times or more the half-crystallization time (t_a) of the high-crystalline polyolefin (A) include a method of increasing a ratio of the low-crystalline polyolefin (B) in the combination of the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B); a method of changing the low-crystalline polyolefin (B) to one having a longer half-crystalline time (t_b); and the like. Meanwhile, examples of a method of controlling the half-crystallization time (t_c) of the resin composition (C) to 2.0 times or less the half-crystalline time (t_a) of the high-crystalline polyolefin (A) include a method of decreasing a ratio of the low-crystalline polyolefin (B) in the combination of the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B); a method of changing the low-crystalline polyolefin (B) to one having a shorter half-crystalline time (t_b); and the like.

[0031] The content of the high-crystalline polyolefin (A) in the above-described resin composition (C) is not particularly limited so long as it falls within the range where the condition (2) regarding the resin composition (C) can be satisfied. In addition, the contents of the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B) in order to satisfy the condition (2) regarding the resin composition (C) vary depending upon what kinds of polyolefins are selected with respect to the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B).

[0032] As an example, in the case where the high-crystalline polyolefin (A) is a general-purpose polypropylene, and the low-crystalline polyolefin (B) is a low-crystalline polypropylene satisfying the above-described initial elastic modulus, the content of the high-crystalline polyolefin (A) in the above-described resin composition (C) is preferably 50 to 98% by mass, and more preferably 60 to 95% by mass.

[0033] In addition, the content of the low-crystalline polyolefin (B) in the above-described resin composition (C) is

preferably 2 to 50% by mass, and more preferably 5 to 40% by mass.

[0034] Furthermore, in the above-described resin composition (C), the content of the low-crystalline polypropylene satisfying the above-described initial elastic modulus is preferably 2 to 35% by mass, any more preferably 5 to 30% by mass on the basis of a total sum of the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B).

[0035] The above-described resin composition (C) may contain other thermoplastic resin and various additives, such as a release agent, etc. so long as it satisfies the above-described physical properties.

[0036] Examples of the other thermoplastic resin include olefin-based polymers. Specifically, examples thereof include a polypropylene, a propylene-ethylene copolymer, a propylene-ethylene-diene copolymer, a polyethylene, an ethylene/ α -olefin copolymer, an ethylene-vinyl acetate copolymer, a hydrogenated styrene-based elastomer, and the like. These may be used solely or may be used in combination of two or more kinds thereof.

[0037] The above-described release agent refers to an additive for improving release properties such that the molded nonwoven fabric does not attach to a roll or a conveyor of a molding machine. The release agent which is contained in the resin composition (C) is called an internal release agent, and the internal release agent refers to an additive for improving release properties of the nonwoven fabric upon being added to the resin raw material. An external release agent as described later refers to an additive for improving release properties of the nonwoven fabric upon being coated directly on a roll or a conveyor of a molding machine.

[0038] Examples of the internal release agent include organic carboxylic acids or metal salts thereof, aromatic sulfonic acid salts or metal salts thereof, organic phosphoric acid compounds or metal salts thereof, dibenzylidene sorbitol or derivatives thereof, rhodinic acid partial metal salts, inorganic fine particles, imidic acids, amide acids, quinacridones, quinones, and mixtures thereof.

[0039] Examples of the metal in the above-described metal salt of an organic carboxylic acid include Li, Ca, Ba, Zn, Mg, Al, Pb, and the like. In addition, examples of the carboxylic acid include fatty acids, such as octyic acid, palmitic acid, lauric acid, stearic acid, behenic acid, montanic acid, 12-hydroxystearic acid, oleic acid, isostearic acid, ricinoleic acid, etc.; and aromatic acids, such as benzoic acid, p-t-b-benzoic acid, etc. Specific examples thereof include aluminum benzoate, aluminum p-t-butylbenzoate, sodium adipate, sodium thiophenecarboxylate, sodium pyrrolecarboxylate, and the like.

[0040] Specific examples of the above-described dibenzylidene sorbitol or derivative thereof include dibenzylidene sorbitol, 1,3:2,4-bis(o-3,4-dimethylbenzylidene)sorbitol, 1,3:2,4-bis(o-2,4-dimethylbenzylidene)sorbitol, 1,3:2,4-bis(o-4-ethylbenzylidene)sorbitol, 1,3:2,4-bis(o-4-chlorobenzylidene)sorbitol, 1,3:2,4-dibenzylidene sorbitol, and the like. More specifically, GELOL MD and GELOL MD-R, all of which are manufactured by New Japan Chemical Co., Ltd., and the like are exemplified.

[0041] Examples of the above-described rhodinic acid partial metal salt include PINECRYSTAL KM1600, PINECRYSTAL KM1500, and PINECRYSTAL KM1300, all of which are manufactured by Arakawa Chemical Industries, Ltd., and the like.

[0042] Examples of the above-described inorganic fine particle include talc, clay, mica, asbestos, glass fiber, glass flake, glass bead, calcium silicate, montmorillonite, bentonite, graphite, aluminum powder, alumina, silica, diatomaceous earth, titanium oxide, magnesium oxide, pumice powder, pumice balloon, aluminum hydroxide, magnesium hydroxide, basic magnesium carbonate, dolomite, calcium sulfate, potassium titanate, barium sulfate, calcium sulfite, molybdenum sulfide, and the like. In addition, synthetic silica may be used as the silica, and examples thereof include SYLSIA, manufactured by Fuji Silysia Chemical Ltd., MIZUKASIL, manufactured by Mizusawa Industrial Chemicals, Ltd., and the like.

[0043] Examples of the above-described amide compound include erucic acid amide, oleic acid amide, stearic acid amide, behenic acid amide, ethylene bisstearic acid amide, ethylene bisoleic acid amide, stearyl erucamide, oleyl palmitamide, adipic acid dianilide, suberic acid dianilide, and the like.

[0044] Examples of the above-described organic phosphoric metal salt include ADEKASTAB NA-11 and ADEKASTAB NA-21, all of which are manufactured by Adeka Corporation, and the like.

[0045] These internal release agents can be used solely or in combination of two or more kinds thereof. In the present invention, among these internal release agents, one selected from erucic acid amide, dibenzylidene sorbitol, 1,3:2,4-bis(o-3,4-dimethylbenzylidene)sorbitol, 1,3:2,4-bis(o-2,4-dimethylbenzylidene)sorbitol, 1,3:2,4-bis(o-4-ethylbenzylidene)sorbitol, 1,3:2,4-bis(o-4-chlorobenzylidene)sorbitol, and 1,3:2,4-dibenzylidene sorbitol is preferred.

[0046] In the resin composition (C), the content of the internal release agent is preferably 10 to 10,000 ppm by mass, and more preferably 100 to 5,000 ppm by mass on the basis of the resin mixture from which the additives are eliminated. When the content of the internal release agent is 10 ppm by mass or more, the function as the release agent is revealed, whereas when it is 10,000 ppm by mass or less, a balance between the function as the release agent and the economy becomes good.

[0047] As the additive other than the release agent, any conventionally known additives may be blended. Examples of the additive include a foaming agent, a crystal nucleating agent, a weatherability stabilizer, a UV absorber, a light stabilizer, a heat resistance stabilizer, an antistatic agent, a flame retardant, a synthetic oil, a wax, an electric property-

improving agent, a slip inhibitor, an anti-blocking agent, a viscosity-controlling agent, a coloring inhibitor, a defogging agent, a lubricant, a pigment, a dye, a plasticizer, a softening agent, an age resistor, a hydrochloric acid-absorbing agent, a chlorine scavenger, an antioxidant, and an antitack agent, and the like.

5 [Nonwoven Fabric]

[0048] The nonwoven fabric of the first invention is one obtained by using the above-described resin composition (C) as the raw material, and preferably one produced by a spunbond method. Typically, in the spunbond method, the nonwoven fabric is produced in such a manner that a melt-kneaded resin composition is spun, stretched, and opened to form continuous long fibers, and subsequently, in a continued step, the continuous long fibers are accumulated on a moving collecting surface and entangled. In this method, a nonwoven fabric can be produced continuously, and the resulting nonwoven fabric has large strength because fibers constituting the nonwoven fabric are stretched continuous long fibers.

[0049] As the spunbond method of producing the fibrous nonwoven fabric of the first invention, conventionally known methods can be adopted. Fibers can be produced by extruding a molten polymer, for example, from a large nozzle with several thousands of holes or a group of small nozzles having, for example, about 40 holes. After discharged from the nozzle, molten fibers are cooled by a cross-flow cooling air system, drawn away from the nozzle, and stretched by high-speed airflow. Generally, there are two kinds of air-damping methods, and the both use a venturi effect. In the first air-damping method, filaments are stretched by using a suction slot (slot stretching). This method is conducted by using the width of a nozzle or the width of a machine. In the second air-damping method, filaments are stretched through a nozzle or a suction gun. The filaments formed through the above methods are collected to form a web on a screen (wire) or a hole forming belt. Subsequently, the web passes through a compression roll and then passes between heating calendar rolls, and the web is bounded in a portion where an embossment portion on one roll includes about 10% to 40% of the area of the web, thereby forming a nonwoven fabric.

[0050] Specific conditions for producing the fibrous nonwoven fabric by the above-described spunbond method are hereunder explained.

[Production Condition 1]

[0051] In the case of producing the fibrous nonwoven fabric of the present invention by a spunbonded nonwoven fabric molding machine using an ejector system, when the fibrous nonwoven fabric is produced by using the above-described resin composition (C) by the spunbond method under the following conditions, reducing the fiber diameter can be achieved to an extent that the fiber diameter is 1.0 denier or less.

- (1) Resin temperature: 200°C to 270°C
- (2) Discharge amount per hole: 0.1 g/min to 0.5 g/min
- (3) Ejector pressure: 1.0 kg/cm² to 4.0 kg/cm²
- (4) Suction pressure: 600 rpm to 900 rpm
- (5) Calendar temperature: 100°C to 150°C
- (6) Nip pressure: 40 kg/cm

[0052] As for the above-described production condition 1, in reducing fiber diameter of fibers, in particular, it is preferred to set it to conditions under which relations represented by the following expressions (1-1) to (1-4) are held between the discharge amount per hole ([T] g/min) and the ejector pressure ([E] kg/cm²).

$$[T]/[E] \leq 0.25 \quad (1-1)$$

$$[T]/[E] \leq 0.2 \quad (1-2)$$

$$[T]/[E] \leq 0.13 \quad (1-3)$$

$$[T]/[E] \leq 0.1 \quad (1-4)$$

[0053] When the $[T]/[E]$ is 0.25 or less, the fibers of the resulting fibrous nonwoven fabric are likely to become a fine fiber with 1.3 deniers or less; when it is 0.2 or less, the above-described fibers are likely to become a fine fiber with 1.0 denier or less; when it is 0.13 or less, the above-described fibers are likely to become a fine fiber with 0.8 deniers or less; and when it is 0.1 or less, the above-described fibers are likely to become a fine fiber with 0.6 deniers or less.

[Production Condition 2]

[0054] In the case of producing the fibrous nonwoven fabric of the present invention by a spunbonded nonwoven fabric molding machine using a cabin system, when the fibrous nonwoven fabric is produced by using the above-described resin composition (C) by the spunbond method under the following conditions, reducing the fiber diameter can be achieved to an extent that the fiber diameter is 1.0 denier or less.

- (1) Resin temperature: 200°C to 270°C
- (2) Discharge amount per hole: 0.3 g/min to 0.6 g/min
- (3) Cabin pressure: 4,500 Pa to 8,000 Pa
- (4) Calendar temperature: 100°C to 150°C
- (5) Nip pressure: 100 N/mm

[0055] As for the above-described production condition 2, in reducing fiber diameter of fibers, in particular, it is preferred to set it to conditions under which relations represented by the following expressions (2-1) to (2-4) are held between the discharge amount per hole ($[T]$ g/min) and the cabin pressure ($[C]$ Pa).

$$[T]/[C] \times 1,000 \leq 0.09 \quad (2-1)$$

$$[T]/[C] \times 1,000 \leq 0.06 \quad (2-2)$$

$$[T]/[C] \times 1,000 \leq 0.05 \quad (2-3)$$

[0056] When the " $[T]/[C] \times 1,000$ " is 0.09 or less, the fibers of the resulting fibrous nonwoven fabric are likely to become a fine fiber with 1.3 deniers or less; when it is 0.06 or less, the above-described fibers are likely to become a fine fiber with 1.0 denier or less; and when it is 0.05 or less, the above-described fibers are likely to become a fine fiber with 0.9 deniers or less.

[0057] In producing the fibrous nonwoven fabric of the first invention, in the case of using an external release agent, the external release agent is sprayed onto the above-described moving collecting surface. In the case where the resin composition (C) contains the internal release agent, though the external release agent may not be sprayed onto the above-described moving collecting surface, it may also be used in combination with the internal release agent from the standpoint of obtaining good release properties.

[0058] Specific examples of the above-described external release agent include fluorine-based release agents and silicone-based release agents. Examples of the fluorine-based release agent include DAIFREE, manufactured by Daikin Industries, Ltd. and FRELEASE, manufactured by Neos Company Limited. Examples of the silicone-based release agent include SPRAY 200, manufactured by Dow Corning Toray Silicone Co., Ltd.; KF96SP, manufactured by Shin-Etsu Chemical Co., Ltd.; EPOLEASE 96, manufactured by Pelnex, Ltd.; KURE-1046, manufactured by Kure Engineering Ltd.; and the like. These can be used solely or in combination of two or more kinds thereof. In the first invention, among these external release agents, silicone-based release agents are preferred.

[0059] Examples of a method of spraying the external release agent onto the above-described moving collecting surface include a method by spraying and the like.

[0060] The following fiber products can be given as examples of a fiber product using the fibrous non-woven fabric of the first invention. That is, a member for a disposable diaper, a stretchable member for a diaper cover, a stretchable member for a sanitary product, a stretchable member for a hygienic product, a stretchable tape, an adhesive bandage, a stretchable member for clothing, an insulating material for clothing, a heat insulating material for clothing, a protective suit, a hat, a mask, a glove, a supporter, a stretchable bandage, a base fabric for a fomentation, a non-slip base fabric, a vibration absorber, a finger cot, an air filter for a clean room, an electret filter subjected to electret processing, a separator, a heat insulator, a coffee bag, a food packaging material, a ceiling skin material for an automobile, an acoustic insulating material, a cushioning material, a speaker dust-proof material, an air cleaner material, an insulator skin, a

backing material, an adhesive non-woven fabric sheet, various members for automobiles such as a door trim, various cleaning materials such as a cleaning material for a copying machine, the facing and backing of a carpet, an agricultural beaming, a timber drain, members for shoes such as a sport shoe skin, a member for a bag, an industrial sealing material, a wiping material, a sheet, and the like can be given. The fibrous non-woven fabric of the present invention is preferably used particularly in a hygienic material such as a paper diaper.

<Second Invention>

[0061] A spunbonded nonwoven fabric according to a second invention is constituted of fibers having a fineness of 0.2 to 1.0 denier (preferably 0.2 to 0.8 deniers, more preferably 0.2 to 0.6 deniers, and still more preferably 0.3 to 0.6 deniers).

[0062] Details of the spunbond woven fabric according to the second invention are the same as those in the fibrous nonwoven fabric according to the first invention, except that the spunbond woven fabric is not limited to one composed of the resin composition (C) containing the high-crystalline polyolefin (A) and the low-crystalline polyolefin (B) as described above. The spunbond woven fabric according to the second invention can be suitably produced by the spunbond method (production condition 1) using the above-described ejector system.

[Examples]

[0063] The following Examples are merely explained for the purpose of exemplification and are non-limitative examples.

Example 1

(Preparation of Resin Composition)

[0064] To a resin mixture composed of 10 parts by mass of a low-crystalline polypropylene ("L-MODU (a registered trademark) S901", manufactured by Idemitsu Kosan Co., Ltd., MFR: 50 g/10 min, melting point: 70°C) and 90 parts by mass of a high-crystalline polypropylene A ("NOVATEC SA-03", manufactured by Japan Polypropylene Corporation, MFR: 30 g/10 min, melting point: 160°C), erucic acid amide was added in an amount of 2,000 ppm on the basis of the resin mixture, thereby preparing a resin composition.

[0065] Physical properties of the low-crystalline polypropylene and the high-crystalline polypropylene A as described above were measured by the following measuring methods. Results are shown in Table 1.

[Initial Elastic Modulus]

[0066] The polypropylene was subjected to press molding to fabricate a test piece, the initial elastic modulus of which was then measured by a tensile test in conformity with JIS K-7113.

- Thickness of test piece (No. 2 dumbbell): 1 mm
- Cross-head speed: 50 mm/min
- Loadcell: 100 kg

[Half-crystallization Time]

[0067] A half-crystallization time measured by the following method using FLASH DSC (manufactured by Mettler-Toledo International Inc.) was used.

(1) The sample is melted by heating at 230°C for 2 minutes and then cooled to 25°C at a rate of 2,000°C/sec, and a time change of heating value in an isothermal crystallization process at 25°C is measured.

(2) When an integrated value of heating value from start of the isothermal crystallization to completion of the crystallization is defined as 100%, a time from start of the isothermal crystallization until the integrated value of heating value reaches 50% was defined as the half-crystallization time.

[Melt Flow Rate (MFR)]

[0068] The melt flow rate was measured under conditions at a temperature of 230°C and at a load of 21.18 N in conformity with JIS K7210.

[Melting Point]

[0069] The melting point (T_m - D) was determined from a peak top of a peak observed on the highest temperature side of a melt endothermic curve obtained by maintaining 10 mg of the sample at -10°C for 5 minutes and then increasing the temperature at a rate of $10^{\circ}\text{C}/\text{min}$ by using a differential scanning calorimeter (DSC-7, manufactured PerkinElmer Inc.) under a nitrogen atmosphere.

[Measurement of Weight Average Molecular Weight (M_w) and Molecular Weight Distribution (M_w/M_n)]

[0070] The weight average molecular weight (M_w) and the molecular weight distribution (M_w/M_n) were determined by a gel permeation chromatography (GPC) method. The following device and conditions were used in the measurement to obtain a weight average molecular weight as converted into polystyrene.

<GPC Measuring Device>

[0071]

Column: TOSO GMHHR-H(S)HT

Detector: RI detector for liquid chromatography, WATERS 150C

<Measurement Conditions>

[0072]

Solvent: 1,2,4-trichlorobenzene

Measurement temperature: 145°C

Flow rate: 1.0 mL/min

Sample concentration: 2.2 mg/mL

Injection amount: 160 μL

Calibration curve: Universal Calibration

Analysis program: HT-GPC (ver. 1.0)

[NMR Measurement]

[0073] The ^{13}C -NMR spectrum was measured with the following device under the following conditions. The peak assignment followed to the method proposed by A. Zambelli, et al., "Macromolecules, 8, 687 (1975)".

Device: ^{13}C -NMR device, JNM-EX400 series, manufactured by JEOL, Ltd.

Method: Proton complete decoupling method

Concentration: 220 mg/mL

Solvent: Mixed solvent of 1,2,4-trichlorobenzene and deuterated benzene in a ratio of 90/10 (volume ratio)

Temperature: 130°C

Pulse width: 45°

Pulse repetition time: 4 seconds

Accumulation: 10,000 times

<Calculating Expressions>

[0074]

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

$$R = y/S \times 100$$

$$S = P_{\beta\beta} + P_{\alpha\beta} + P_{\alpha\gamma}$$

S: Signal intensity of carbon atoms in side chain methyl of all the propylene units

$P_{\beta\beta}$: 19.8 to 22.5 ppm

$P_{\alpha\beta}$: 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: Mesopentad chain, 21.7 to 22.5 ppm

[0075] The mesopentad fraction [mmmm], the racemic pentad fraction [rrrr], and the racemic-meso-racemic-meso pentad fraction [rmmr] are measured in conformity with the method proposed by A. Zambelli, et al., "Macromolecules, 6, 925 (1973)" and are a meso fraction, a racemic fraction, and a racemic-meso-racemic-meso fraction, respectively in the pentad units of the polypropylene molecular chain that are measured based on a signal of the methyl group in the ^{13}C -NMR spectrum. As the mesopentad fraction [mmmm] increases, the stereoregularity increases. In addition, the triad fractions [mm], [rr], and [mr] were also calculated by the above-described method.

[0076] In addition, with respect to the above-described resin composition, the half-crystallization time was also measured by the above-described measuring method. Furthermore, a value obtained by dividing the half-crystallization time of the resin composition by the half-crystallization time of the high-crystalline polypropylene was defined as a relative crystallization time ratio. Results are shown in Table 2.

(Production of Fibrous Nonwoven Fabric)

[0077] The above-described resin composition was melt extruded at a resin temperature of 250°C by using a single-screw extruder with a gear pump, and the molten resin was spun by discharging from a nozzle having a nozzle diameter of 0.3 mm (hole number: 841 holes) at a rate of 0.1 g/min in terms of a discharge amount per hole. Fibers obtained by spinning were sucked under the nozzle by an ejector at a pressure of 1.0 kg/cm² while cooling with air and laminated on a net surface moving at a line speed of 11 m/min. A fiber bundle laminated on the net surface was embossed at a nip pressure of 40 N/mm by using calendar rolls heated at 140°C and then wound up by a wind-up roll. Here, $[T]/[E]$ obtained from a relation between the discharge amount per hole and the ejector pressure was 0.1.

[0078] The resulting fibrous nonwoven fabric was measured for basis weight, fineness, breaking strength, breaking strain and static friction coefficient of the nonwoven fabric, and also subjected to cantilever measurement in the following measuring methods. Measurement results are shown in Table 2.

[Basis Weight]

[0079] The weight of the resulting nonwoven fabric of 5 cm × 5 cm was measured, thereby measuring the basis weight (g/10 m²).

[Fineness]

[0080] The fibers in the nonwoven fabric were observed with a polarizing microscope, an average value (d) of diameter of randomly selected five fibers was measured, and the fineness of the nonwoven fabric sample was calculated from the following expression [1] by using a density of the resin ($\rho = 900,000 \text{ g/m}^3$).

$$\text{Fineness (denier)} = \rho \times \pi \times (d/2)^2 \times 9,000 \quad [1]$$

[Breaking Strength-Breaking Strain]

[0081] From a test piece (200 mm in length × 50 mm in width) of the resulting nonwoven fabric, sampling was conducted in the machine direction (MD) and the cross-machine direction (CD) vertical to the machine direction. Using a tensile tester (AUTOGRAPH AG-1, manufactured by Shimadzu Corporation), the test piece was set at an initial length L₀ of 100 mm, stretched at a tensile speed of 300 mm/min, and measured for a stain and a load in the stretching process, and values of the load and the strain at the moment when the nonwoven fabric was broken were defined as breaking strength and breaking strain, respectively.

[Static Friction Coefficient]

[0082] From test pieces (220 mm in length × 100 mm in width and 220 mm in length × 70 mm in width) of the resulting nonwoven fabric, sampling was conducted in the machine direction (MD) and the cross-machine direction (CD) vertical to the machine direction. Two sheets of the nonwoven fabrics were overlaid on a seating of a static friction coefficient measuring device (friction measuring device AN type, manufactured by Toyo Seiki Kogyo Co., Ltd.); a weight of 1,000 g was placed thereon; the seating was inclined at a rate of 2.7 degrees/min; an angle when the nonwoven fabrics slipped 10 mm was measured; and from the weight (1,000 g) of the placed weight and the angle when the nonwoven fabrics

slipped 10 mm, the static friction coefficient was calculated. The smaller friction coefficient shows that the spunbonded nonwoven fabric has good hand touch feeling and texture.

[Cantilever Test]

[0083] A test piece of 100 mm in length \times 100 mm in width was fabricated from the resulting nonwoven fabric, and the cantilever test was conducted by using a cantilever tester having a slope having an incline angle of 45°C in one end of a seating thereof. The test piece was slipped on the seating at a fixed speed in the slope direction, and a movement distance of the nonwoven fabric at the moment when the test piece was bent and one end thereof came into contact with the slope was measured. The measurement was conducted in both of the machine direction (MD) and the cross-machine direction (CD) vertical to the machine direction.

Example 2

[0084] A nonwoven fabric was molded and evaluated in the same manners as those in Example 1, except that in Example 1, the discharge amount per hole was changed to 0.2 g/min, the ejector pressure was changed to 4.0 kg/cm², and the line speed was changed to 24 m/min. Results are shown in Table 2. At that time, [T]/[E] obtained from a relation between the discharge amount per hole and the ejector pressure was 0.05.

Example 3

[0085] A nonwoven fabric was molded and evaluated in the same manners as those in Example 1, except that in Example 1, the discharge amount per hole was changed to 0.3 g/min, the ejector pressure was changed to 2.0 kg/cm², and the line speed was changed to 35 m/min. Results are shown in Table 2. At that time, [T]/[E] obtained from a relation between the discharge amount per hole and the ejector pressure was 0.15.

Comparative Example 1

[0086] A nonwoven fabric was molded and evaluated in the same manners as those in Example 1, except that in Example 1, the addition amount of the low-crystalline polypropylene was changed to 1% by mass, the discharge amount per hole was changed to 0.5 g/min, the ejector pressure was changed to 2.0 kg/cm², and the line speed was changed to 54 m/min. Results are shown in Table 2. At that time, [T]/[E] obtained from a relation between the discharge amount per hole and the ejector pressure was 0.25.

Comparative Example 2

[0087] A nonwoven fabric was molded and evaluated in the same manners as those in Example 1, except that in Example 1, the low-crystalline polypropylene was not added, the discharge amount per hole was changed to 0.5 g/min, the ejector pressure was changed to 2.0 kg/cm², and the line speed was changed to 54 m/min. Results are shown in Table 2. At that time, [T]/[E] obtained from a relation between the discharge amount per hole and the ejector pressure was 0.25.

Table 1

	Low-crystalline polypropylene	High-crystalline polypropylene A	High-crystalline polypropylene B	High-crystalline polypropylene C
Initial elastic modulus (MPa)	125	1,650	1,550	1,450
Half-crystallization time (sec)	540	0.066	0.066	0.066
MFR (g/10 min)	50	30	36	33
Melting point (°C)	70	160	161	163

Table 2

			Examples			Comparative Examples	
			1	2	3	1	2
Composition of resin	High-crystalline PP-A (parts by mass)		90	90	90	99	100
	Low-crystalline PP (parts by mass)		10	10	10	1	0
	Erucic acid amide (ppm)		2000	2000	2000	0	0
Properties of resin	Half-crystallization time (t _c , sec)		0.094	0.094	0.094	0.0693	0.066
	(t _c /t _a)		1.42	1.42	1.42	1.05	1.00
Molding conditions	Resin temperature (°C)		250	250	250	250	250
	Discharge amount per hole (g/min)		0.1	0.2	0.3	0.5	0.5
	Ejector pressure (kg/cm ²)		1	4	2	2	2
	[T]/[E]		0.1	0.05	0.15	0.25	0.25
	Line speed (m/min)		11	24	35	54	54
	Calendar temperature (°C)		140	135	140	140	140
	Nip pressure (N/mm)		40	40	40	40	40
Performance of nonwoven fabric	Basis weight (g/m ²)		13	13	13	13	13
	Fineness (denier)		0.4	0.5	0.9	1.6	1.7
	Breaking strength (N/5 cm)	MD	51	84	50	46	44
		CD	17	22	19	20	19
	Breaking strain (%)	MD	44	70	50	55	51
		CD	58	77	64	67	64
	Static friction coefficient	MD	0.34	0.37	0.29	0.46	0.46
		CD	0.44	0.46	0.35	0.57	0.56
	Cantilever test (mm)	MD	52	48	56	50	51
		CD	26	30	45	32	33

Example 4

(Preparation of Resin Composition)

[0088] To a resin mixture composed of 10 parts by mass of a low-crystalline polypropylene ("L-MODU (a registered trademark) S901", manufactured by Idemitsu Kosan Co., Ltd., MFR: 50 g/10 min, melting point: 70°C) and 90 parts by mass of a high-crystalline polypropylene B ("PP3155", manufactured by ExxonMobil, MFR: 36 g/10 min, melting point: 161°C), erucic acid amide was added in an amount of 2,000 ppm on the basis of the resin mixture, thereby preparing a resin composition.

[0089] Physical properties of the above-described high-crystalline polypropylene B were measured by the above-described measuring methods. Results are shown in Table 1.

[0090] In addition, with respect to the above-described resin composition, its half-crystallization time was measured by the above-described measuring method. Furthermore, a value obtained by dividing the half-crystallization time of the resin composition by the half-crystallization time of the high-crystalline polypropylene was defined as a relative crystallization time ratio. Results are shown in Table 3.

[0091] The above-described resin composition was melt extruded at a resin temperature of 250°C by using a single-screw extruder with a gear pump, and the molten resin was spun by discharging from a nozzle having a nozzle diameter of 0.6 mm (hole number: 5,800 holes/m) at a rate of 0.47 g/min in terms of a discharge amount per hole. Fibers obtained by spinning were sucked under the nozzle by a cooling air duct at a cabin pressure of 8,000 Pa while cooling with air

and laminated on a net surface moving at a line speed of 180 m/min. A fiber bundle laminated on the net surface was embossed at a nip pressure of 100 N/mm by using calendar rolls heated at 140°C and then wound up by a wind-up roll. Here, "[T]/[C] × 1,000" obtained from a relation between the discharge amount per hole and the cabin pressure was 0.06.

[0092] The resulting nonwoven fabric was measured for basis weight, fineness, breaking strength, breaking strain and static friction coefficient of the nonwoven fabric, and also subjected to cantilever measurement in the above-described measuring methods. Measurement results are shown in Table 3.

Example 5

[0093] A nonwoven fabric was molded and evaluated in the same manners as those in Example 4, except that in Example 4, the cabin pressure was changed to 6,500 Pa. Results are shown in Table 3. At that time, [T]/[C] obtained from a relation between the discharge amount per hole and the cabin pressure was 0.07.

Example 6

[0094] A nonwoven fabric was molded and evaluated in the same manners as those in Example 4, except that in Example 4, 15 parts by mass of the low-crystalline polypropylene and 85 parts by mass of the high-crystalline polypropylene B were mixed, and the erucic acid amide was not added, thereby preparing a resin composition; the cabin pressure was changed to 7,500 Pa; and the line speed was changed to 150 m/min. Results are shown in Table 3. At that time, [T]/[C] obtained from a relation between the discharge amount per hole and the cabin pressure was 0.05.

Example 7

[0095] A nonwoven fabric was molded and evaluated in the same manners as those in Example 6, except that in Example 6, the cabin pressure was changed to 6,000 Pa. Results are shown in Table 3. At that time, [T]/[C] obtained from a relation between the discharge amount per hole and the cabin pressure was 0.06.

Example 8

(Preparation of Resin Composition)

[0096] To a resin mixture composed of 5 parts by mass of a low-crystalline polypropylene ("L-MODU (a registered trademark) S901", manufactured by Idemitsu Kosan Co., Ltd., MFR: 50 g/10 min, melting point: 70°C) and 95 parts by mass of a high-crystalline polypropylene B ("PP3155", manufactured by Exxon Mobil Corporation, MFR: 36 g/10 min, melting point: 161°C), erucic acid amide was added in an amount of 2,000 ppm on the basis of the resin mixture, thereby preparing a resin composition.

[0097] In addition, with respect to the above-described resin composition, its half-crystallization time was measured by the above-described measuring method. Furthermore, a value obtained by dividing the half-crystallization time of the resin composition by the half-crystallization time of the high-crystalline polypropylene was defined as a relative crystallization time ratio. Results are shown in Table 3.

[0098] The above-described resin composition was melt extruded at a resin temperature of 245°C by using a single-screw extruder with a gear pump, and the molten resin was spun by discharging from a nozzle having a nozzle diameter of 0.6 mm (hole number: 5,800 holes/m) at a rate of 0.40 g/min in terms of a discharge amount per hole. Fibers obtained by spinning were sucked under the nozzle by a cooling air duct at a cabin pressure of 5,500 Pa while cooling with air and laminated on a net surface moving at a line speed of 530 m/min. A fiber bundle laminated on the net surface was embossed at a nip pressure of 100 N/mm by using calendar rolls heated at 146°C and then wound up by a wind-up roll. Here, "[T]/[C] × 1,000" obtained from a relation between the discharge amount per hole and the cabin pressure was 0.07.

[0099] The resulting nonwoven fabric was measured for basis weight, fineness, breaking strength, breaking strain and static friction coefficient of the nonwoven fabric, and also subjected to cantilever measurement in the above-described measuring methods. Measurement results are shown in Table 3.

Example 9

(Preparation of Resin Composition)

[0100] To a resin mixture composed of 20 parts by mass of a low-crystalline polypropylene ("L-MODU (a registered trademark) S901", manufactured by Idemitsu Kosan Co., Ltd., MFR: 50 g/10 min, melting point: 70°C) and 80 parts by mass of a high-crystalline polypropylene C ("MOPLen HP561S", manufactured by LyondellBasell, MFR: 33 g/10 min,

melting point: 163°C), erucic acid amide was added in an amount of 2,000 ppm on the basis of the resin mixture, thereby preparing a resin composition.

[0101] Physical properties of the above-described high-crystalline polypropylene C were measured by the above-described measuring methods. Results are shown in Table 1.

[0102] In addition, with respect to the above-described resin composition, its half-crystallization time was measured by the above-described measuring method. Furthermore, a value obtained by dividing the half-crystallization time of the resin composition by the half-crystallization time of the high-crystalline polypropylene was defined as a relative crystallization time ratio. Results are shown in Table 3.

[0103] The above-described resin composition was melt extruded at a resin temperature of 240°C by using a single-screw extruder with a gear pump, and the molten resin was spun by discharging from a nozzle having a nozzle diameter of 0.6 mm (hole number: 5,800 holes/m) at a rate of 0.57 g/min in terms of a discharge amount per hole. Fibers obtained by spinning were sucked under the nozzle by a cooling air duct at a cabin pressure of 6,000 Pa while cooling with air and laminated on a net surface moving at a line speed of 214 m/min. A fiber bundle laminated on the net surface was embossed at a nip pressure of 70 N/mm by using calendar rolls heated at 136°C and then wound up by a wind-up roll. Here, "[T]/[C] × 1,000" obtained from a relation between the discharge amount per hole and the cabin pressure was 0.10.

[0104] The resulting nonwoven fabric was measured for basis weight, fineness, breaking strength, breaking strain and static friction coefficient of the nonwoven fabric, and also subjected to cantilever measurement in the above-described measuring methods. Measurement results are shown in Table 3.

Comparative Example 3

[0105] A nonwoven fabric was molded and evaluated in the same manners as those in Example 4, except that in Example 4, 1 part by mass of the low-crystalline polypropylene and 99 parts by mass of the high-crystalline polypropylene B were mixed, and the erucic acid amide was not added, thereby preparing a resin composition; the cabin pressure was changed to 4,500 Pa; and the line speed was changed to 220 m/min. Results are shown in Table 3. At that time, [T]/[C] obtained from a relation between the discharge amount per hole and the cabin pressure was 0.13.

Comparative Example 4

[0106] A nonwoven fabric was molded and evaluated in the same manners as those in Example 4, except that in Example 4, only the high-crystalline polypropylene B was added as the raw material resin without adding the low-crystalline polypropylene and the erucic acid amide; the cabin pressure was changed to 4,500 Pa; and the line speed was changed to 220 m/min. Results are shown in Table 3. At that time, [T]/[C] obtained from a relation between the discharge amount per hole and the cabin pressure was 0.14.

Comparative Example 5

[0107] A resin composition was prepared by mixing 25 parts by mass of a low-crystalline polypropylene ("L-MODU (a registered trademark) S901", manufactured by Idemitsu Kosan Co., Ltd., MFR: 50 g/10 min, melting point: 70°C) and 75 parts by mass of the high-crystalline polypropylene C ("MOPLEN HP561S", manufactured by LyondellBasell, MFR: 33 g/10 min, melting point: 163°C) without adding erucic acid amide.

[0108] In addition, with respect to the above-described resin composition, its half-crystallization time was measured by the above-described measuring method. Furthermore, a value obtained by dividing the half-crystallization time of the resin composition by the half-crystallization time of the high-crystalline polypropylene was defined as a relative crystallization time ratio. Results are shown in Table 3.

[0109] The above-described resin composition was melt extruded at a resin temperature of 236°C by using a single-screw extruder with a gear pump, and the molten resin was spun by discharging from a nozzle having a nozzle diameter of 0.6 mm (hole number: 5,800 holes/m) at a rate of 0.57 g/min in terms of a discharge amount per hole. Fibers obtained by spinning were sucked under the nozzle by a cooling air duct at a cabin pressure of 5,500 Pa while cooling with air and laminated on a net surface moving at a line speed of 215 m/min. A fiber bundle laminated on the net surface was embossed at a nip pressure of 90 N/mm by using calendar rolls heated at 134°C and then wound up by a wind-up roll. Here, "[T]/[C] × 1,000" obtained from a relation between the discharge amount per hole and the cabin pressure was 0.10.

[0110] The resulting nonwoven fabric was measured for basis weight, fineness, breaking strength, breaking strain and static friction coefficient of the nonwoven fabric, and also subjected to cantilever measurement in the above-described measuring methods. Measurement results are shown in Table 3.

Table 3

		Examples						Comparative Examples				
		4	5	6	7	8	9	3	4	5		
Composition of resin	High-crystalline PP-B (parts by mass)	90	90	85	85	95	0	99	100	0		
	High-crystalline PP-C (parts by mass)	0	0	0	0	0	80	0	0	75		
	Low-crystalline PP (parts by mass)	10	10	15	15	5	20	1	0	25		
Properties of resin	Erucic acid amide (ppm)	2000	2000	0	0	2000	2000	0	0	0		
	Half-crystallization time (t_c , sec)	0.094	0.094	0.11	0.11	0.081	0.127	0.0693	0.066	0.141		
	(t_c/t_g)	1.42	1.42	1.67	1.67	1.21	1.91	1.05	1.00	2.12		
Molding conditions	Resin temperature ($^{\circ}\text{C}$)	250	250	250	250	245	240	250	250	236		
	Discharge amount per hole (g/min)	0.47	0.47	0.39	0.36	0.40	0.57	0.57	0.57	0.57		
	Cabin pressure (MPa)	8000	6500	7500	6000	5500	6000	4500	4000	5500		
	$[\eta]/[\eta] \times 1,000$	0.06	0.07	0.05	0.06	0.07	0.10	0.13	0.14	0.10		
	Line speed (m/min)	180	180	150	140	530	214	220	220	215		
	Calendar temperature ($^{\circ}\text{C}$)	140	140	140	140	146	136	140	140	134		
	Nip pressure (N/mm)	100	100	100	100	100	70	100	100	90		
	Basis weight (g/m ²)	15	15	15	15	13	15	15	15	15		
	Fineness (denier)	0.92	1.1	0.87	0.97	1.1	1.4	1.7	1.8	1.5		
Performance of nonwoven fabric	Breaking strength (cm) strength (N/5)	MD	45	50	49	36	22	35	32	38		
		CD	21	20	25	31	18	16	15	24		
	Breaking strain (%)	MD	67	72	67	63	47	50	43	54		
		CD	87	79	86	79	80	65	50	72		
	friction Static friction coefficient	MD	0.26	0.25	0.57	0.57	0.27	0.55	0.55	0.61		
		CD	0.3	0.3	0.63	0.63	0.28	0.6	0.58	0.72		
	Cantilever test (mm)	MD	38	39	38	38	32	50	47	40		
		CD	24	23	24	24	22	35	33	30		

INDUSTRIAL APPLICABILITY

[0111] The fibrous nonwoven fabric of the present invention is extremely small in fiber diameter and good in hand touch feeling and is especially preferably used for hygienic materials, such as a paper diaper, etc.

Claims

1. A fibrous nonwoven fabric comprising a resin composition (C) comprising a high-crystalline polyolefin (A) and a low-crystalline polyolefin (B), the fibrous nonwoven fabric satisfying the following conditions (1) and (2):

(1) a half-crystallization time (t_a) of the high-crystalline polyolefin (A) and a half-crystallization time (t_b) of the low-crystalline polyolefin (B) satisfy a relation of $t_a < t_b$; and

(2) a half-crystallization time (t_c) of the resin composition (C) is 1.2 to 2.0 times the half-crystallization time (t_a) of the high-crystalline polyolefin (A).

2. The fibrous nonwoven fabric according to claim 1, wherein a fineness of fibers constituting the fibrous nonwoven fabric is 0.2 to 1.3 deniers.

3. The fibrous nonwoven fabric according to claim 2, wherein the fineness of fibers constituting the fibrous nonwoven fabric is 0.2 to 0.8 deniers.

4. The fibrous nonwoven fabric according to any one of claims 1 to 3, wherein an initial elastic modulus of the high-crystalline polyolefin (A) is 500 to 2,000 MPa, and an initial elastic modulus of the low-crystalline polyolefin (B) is 5 MPa or more and less than 500 MPa.

5. The fibrous nonwoven fabric according to any one of claims 1 to 4, wherein when molding the fibrous nonwoven fabric, molding is performed in a discharge amount per hole of 0.1 to 0.5 g/min.

6. A spunbonded nonwoven fabric constituted of fibers having a fineness of 0.2 to 1.0 denier.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052164

A. CLASSIFICATION OF SUBJECT MATTER

D04H1/4291(2012.01)i, D04H3/007(2012.01)i, D04H3/16(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D04H1/00-18/04, D01F1/00-6/96, D01F9/00-9/04, C08K3/00-13/08,
C08L1/00-101/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

Thomson Innovation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/030893 A1 (Idemitsu Kosan Co., Ltd.), 17 March 2011 (17.03.2011), claims; paragraphs [0001], [0008], [0009], [0012] to [0018], [0027] to [0032]; examples & US 2012/0208422 A1 & EP 2479331 A1	1-6
X A	JP 2011-168944 A (Idemitsu Kosan Co., Ltd.), 01 September 2011 (01.09.2011), claims; paragraphs [0001], [0005], [0025] to [0029]; examples & US 2012/0302982 A1 & EP 2527508 A1 & WO 2011/090132 A1	1-5 6

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
25 April, 2014 (25.04.14)Date of mailing of the international search report
13 May, 2014 (13.05.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052164

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 08-003853 A (Mitsui Petrochemical Industries, Ltd.), 09 January 1996 (09.01.1996), claims; paragraph [0009]; table 1 & CN 1112975 A	6 1-5
A	WO 2012/105567 A1 (Idemitsu Kosan Co., Ltd.), 09 August 2012 (09.08.2012), claims; paragraphs [0001], [0008] to [0017], [0025] to [0031]; examples (Family: none)	1-6

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052164

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

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

The invention in claims 1-5 is "fibrous nonwoven fabric which is constituted of a resin composition (C) comprising a highly crystalline polyolefin (A) and a lowly crystalline polyolefin (B)".

Meanwhile, the invention in claim 6 is "spunbonded nonwoven fabric configured from fibers having a fineness of 0.2-1.0 deniers".
(Continued to extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/052164

Continuation of Box No.III of continuation of first sheet(2)

As such, the spunbonded nonwoven fabric according to the invention in claim 6 is nonwoven fabric constituted of fibers having a specific fineness in which the resin for the nonwoven-fabric-constituent fibers does not need to include a polyolefin and is not specified at all. Consequently, there is no matter common among all the invention in claims 1-5.

There is no other common matter which is considered to be a special technical feature and any technical relationship cannot be found between the inventions of claims 1-5 and the invention of claim 6.

Consequently, it is obvious that the inventions of claims 1 - 6 do not comply with the requirement of unity of invention.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2011030893 A [0004]