

DESCRIPTION

TITLE OF INVENTION: SPUNBONDED NONWOVEN FABRIC

TECHNICAL FIELD

[0001]

The present invention relates to a spun-bonded nonwoven fabric composed of polyolefin fibers, which is excellent in waterproofness and softness, and is excellent in moldability as building material applications.

BACKGROUND ART

[0002]

In recent years, nonwoven fabrics have been used in various applications and are expected to grow in the future. The nonwoven fabrics are employed in a wide range of applications such as industrial materials, civil engineering materials, building materials, living materials, agricultural materials, sanitary materials, and medical materials.

[0003]

Building materials draw attention as an application of nonwoven fabrics. In recent construction of buildings such as a wooden house, a ventilation layer construction method has been widely employed. In the method, a ventilation layer is provided between an outer wall material and a heat insulation material, and moisture that has penetrated into a wall body is released to the outside through the ventilation layer. In the ventilation layer construction method, a spun-bonded nonwoven fabric is utilized as a house wrapping material which is a breathable-waterproof sheet having both waterproofness of preventing rainwater from infiltrating from the outside of a building and breathability of allowing moisture in the wall escape to the outside. The spun-bonded nonwoven fabric is excellent in breathability because of its structure, while it has poor waterproofness. Therefore, the spun-bonded nonwoven fabric is made into a laminate with a film with excellent waterproofness to make a breathable-waterproof sheet for use as a house wrapping material.

[0004]

The house wrapping material is fixed on a base by a binding needle (also referred to as a tucker needle or a staple) and employed in a construction work. It is thus required to have excellent durability over a long period of time, weather resistance under conditions of high temperature and low temperature, durability (hydrolysis resistance) of long term use, and

excellent moldability at the time of construction.

[0005]

In the related art, in order to improve the balance between breathability and waterproofness, a house wrapping material which is a laminate of a polyester-based nonwoven fabric having a fiber diameter of 3 to 28 microns and a basis weight of 5 to 50 g/m², and a film having a thickness of 7 to 60 microns made of block copolymerized polyester having a hard segment and a soft segment superposed on the nonwoven fabric, has been proposed (see Patent Literature 1).

CITATION LIST

PATENT LITERATURE

[0006]

Patent Literature 1: Japanese Patent No. 3656837

SUMMARY

TECHNICAL PROBLEM

[0007]

However, since the house wrapping material in the related art is a laminate of a nonwoven fabric and a film, there is a problem that the sheet is hard and has poor moldability. The hardness and the poor moldability of the sheet are due to the film, and reducing a proportion of the film to be bonded is effective, but the reduction of the film proportion is restricted in view of waterproofness.

As described above, a nonwoven fabric having both waterproofness and softness and excellent in moldability has been sought in the related art.

[0008]

Therefore, in view of the above problems, an object of the present disclosure is, as compared with the related art, to provide a spun-bonded nonwoven fabric composed of fibers made of polyolefin, having both waterproofness and softness and excellent in workability.

SOLUTION TO PROBLEM

[0008a]

In an aspect, there is provided a spun-bonded nonwoven fabric composed of polyolefin fibers, wherein a surface of the nonwoven fabric has an average pore diameter of 0.1 to 25 μm , and a maximum pore diameter of 50 μm or less, the nonwoven fabric has water pressure resistance per unit basis weight of 7 mm H₂O/(g/m²) or more, and the spun-bonded nonwoven fabric has an apparent density in the range of from 0.10 g/cm³ to 0.30 g/cm³.

[0009]

The spun-bonded nonwoven fabric of the present disclosure is composed of polyolefin fibers, in which a surface of the nonwoven fabric has an average pore diameter of 0.1 to 25 μm , a maximum pore diameter of 50 μm or less, and the spun-bonded nonwoven fabric has water

pressure resistance per unit basis weight of 7 mm H₂O/(g/m²) or more.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, the polyolefin fiber constituting the nonwoven fabric has an average single fiber diameter of 6.5 to 11.9 μm.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, a kinetic friction coefficient between the polyolefin fibers constituting the nonwoven fabric is 0.01 to 0.3.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, the fiber constituting the nonwoven fabric has an MFR of 155 to 850 g/10 min.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, the fiber constituting the nonwoven fabric includes a fatty acid amide compound having 23 or more and 50 or less carbon atoms.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, an addition amount of the fatty acid amide compound is 0.01% to 5.0% by mass.

According to a preferred example of the spun-bonded nonwoven fabric of the disclosure, the fatty acid amide compound is ethylene bisstearic acid amide.

ADVANTAGEOUS EFFECTS

[0010]

According to the present disclosure, a spun-bonded nonwoven fabric that is composed of polyolefin fibers with good spinnability and high productivity despite of their small single fiber diameter, has uniform texture, a smooth surface and excellent softness, a small pore diameter size of the nonwoven fabric, and high water resistance, can be obtained. Based on these characteristics, the spun-bonded nonwoven fabric of the present disclosure can be suitably utilized as a breathable-waterproof sheet application in particular.

DESCRIPTION OF EMBODIMENTS

[0011]

The spun-bonded nonwoven fabric of the present invention is a spun-bonded nonwoven fabric composed of polyolefin fibers, in which the nonwoven fabric has an average pore diameter size of 0.1 to 25 μm, a maximum pore diameter size of 50 μm or less, and the nonwoven fabric has a water pressure resistance per unit basis weight of 7 mm H₂O/(g/m²) or more.

[0012]

Accordingly, a spun-bonded nonwoven fabric having a small pore diameter on a surface of the nonwoven fabric and excellent in water resistance can be made, and a spun-bonded nonwoven fabric having the required level of waterproofness and workability for a breathable-waterproof sheet such as a house wrapping material can be made.

[0013]

For the polyolefin-based resin in the present invention, examples of a polypropylene-based resin include a propylene homopolymer or a copolymer of propylene and various α -olefins, and examples of a polyethylene-based resin include an ethylene homopolymer or a copolymer of ethylene and various α -olefins, and the polypropylene-based resin is particularly preferably employed in view of characteristics of spinnability and strength.

[0014]

In the polyolefin-based resin in the present invention, a proportion of the propylene homopolymer is preferably 60% by mass or more, more preferably 70% by mass or more, and even more preferably 80% by mass or more. By setting so, good spinnability is maintained and strength is improved.

[0015]

The polyolefin-based resin to be employed in the present invention may be a mixture of two or more polyolefin-based resins. A resin composition containing another olefin-based resin, a thermoplastic elastomer, etc. may also be employed.

[0016]

A melt flow rate (may be abbreviated as MFR) of the polyolefin resin included in the spun-bonded nonwoven fabric of the present invention (polypropylene: ASTM D1238, load: 2160 g, temperature: 230°C, polyethylene: ASTM D1238, load: 2160 g, temperature: 190°C) is preferably 155 to 850 g/10 min, more preferably 155 to 600 g/10 min, and even more preferably 155 to 400 g/10 min. Further, two or more resins having different MFR can be blended at any proportion to adjust the MFR of the polyolefin resin. By setting the MFR in a range of 155 to 850 g/10 min, performing stable spinning becomes easier, development of orientation crystallization becomes easier, and obtaining high-strength fibers becomes easier.

[0017]

Certainly, two or more resins having different MFR can be blended at any proportion to adjust the MFR of the polyolefin-based resin. In this case, an MFR of the resin to be blended with the main polyolefin-based resin is preferably 10 to 1000 g/10 min, more preferably 20 to 800 g/10 min, and even more preferably 30 to 600 g/10 min. By setting so,

it is possible to prevent the partial occurrence of viscosity unevenness in the blended polyolefin-based resin, resulting in non-uniform fineness, and to prevent the spinnability from deterioration.

[0018]

In addition, when fibers, which will be described later, are spun, resins to be used may be decomposed to adjust MFR for preventing the partial occurrence of viscosity unevenness, for making the fineness of fibers uniform, and for making fiber diameters smaller, which will be described later. However, a free radical agent such as a peroxide, particularly a dialkyl peroxide should not be added. When this method is performed, partial viscosity unevenness occurs and the fineness becomes non-uniform, and hence, the fiber diameter is hardly made sufficiently small, and spinnability may be deteriorated due to the partial viscosity unevenness and bubbles caused by cracked gas.

[0019]

In the present invention, a composite fiber obtained by combining the polyolefin resins can also be employed. Examples of a composite form of the composite fiber include composite forms such as a concentric core-sheath type, an eccentric core-sheath type, and a sea-island type. Among them, the concentric core-sheath type composite form is preferred since it has an excellent spinnability and the fibers can be uniformly bonded to each other by thermal bonding because of making a low melting point component serve as a sheath component.

[0020]

Additives in common use, such as an antioxidant, weathering agent, light stabilizer, antistatic agent, antifogging agent, antiblocking agent, lubricant, nucleator, and pigment, or other polymers can be added to the polyolefin-based resin in the present invention, so long as the addition thereof does not impair the effects of the invention.

[0021]

The polyolefin-based resin in the present invention has a melting point of preferably 80°C to 200°C, more preferably 100°C to 180°C, and even more preferably 120°C to 180°C. By setting the melting point to preferably 80°C or higher, more preferably 100°C or higher, and even more preferably 120°C or higher, heat resistance that can withstand practical use is easily attained. By setting the melting point to preferably 200°C or lower, more preferably 180°C or lower, the filaments discharged from a spinneret is easily cooled, fusion of fibers are prevented and stable spinning is easily performed.

[0022]

The polyolefin fibers constituting the spun-bonded nonwoven fabric in the present invention preferably have an average single fiber diameter of 6.5 to 11.9 μm . By setting the average single fiber diameter to preferably 6.5 μm or more, more preferably 7.5 μm or more, and even more preferably 8.4 μm or more, a decrease in spinnability can be prevented and a high-quality nonwoven fabric can be stably produced. Meanwhile, by setting the average single fiber diameter to preferably 11.9 μm or less, more preferably 11.2 μm or less, and even more preferably 10.6 μm or less, a spun-bonded nonwoven fabric having high uniformity in the surface of the nonwoven fabric can be made, and hence a spun-bonded nonwoven fabric with small pore diameter in the surface thereof and with excellent water resistance that can withstand practical use can be obtained.

[0023]

The polyolefin fibers constituting the spun-bonded nonwoven fabric in the present invention preferably has CV value of a single fiber diameter of 0.1% to 7.0%. By setting the CV value of the single fiber diameter to preferably 0.1% or more, more preferably 1.0% or more, and even more preferably 2.0% or more, complication of production equipment and extreme reduction in productivity can be prevented. Meanwhile, by setting the CV value of the single fiber diameter to preferably 7.0% or less, more preferably 6.0% or less, and even more preferably 5.0% or less, occurrence of a rough feeling on the surface is prevented, and a laminated nonwoven fabric having high uniformity can be obtained. Back pressure of a spinneret, uniformity of yarn cooling conditions and stretching conditions mainly affect the CV value of the single fiber diameter, and the CV value can be controlled by appropriately adjusting them.

[0024]

The polyolefin fiber constituting the spun-bonded nonwoven fabric in the present invention preferably has an MFR of 155 to 850 g/10 min. By setting the MFR thereof to preferably 155 to 850 g/10 min, more preferably 155 to 600 g/10 min, even more preferably 155 to 400 g/10 min, the filaments being discharged can readily follow deformations, even when the filaments are drawn at a high spinning speed to increase the productivity. Stable spinning is hence possible. In addition, since stable drawing at a high spinning speed is possible, orientation and crystallization of the fibers can be promoted to impart high mechanical strength to the polyolefin fibers.

[0025]

In a preferred embodiment of the spun-bonded nonwoven fabric of the present invention, from the standpoint of improving slipperiness between the fibers, slipperiness as

texture, and softness, the polyolefin-based fibers, which are constituent fibers, composed of polyolefin resins contain a fatty acid amide compound having 23 or more and 50 or less carbon atoms.

[0026]

It is known that the number of carbon atoms of a fatty acid amide compound incorporated into the polyolefin fibers affects the change in a moving speed of the fatty acid amide compound to the fiber surface. By setting a fatty acid amide compound to preferably have 23 or more carbon atoms, more preferably 30 or more carbon atoms, excessive exposure of the fatty acid amide compound on the fiber surface is inhibited, excellent spinnability and working stability are attained, and high production efficiency is hence maintained. Further, when the filaments are collected as a spun-bonded nonwoven fabric web, moderate slipperiness can be imparted to the fibers, and the uniformity of the nonwoven fabric surface can be attained and the pore diameter of the nonwoven fabric surface can be made smaller. Meanwhile, by setting a fatty acid amide compound to preferably have 50 or less carbon atoms, more preferably 42 or less carbon atoms, this fatty acid amide compound readily migrates to the fiber surface, making it possible to impart slipperiness between the spun-bonded nonwoven fabric fibers or slipperiness and softness of the nonwoven fabric surface.

[0027]

Examples of the fatty acid amide compound having 23 or more and 50 or less carbon atoms included in the present invention include saturated fatty acid monoamide compounds, saturated fatty acid diamide compounds, unsaturated fatty acid monoamide compounds, and unsaturated fatty acid diamide compounds.

[0028]

Specific examples of the fatty acid amide compound having 23 to 50 carbon atoms include tetradocosanoic acid amide, hexadocosanoic acid amide, octadocosanoic acid amide, nervonic acid amide, tetracosapentaenoic acid amide, nisinic acid amide, ethylenebislauric acid amide, methylenebislauric acid amide, ethylene bisstearic acid amide, ethylene bishydroxystearic acid amide, ethylene bisbehenic acid amide, hexamethylene bisstearic acid amide, hexamethylene bisbehenic acid amide, hexamethylene hydroxystearic acid amide, distearyl adipic acid amide, distearyl sebacic acid amide, ethylene bisoleic acid amide, ethylene biserucic acid amide, and hexamethylene bisoleic acid amide. Two or more of these amide compounds may be used in combination.

In the present invention, it is especially preferred to use the ethylene bisstearic acid

amide, which is a saturated fatty acid diamide compound, among those fatty acid amide compounds. Ethylene bisstearic acid amide has excellent thermal stability and is hence usable in melt spinning. With the polyolefin-based fibers into which ethylene bisstearic acid amide has been blended, when the filaments are collected as the spun-bonded nonwoven fabric web while maintaining high productivity, moderate slipperiness can be imparted to the fibers, and the uniformity of the nonwoven fabric surface can be attained and the pore diameter of the nonwoven fabric surface can be made smaller.

[0029]

In the present invention, an addition amount of the fatty acid amide compound to the polyolefin fibers composed of the polyolefin-based resin, which polyolefin fibers constituting the spun-bond nonwoven fabric, is preferably 0.01% to 5.0% by mass. By setting the addition amount of the fatty acid amide compound to preferably 0.01% to 5.0% by mass, more preferably 0.1% to 3.0% by mass, even more preferably 0.1% to 1.0% by mass, when the filaments are collected as the spun-bonded nonwoven fabric web while maintaining the spinnability, moderate slipperiness can be imparted to the fibers, and the uniformity of the nonwoven fabric surface is attained and the pore diameter of the nonwoven fabric surface can be made smaller.

[0030]

The term “addition amount” herein means the proportion by mass percent of the fatty acid amide compound added to the polyolefin-based fibers constituting the spun-bonded nonwoven fabric of the invention, specifically to the whole resin constituting the polyolefin-based fibers. For example, in the case where the fatty acid amide compound is added only to the sheath ingredient to be used as a component of core-sheath type composite fibers, the proportion thereof to the sum of the core and sheath ingredients is calculated.

[0031]

A kinetic friction coefficient between the fibers constituting the spun-bonded nonwoven fabric of the present invention is preferably 0.01 to 0.3. By setting the kinetic friction coefficient to 0.01 or more, preferably 0.1 or more, it is possible to provide slipperiness between the fibers, and when the spun-bonded nonwoven fabric web is collected, the fibers can moderately slip, and the uniformity of the nonwoven fabric surface can be improved. By setting the kinetic friction coefficient to 0.3 or less, preferably 0.25 or less, the nonwoven fabric surface is not too slippery, and workability and handling properties when the spun-bonded nonwoven fabric is used as a nonwoven fabric for building materials become good. The kinetic friction coefficient between spun-bonded fibers can be controlled by a

polymer type, a single fiber diameter, types of lubricant to be added to the fibers and an addition amount thereof, and a fiber shape.

[0032]

It is important that the spun-bonded nonwoven fabric of the present invention has water pressure resistance per basis weight of 7 mm H₂O/(g/m²) or more. By setting the water pressure resistance per basis weight to 7 mm H₂O/(g/m²) or more, more preferably 8 mm H₂O/(g/m²) or more, even more preferably 9 mm H₂O/(g/m²) or more, the spun-bonded nonwoven fabric alone can be applied as a breathable-waterproof sheet in applications where low waterproofness is required. In addition, in bonding with a film, a proportion of the film to be bonded can be reduced, and decrease in breathability due to the film and workability deterioration due to a decrease in sheet texture can be prevented. Further, in order to prevent deterioration of workability in use as a building material application resulting from lowered softness due to high density spun-bonded nonwoven fabric, and to prevent reduction in productivity due to thinning of fibers, the water pressure resistance per basis weight is preferably 20 mm H₂O/(g/m²) or less. The water pressure resistance per basis weight can be controlled by the single fiber diameter, the pore diameter of the nonwoven fabric surface, apparent density, and thermocompression bonding conditions (degree of press bonding, temperature, and linear pressure).

[0033]

It is important that the surface of the spun-bonded nonwoven fabric of the present invention has a maximum pore diameter of 50 μm or less. By setting the maximum pore diameter to 50 μm or less, preferably 45 μm or less, and more preferably 40 μm or less, a decrease in water pressure resistance due to local pore opening can be prevented. A lower limit of the maximum pore diameter is not particularly limited, but the maximum pore diameter is preferably 0.1 μm or more in order to prevent deterioration of workability in use as a building material application resulting from lowered softness due to high density spun-bonded nonwoven fabric. The maximum pore diameter of the nonwoven fabric can be controlled by a single fiber diameter, a fiber dispersion state, a kinetic friction coefficient between single fibers, a nonwoven fabric basis weight, thermal bonding conditions (temperature, pressure), and the like.

[0034]

It is important that the surface of the spun-bonded nonwoven fabric of the present invention has an average pore diameter of 0.1 μm to 25 μm. By setting the average pore diameter to 0.1 μm or more, preferably 0.5 μm or more, more preferably 1 μm or more, the

spun-bonded nonwoven fabric can be made moderately soft, and by setting the average pore diameter to 25 μm or less, more preferably 23 μm or less, even more preferably 21 μm or less, high water resistance can be expressed. The average pore diameter of the nonwoven fabric can be controlled by a single fiber diameter, a fiber dispersion state, a kinetic friction coefficient between single fibers, a nonwoven fabric basis weight, thermal bonding conditions (temperature, pressure), and the like.

[0035]

The spun-bonded nonwoven fabric of the present invention preferably has a basis weight of 10 to 100 g/m^2 . By setting the basis weight to preferably 10 g/m^2 or higher, more preferably 13 g/m^2 or higher, even more preferably 15 g/m^2 or higher, spun-bonded nonwoven fabric having mechanical strength practically usable can be obtained. Meanwhile, by setting the basis weight to preferably 100 g/m^2 or lower, more preferably 50 g/m^2 or lower, and even more preferably 30 g/m^2 or lower, when the spun-bonded nonwoven fabric is employed as a house wrapping material, the weight thereof becomes suitable for a worker to hold it in hand while carrying out the work at the time of construction, and a laminated nonwoven fabric excellent in handleability at the time of construction can be obtained. The laminated nonwoven fabric has an excellent handling properties when it is used as another application.

[0036]

The spun-bonded nonwoven fabric of the present invention preferably has a thickness of 0.05 to 1.50 mm. By setting the thickness to preferably 0.05 to 1.50 mm, more preferably 0.08 to 1.00 mm, even more preferably 0.10 to 0.80 mm, softness and moderate cushioning properties are provided, and when the spun-bonded nonwoven fabric is employed as a house wrapping material, the weight thereof becomes suitable for a worker to hold it in hand while carrying out the work at the time of construction, rigidity of the nonwoven fabric is not too strong, and a laminated nonwoven fabric having excellent handleability at the time of construction can be obtained.

[0037]

The spun-bonded nonwoven fabric of the present invention preferably has apparent density of 0.05 to 0.30 g/cm^3 . By setting the apparent density to preferably 0.30 g/cm^3 or less, more preferably 0.25 g/cm^3 or less, even more preferably 0.20 g/cm^3 or less, deterioration of the softness of the spun-bonded nonwoven fabric by packing the fibers tightly can be prevented. Meanwhile, by setting the apparent density to preferably 0.05 g/cm^3 or more, more preferably 0.08 g/cm^3 or more, even more preferably 0.10 g/cm^3 or more, a

spun-bonded nonwoven fabric having handleability and strength or softness that can withstand practical use, while preventing occurrence of fluffing or delamination, can be obtained.

[0038]

A stress per basis weight at 5% elongation of the spun-bonded nonwoven fabric of the present invention (hereinafter, may also be described as 5% modulus per basis weight) is preferably 0.06 to 0.33 (N/25 mm)/(g/m²), more preferably 0.13 to 0.30 (N/25 mm)/(g/m²), even more preferably 0.20 to 0.27 (N/25 mm)/(g/m²). By setting so, it is possible to obtain a spun-bonded nonwoven fabric that is soft and excellent in a sense of touch while maintaining strength which renders the spun-bonded nonwoven fabric practically usable.

[0039]

In the present invention, the stress per basis weight at 5% elongation of the spun-bonded nonwoven fabric adopts a value measured by the following procedure in accordance with “6.3 Tensile Strength and Elongation Rate (ISO method)” of JIS L1913: 2010.

(1) Three test pieces of 25 mm × 300 mm per width of 1 m are collected in a lengthwise direction (a longitudinal direction of the nonwoven fabric) and a widthwise direction (a transverse direction of the nonwoven fabric) of the nonwoven fabric.

(2) The test pieces are clamped and set in a tensile tester at intervals of 200 mm.

(3) A tensile test is conducted at a tensile speed of 100 mm/min, and a stress at 5% elongation (5% modulus) is measured.

(4) An average value of the 5% modulus in the lengthwise direction and the widthwise direction measured for each test piece is determined, a 5% modulus per basis weight is calculated based on the following equation, and the calculated value is rounded off to two decimal places.

· 5% modulus per basis weight ((N/25 mm)/(g/m²)) = [average value of 5% modulus (N/25 mm)]/basis weight (g/m²).

[0040]

Preferred modes of a method for producing the spun-bonded nonwoven fabric of the present invention are explained below in detail.

The spun-bonded nonwoven fabric of the present invention is a long fiber nonwoven fabric produced by a spun-bonding (S) method. Examples of the method for producing the nonwoven fabric include a spun-bonding method, a flash spinning method, a wet method, a carding method, and an air-laid method, and the spun-bonding method is, not only excellent

in productivity and mechanical strength, but also can reduce fluffing and falling of fibers which easily occur in a short fiber nonwoven fabric. In addition, a plurality of spun-bonded (S) nonwoven fabric layers are laminated, such as SS, SSS, and SSSS, and hence productivity and texture uniformity are improved. Thus, the method is the preferred mode.

[0041]

In the spun-bonding method, first, a molten thermoplastic resin (polyolefin-based resin) is spun from a spinneret as long fibers, then the fibers are suctioned and stretched with compressed air by an ejector, and subsequently the fibers are collected on a moving net to obtain a nonwoven fiber web. Further, the obtained nonwoven fiber web is subjected to a heat bonding treatment to obtain a spun-bonded nonwoven fabric.

[0042]

The spinneret and ejector can have various shapes including round and rectangular shapes. A rectangular spinneret and a rectangular ejector are preferably used in combination, because the amount of compressed air to be used is relatively small and an energy cost is excellent, the filaments are less likely to suffer fusion bonding to each other or abrasion therebetween, and filament spread is easy.

[0043]

In the present invention, the polyolefin-based resin is melted in an extruder, metered and supplied to a spinneret, and ejected as long fibers. A spinning temperature in melting and spinning a polyolefin-based resin is preferably 200°C to 270°C, more preferably 210°C to 260°C, even more preferably 220°C to 250°C. By setting a spinning temperature within that range, the polyolefin-based resin can be kept in a stable molten state, making it possible to obtain excellent spinning stability.

[0044]

The back pressure of the spinneret is preferably 0.1 to 6.0 MPa. By setting the back pressure to preferably 0.1 to 6.0 MPa, more preferably 0.3 to 6.0 MPa, even more preferably 0.5 to 6.0 MPa, occurrence of variation of the fiber diameter due to deterioration of discharge uniformity and increase in the spinneret size to increase the pressure resistance can be prevented. The back pressure of the spinneret can be adjusted by a discharge pore diameter, a discharge pore depth, and the spinning temperature of the spinneret, and among them, the discharge pore diameter has a large effect.

[0045]

The ejected long-fiber filaments are then cooled. Examples of methods for cooling the ejected filaments include a method in which cold air is forcedly blown against the

filaments, a method in which the filaments are allowed to be cooled naturally at the temperature of the atmosphere around the filaments, and a method in which the distance between the spinneret and the ejector is controlled. Two or more of these methods can be used in combination. Cooling conditions may be suitably adjusted while taking into account of the ejection rate per single hole of the spinneret, spinning temperature, atmosphere temperature, etc. However, in the method of forcibly blowing cool air to the filaments, it is preferable that wind speed variation when measuring 10 points at equal intervals in the width direction in the area to be blown out should be 25% or less. By setting the wind speed variation of 25% or less, more preferably 20% or less, even more preferably 15% or less, the filaments can be uniformly cooled, and a fiber with a small single fiber CV can be obtained. The wind speed variation in the present invention is calculated by the following formula.

$$\cdot \text{Wind speed variation (\%)} = (\text{maximum wind speed} - \text{minimum wind speed}) / \text{average wind speed} \times 100$$

[0046]

Next, the filaments which have been cooled and solidified are drawn and stretched by the compressed air jetted from the ejector.

The spinning speed is preferably 3,500 to 6,500 m/min, more preferably 4,000 to 6,500 m/min, even more preferably 4,500 to 6,500 m/min. By controlling the spinning speed to 3,500 to 6,500 m/min, the process is made to have high production efficiency and the orientation and crystallization of the fibers are enhanced, making it possible to obtain long fibers having high strength. The spinnability usually becomes worse as the spinning speed increases, making it impossible to stably produce filaments. However, as stated above, the desired polyolefin fibers can be stably spun by using the polyolefin-based resin having an MFR within a specific range.

[0047]

Subsequently, the long fibers obtained are collected on a moving net to form a nonwoven fiber web. In the present invention, the filaments come out of the ejector are ejected at a high speed since the filaments are stretched at the high spinning speed. The filaments so ejected at the high speed are spread under control and are collected in a net. A spun-bonded nonwoven fabric having less fiber entanglement and high uniformity can be hence obtained.

[0048]

Examples of a method for spreading the filaments ejected from the ejector under control include: a method in which a flat plate is installed at an angle between the ejector and

the net to guide the filaments; a method in which a plurality of grooves having different angles are provided on the flat plate, so that the filaments falling along the flat plate and the filaments falling along the grooves are separated and dispersed in a nonwoven fiber web flow direction to spread the filaments; and a method in which a plurality of flat plates with different angles are arranged in a comb-tooth shape at an outlet of the ejector and the filaments are dropped along each flat plate to be dispersed and spread in the nonwoven fiber web flow direction.

[0049]

In particular, the method in which the plurality of flat plates with different angles are arranged in a comb-tooth shape at the outlet of the ejector and the filaments are dropped along the flat plates respectively is a preferred mode, since the filaments having a thin fiber diameter are efficiently dispersed in the nonwoven fiber web flow direction and can be spread under control without slowing down as much as possible.

[0050]

In a preferred embodiment of the present invention, a thermal flat roll is brought into contact with the nonwoven fiber web from one side on the net for temporary bonding. In this way, a surface layer of the nonwoven fiber web can be prevented from being turned over or blown when being conveyed on the net to prevent the texture from being deteriorated, and thus conveying performance can be improved from the collection of the filaments to the thermocompression bonding.

[0051]

The nonwoven fiber web obtained is subsequently integrated by heat bonding, and the desired spun-bonded nonwoven fabric can be obtained.

[0052]

Examples of methods for integrating the nonwoven fiber web by heat bonding include methods of heat bonding with various rolls such as: hot embossing rolls which are a pair of rolls, upper and lower, that have an engraved surface (have recesses and protrusions on the surface) respectively; hot embossing rolls which include a combination of a roll having a flat (smooth) surface and a roll which has an engraved surface (has recesses and protrusions on the surface); and hot calendar rolls which include a pair of flat (smooth) rolls, upper and lower; and ultrasonic bonding of heat welding by ultrasonic vibration of a horn. In a preferred embodiment, the hot embossing rolls which are the pair of rolls, upper and lower, that have the engraved surface (have recesses and protrusions on the surface) respectively or the hot embossing rolls which include the combination of the roll having the flat (smooth)

surface and the roll which has the engraved surface (has recesses and protrusions on the surface) are used, so as to attain excellent production efficiency, and partially impart strength to heat-bonded portions while texture and touch which are unique to nonwoven fabrics can be maintained in non-bonded portions.

[0053]

In a preferred embodiment, a metal roll and a metal roll are paired as surface materials of the hot embossing rolls, so as to obtain a sufficient thermocompression bonding effect and to prevent the engraved surface (recesses and protrusions) of one embossing roll from being transferred to a surface of the other roll.

[0054]

A proportion of an embossed bonding area by such hot embossing rolls is preferably 5% to 30%. By setting the proportion of the bonding area to preferably 5% or higher, more preferably 8% or higher, even more preferably 10% or higher, strength which renders the spun-bonded nonwoven fabric practically usable can be obtained. Meanwhile, by setting the proportion of the bonding area to preferably 30% or less, more preferably 25% or less, even more preferably 20% or less, moderate softness and handling properties, suitable for use in especially an application of building materials can be obtained. Even when the ultrasonic bonding is used, the proportion of the bonding area should be preferably in the same range.

[0055]

The term “proportion of bonding area” herein means a proportion of bonded portions to the whole spun-bonded nonwoven fabric. Specifically, in the case of heat bonding with a pair of rolls having recesses and protrusions, the proportion of those portions (bonded portions) of the nonwoven fiber web at which both protrusions of the upper roll and protrusions of the lower roll have come into contact to the whole spun-bonded nonwoven fabric. In the case of heat bonding with a roll having recesses and protrusions and a flat roll, that term means the proportion of those portions (bonded portions) of the nonwoven fiber web at which protrusions of the roll having recesses and protrusions have come into contact to the whole spun-bonded nonwoven fabric. In the case of ultrasonic bonding, the term means a proportion of portions (bonded portions) which are heat welded by ultrasonic machining to the whole spun-bonded nonwoven fabric.

[0056]

The shape of the bonding portions formed by the hot embossing rolls and ultrasonic bonding can be any of circular, elliptic, square, rectangular, parallelogrammic, rhombic, regularly hexagonal, and regularly octagonal shapes and the like. It is preferable that the

bonded portions are uniformly present at constant intervals in the longitudinal direction (conveyance direction) and the transverse direction of the spun-bonded nonwoven fabric. This makes it possible to reduce variation in strength of the spun-bonded nonwoven fabric. [0057]

In a preferred mode, the hot embossing rolls have a surface temperature during heat bonding of -50°C to -15°C with respect to the melting point of the polyolefin-based resin being used. By setting the surface temperature of the hot rolls to a temperature of preferably -50°C or higher, more preferably -45°C or higher with respect to the melting point of the polyolefin-based resin, moderate heat-bonding is rendered and the spun-bonded nonwoven fabric with practically usable strength can be obtained. By setting the surface temperature of the hot embossing rolls to a temperature of preferably -15°C or lower more preferably -20°C or lower with respect to the melting point of the polyolefin-based resin, excessive heat bonding can be inhibited, and moderate softness and workability can be obtained as the spun-bonded nonwoven fabric for building materials. [0058]

The linear pressure of the hot embossing rolls during the heat bonding is preferably 50 to 500 N/cm. By setting the linear pressure of the rolls to preferably 50 N/cm or higher, more preferably 100 N/cm or higher, even more preferably 150 N/cm or higher, moderate heat-bonding is rendered and the spun-bonded nonwoven fabric with practically usable strength can be obtained. Meanwhile, by setting the linear pressure of the hot embossing rolls to preferably 500 N/cm or less, more preferably 400 N/cm or less, even more preferably 300 N/cm or less, moderate softness and workability can be obtained as the spun-bonded nonwoven fabric for building materials. [0059]

In the present invention, for the purpose of adjusting the thickness of the spun-bonded nonwoven fabric, thermocompression bonding can be performed by a hot calendar roll including a pair of upper and lower flat rolls before and/or after heat bonding by the hot embossing rolls. The pair of upper and lower flat rolls means a metal roll or an elastic roll having no recess or protrusion on a surface of the roll, a metal roll and a metal roll can be paired or a metal roll and an elastic roll can be paired for use. The term “elastic roll” herein refers to a roll made of a material having elasticity as compared with the metal roll. Examples of the elastic roll include so-called paper rolls such as paper, cotton, and aramid paper, or resin rolls made of urethane-based resins, epoxy-based resins, silicon-based resins, polyester-based resins, hard rubber, and a mixture thereof.

[0060]

The spun-bonded nonwoven fabric of the present invention has high productivity, uniform texture, a smooth surface, excellent softness, and high water resistance, and therefore can be suitably used as a nonwoven fabric for house wrapping for which breathability and waterproofness are required as an application of building materials.

EXAMPLES

[0061]

Next, the spun-bonded nonwoven fabric of the present invention will be described in detail based on Examples.

(1) Melt flow rate (MFR)

Melt flow rates of a polyolefin-based resin and fibers were measured in accordance with ASTM D-1238 respectively under the conditions of a load of 2,160 g and a temperature of 230°C.

[0062]

(2) Average single fiber diameter (μm):

Spun filaments were drawn and stretched by an ejector and collected on a net to obtain a nonwoven fiber web. Ten small sample pieces were randomly collected from the nonwoven fiber web, the surface of each sample was photographed with a microscope at a magnification of 500 to 1,000 diameters. Ten fibers were selected from each sample, and the hundred fibers in total were examined for fiber width. From the average value, the average single fiber diameter (μm) was calculated.

[0063]

(3) CV value (%) of single fiber diameter

A CV value of the single fiber diameter was calculated based on the following equation from a standard deviation and the average single fiber diameter of the single fiber diameter obtained from the 100 fibers examined in the above (2).

$$\cdot \text{CV value (\%)} \text{ of single fiber diameter} = \text{standard deviation/average value} \times 100$$

[0064]

(4) Spinning Speed (m/min):

The mass per length of 10,000 m was calculated from the average single fiber diameter and the solid density of the polyolefin-based resin used, and the calculated value was rounded off to the first decimal place to obtain the average single-fiber fineness (dtex). The spinning speed was calculated from the average single-fiber fineness and the rate of resin

discharged from the spinneret single hole (hereinafter referred to as “single-hole discharge rate”) (g/min) set under each set of conditions, using the following equation

· Spinning speed (m/min) = (10,000 × [single-hole discharge rate (g/min)]/[average single-fiber fineness (dtex)]).

[0065]

(5) Kinetic Friction Coefficient between Spun-bonded Nonwoven Fabric's fibers:

The friction coefficient between the fibers constituting the spun-bonded nonwoven fabric was measured in accordance with JIS L1015: 2010. The fibers were collected from the spun-bonded nonwoven fabric, the fibers were wound in a cylinder having an outer diameter of 8 mm of a radar type friction coefficient tester so that the fibers were parallel to the axis of the cylinder. Initial loads were put in both ends of the fibers, and the fibers were hanged in the center of the cylindrical sliver, and one end thereof is connected to a torsion balance hook. The cylindrical sliver was rotated at a circumferential speed of 90 cm/min, a load at which both ends of the fibers were balanced by the torsion balance was determined, and the kinetic friction coefficient was calculated by the following equation. For the fibers collected from any three different places, the kinetic friction coefficients were measured and an average thereof was determined as the kinetic friction coefficient.

· Kinetic friction coefficient (μ_d) = $0.733 \log(W/(W - m))$

wherein,

W: Load applied to both ends of fibers,

m: Torsion balance reading.

[0066]

(6) Basis Weight of Spun-bonded Nonwoven Fabric:

In accordance with JIS L1913 (year 2010), 6.2 “Mass per unit area”, three test pieces having a size of 20 cm × 25 cm were cut out per the sample width of 1 m and were each examined for normal-state mass (g), and an average of the basis weight of the spun-bonded nonwoven fabric was converted to mass per m² (g/m²).

[0067]

(7) Apparent Density of Spun-bonded Nonwoven Fabric:

In accordance with 5.1 of JIS L1906 (year 2000 edition), thicknesses (mm) at 10 points per meter of the spun-bonded nonwoven fabric were measured in an unit of 0.01 mm at equal intervals in the width direction of the nonwoven fabric at a load of 10 kPa by using a pressure element having a diameter of 10 mm, and an average value thereof was rounded off

to two decimal places.

Subsequently, the apparent density (g/cm^3) of the spun-bonded nonwoven fabric was calculated based on the following equation from the basis weight and the thickness before the rounding off, and rounded off to two decimal places.

$$\cdot \text{ Apparent density } (\text{g/cm}^3) = [\text{basis weight } (\text{g/m}^2)]/[\text{thickness } (\text{mm})] \times 10^{-3}$$

[0068]

(8) Water Pressure Resistance per Unit Basis Weight of Spun-bonded Nonwoven Fabric:

The water pressure resistance of the spun-bonded nonwoven fabric was measured in accordance with “7.1.1 A method (low water pressure method)” in JIS L1092: 2009. Five test pieces of width of $150 \text{ mm} \times 150 \text{ mm}$ were collected at equal intervals in the width direction of the spun-bonded nonwoven fabric, the test pieces were set to a clamp (with a contact area of water to the test pieces of 100 cm^2) by using an FX-3000-IV water pressure resistant tester “hydro-tester” manufactured by Textest Co., Switzerland, a water level was raised at a rate of $600 \text{ mm/min} \pm 30 \text{ mm/min}$ in a leveling instrument with water, water was transmitted through the test pieces, and the water level when water droplets were generated at three places on the back side was measured in a unit of mm. The measurement was performed with five test pieces, and an average value thereof was set as the water pressure resistance ($\text{mm H}_2\text{O}$). The water pressure resistance thus determined was divided by the basis weight before the rounding off based on the following formula, and water pressure resistance per unit basis weight ($\text{mm H}_2\text{O}/(\text{g/m}^2)$) was determined by being rounded off to one decimal place.

$$\cdot \text{ Water pressure resistance per unit basis weight } (\text{mm H}_2\text{O}/(\text{g/m}^2)) = [\text{Water pressure resistance } (\text{mm H}_2\text{O})]/[\text{basis weight } (\text{g/m}^2)]$$

[0069]

(9) Maximum Pore Diameter and Average Pore Diameter of Spun-bonded Nonwoven Fabric:

The maximum pore diameter and the average pore diameter were evaluated in accordance with JIS K 3832 (bubble point method) by a porous material automatic fine pore measurement system “Capillary Flow Porometer CPF-1500 AEXLC”. A measurement sample has a diameter of 25 mm, and fine pore diameter distribution measurement was performed using Galwick (surface tension: 16 mN/m) as a measurement liquid having a known surface tension. Air pressure was applied to the nonwoven fabric completely

immersed in the measurement liquid, and the maximum pore diameter was calculated from pressure (bubble point) when an appearance of air bubbles was observed. An average value of the pore diameter was calculated from the pore diameter distribution obtained from the measurement. In the measurement, any five places per sample were sampled, and a value determined by rounding off to the first decimal place of the average, and the value with the first decimal place was used.

[0070]

(10) Softness of nonwoven fabric (moldability):

As a sensory evaluation of the sense of touch of the nonwoven fabric, the softness was scored based on the following criteria. The softness was scored by 10 persons and an average thereof was evaluated as the sense of touch of the nonwoven fabric. The higher the score is, the better the softness is, and thus workability in various works was determined to be good, and the softness of 4.0 points or higher was taken as pass.

<Softness (Moldability)>

- 5 points: soft (good moldability)
- 4 points: between 5 points and 3 points
- 3 points: usual
- 2 points: between 3 points and 1 point
- 1 point: hard (poor moldability)

[0071]

[Example 1]

A polypropylene resin made of a homopolymer having a melt flow rate (MFR) of 200 g/10 min was melted with an extruder and discharged from a rectangular spinneret having a spinning temperature of 235°C, a hole diameter ϕ of 0.30 mm, and a hole depth of 2 mm at a single-hole discharge rate of 0.32 g/min. The resultant filaments were cooled and solidified by blowing cold air with 13% variation in wind speed, subsequently drawn and stretched by compressed air jetted from a rectangular ejector at an ejector pressure of 0.35 MPa. A fiber spreading device in which a flat plate having a width of 2 cm and a length of 10 cm facing right downward and a flat plate having a width of 2 cm and a length of 10 cm inclined 10° to 30° on an upstream side of the sheet flow direction were alternately arranged in a comb-tooth shape at an ejector outlet was provided. The filaments were dispersed and spread in the sheet flow direction along the flat plates, and collected on a moving net. A nonwoven fiber web composed of long polypropylene fibers was thus obtained. The long

polypropylene fibers obtained had the following properties. The average single fiber diameter was 10.1 μm , and the spinning speed calculated therefrom was 4,400 m/min. With respect to spinnability, no filament breakage occurred during 1-hour spinning, and the fiber had good spinnability.

Subsequently, a pair of embossing rolls composed of an upper roll, which was a metallic embossing roll having polka dots formed by engraving and having a proportion of bonding area of 16%, and a lower roll, which was a metallic flat roll, was used to heat-bond the obtained nonwoven fiber web at a linear pressure of 300 N/cm and a heat-bonding temperature of 130°C, and a spun-bonded nonwoven fabric having a basis weight of 30 g/m² was obtained. The obtained spun-bonded nonwoven fabric was evaluated by measuring the thickness, the apparent density, the maximum pore size, the average pore size, the kinetic friction coefficient between the fibers, the MFR of the fibers, and the water pressure resistance per unit basis weight. The results thereof are shown in Table 1.

[0072]

[Example 2]

A nonwoven fabric composed of long polypropylene fibers was obtained by the same method as in Example 1, except that the single-hole discharge rate was changed to 0.21 g/min, and the ejector pressure was changed to 0.50 MPa. The spun-bonded long fibers obtained had the following properties. The average single fiber diameter was 7.2 μm , and the spinning speed calculated therefrom was 5,700 m/min. With respect to spinnability, no filament breakage occurred during 1-hour spinning, and the fiber had good spinnability. The results thereof are shown in Table 1.

[0073]

[Example 3]

A nonwoven fabric composed of long polypropylene fibers was obtained by the same method as in Example 1, except that the ejector pressure was changed to 0.50 MPa. The spun-bonded long fibers obtained had the following properties. The average single fiber diameter was 8.9 μm , and the spinning speed calculated therefrom was 5,600 m/min. With respect to spinnability, no filament breakage occurred during 1-hour spinning, and the fiber had good spinnability. The results thereof are shown in Table 1.

[0074]

[Example 4]

A spun-bonded nonwoven fabric was obtained by the same method as in Example 1, except that 1.0% by mass ethylene bisstearic acid amide was added as a fatty acid amide

compound to the polypropylene resin composed of a homopolymer. The results thereof are shown in Table 1.

[0075]

[Example 5]

A spun-bonded nonwoven fabric was obtained by the same method as in Example 2, except that 1.0% by mass ethylene bisstearic acid amide was added as a fatty acid amide compound to the polypropylene resin composed of a homopolymer. The results thereof are shown in Table 1.

[0076]

[Example 6]

A spun-bonded nonwoven fabric was obtained by the same method as in Example 3, except that 1.0% by mass ethylene bisstearic acid amide was added as a fatty acid amide compound to the polypropylene resin composed of a homopolymer. Results are shown in Table 2.

[0077]

[Example 7]

A spun-bonded nonwoven fabric composed of long polypropylene fibers was obtained by the same method as in Example 1, except that 1.0% by mass of ethylene bisstearic acid amide was added as a fatty acid amide compound to the polypropylene resin composed of a homopolymer having an MFR of 60 g/10 min, and an ejector pressure was 0.20 MPa. The spun-bonded long fibers obtained had the following properties. The average single fiber diameter was 11.8 μm , and the spinning speed calculated therefrom was 3,200 m/min. With respect to spinnability, no filament breakage occurred during 1-hour spinning, and the fiber had good spinnability. Results are shown in Table 2.

[0078]

[Comparative Example 1]

A spun-bonded nonwoven fabric was obtained by the same method as in Example 7, except that 1.0% by mass ethylene bisstearic acid amide was not added as a fatty acid amide compound. Results are shown in Table 2.

[0079]

[Comparative Example 2]

A spun-bonded nonwoven fabric was obtained by the same method as in Comparative Example 1, except that the ejector pressure was changed to 0.15 MPa by using the polypropylene resin composed of a homopolymer having an MFR of 35 g/10 min.

Results are shown in Table 2.

[0080]

Table 1

		Unit	Example 1	Example 2	Example 3	Example 4	Example 5
Raw material	Type of resin	-	PP	PP	PP	PP	PP
	MFR of resin	g/10 min	200	200	200	200	200
	Fatty acid amide compound	-	-	-	-	Ethylene bisstearic acid amide	Ethylene bisstearic acid amide
Fiber	Average single fiber diameter	μm	10.1	7.2	8.9	10.1	7.2
	Melt flow rate	g/10 min	210	210	210	210	210
	Spinning speed	m/min	4400	5700	5600	4400	5700
	Single fiber CV	%	4.2	3.4	3.4	3.5	2.8
	Coefficient of friction between fibers	-	0.28	0.27	0.27	0.23	0.21
Nonwoven fabric	Basis weight	g/m^2	30	30	30	30	30
	Thickness	mm	0.2	0.2	0.2	0.2	0.2
	Apparent density	g/cm^3	0.150	0.150	0.150	0.150	0.150
	Water pressure resistance	mm H ₂ O	248	346	290	256	366
	Water pressure resistance per unit basis weight	mm H ₂ O/(g/m ²)	8.3	11.5	9.7	8.5	12.2
	Maximum pore diameter	μm	30	16	24	28	13
	Average pore diameter	μm	20	13	17	19	9
	Softness and moldability of nonwoven fabric	Point	4.1	4.5	4.3	4.2	4.8

[0081]

Table 2

		Unit	Example 6	Example 7	Comparative Example 1	Comparative Example 2
Raw material	Type of resin	-	PP	PP	PP	PP
	MFR of resin	g/10 min	200	60	60	35
	Fatty acid amide compound	-	Ethylene bisstearic acid amide	Ethylene bisstearic acid amide	-	-
Fiber	Average single fiber diameter	μm	8.9	11.8	11.8	14.5
	Melt flow rate	g/10 min	210	65	65	38
	Spinning speed	m/min	5600	3200	3200	2200
	Single fiber CV	%	3.3	6.2	6.2	7.1
	Coefficient of friction between fibers	-	0.22	0.24	0.30	0.32
Nonwoven fabric	Basis weight	g/m^2	30	30	30	30
	Thickness	mm	0.2	0.2	0.2	0.2
	Apparent density	g/cm^3	0.150	0.150	0.150	0.150
	Water pressure resistance	mm H ₂ O	302	212	188	150
	Water pressure resistance per unit basis weight	mm H ₂ O/(g/m ²)	10.1	7.1	6.3	5.0
	Maximum pore diameter	μm	22	41	51	61
	Average pore diameter	μm	15	24	28	33
	Softness and moldability of nonwoven fabric	Point	4.6	4.0	3.8	3.5

[0082]

The spun-bonded nonwoven fabrics of Examples 1 to 7 had the average single fiber diameter of 6.5 to 11.9 μm , the average pore diameter of the nonwoven fabric surface of 0.1 to 25 μm since the single fiber CV was small and uniform. And they had the maximum pore diameter of 50 μm or less, so that they had the water pressure resistance per unit basis weight of 7 mm $\text{H}_2\text{O}/(\text{g}/\text{m}^2)$ or more of excellent water resistance., And the also had excellent softness and moldability. Particularly, in Examples 4 to 6 in which ethylene bis-stearic acid amide was added, because of a small friction coefficient between fibers, moderate slipperiness at the time of collecting the fiber web was given. Further, the average pore diameter on the nonwoven fabric surface was 0.1 to 25 μm , and the maximum pore diameter was 50 μm or less, so that the nonwoven fabrics had excellent water pressure resistance per unit basis weight. These nonwoven fabrics were suitable for use as a nonwoven fabric for building materials such as a nonwoven fabric for house wrapping materials which are required to have breathability and waterproofness.

Meanwhile, in Comparative Examples 1 and 2, since the average pore diameter of the nonwoven fabric surface was larger than 25 μm and the maximum pore diameter was larger than 50 μm , the water resistance was inferior.

[0083]

Although the invention has been described in detail with reference to the specific embodiments, it will be apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the invention. This application is based on Japanese Patent Application 2017-211607 filed on November 1, 2017 and Japanese Patent Application 2018-141052 filed on July 27, 2018, contents of which are incorporated by reference herein.

CLAIMS

1. A spun-bonded nonwoven fabric composed of polyolefin fibers, wherein a surface of the nonwoven fabric has an average pore diameter of 0.1 to 25 μm , and a maximum pore
5 diameter of 50 μm or less, the nonwoven fabric has water pressure resistance per unit basis weight of 7 mm $\text{H}_2\text{O}/(\text{g}/\text{m}^2)$ or more, and the spun-bonded nonwoven fabric has an apparent density in the range of from 0.10 g/cm^3 to 0.30 g/cm^3 .
2. The spun-bonded nonwoven fabric according to claim 1, wherein the fiber
10 constituting the nonwoven fabric has an average single fiber diameter of 6.5 to 11.9 μm .
3. The spun-bonded nonwoven fabric according to claim 1 or 2, wherein a kinetic friction coefficient between the fibers constituting the nonwoven fabric is 0.01 to 0.3.
- 15 4. The spun-bonded nonwoven fabric according to any one of claims 1 to 3, wherein the fiber constituting the nonwoven fabric has an MFR of 155 to 850 g/10 min.
5. The spun-bonded nonwoven fabric according to any one of claims 1 to 4, wherein the
fiber constituting the nonwoven fabric comprises a fatty acid amide compound having 23 or
20 more and 50 or less carbon atoms.
6. The spun-bonded nonwoven fabric according to claim 5, wherein an addition amount of the fatty acid amide compound is 0.01% to 5.0 % by mass.
- 25 7. The spun-bonded nonwoven fabric according to claim 5 or 6, wherein the fatty acid amide compound is ethylene bisstearic acid amide.