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(54) **SPUN-BONDED NON-WOVEN FABRIC**

(57) To provide a spun-bonded nonwoven fabric having excellent strength even at a low basis weight and excellent flexibility and touch feeling, the spun-bonded nonwoven fabric of the present invention is a spun-bonded nonwoven fabric made of a core-sheath composite fiber containing polypropylene-based resin as a main component, in which the spun-bonded nonwoven fabric

has a bonding area and a non-bonding area, and a ratio (Os/Oc) of an orientation parameter Os of a sheath component of the core-sheath composite fiber in the non-bonding area to an orientation parameter Oc of a core component of the core-sheath composite fiber in the non-bonding area is 0.10 to 0.90.

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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a spun-bonded nonwoven fabric.

BACKGROUND ART

10 **[0002]** Many sanitary products such as paper diapers and sanitary napkins are incinerated or landfilled after use due to hygienic problems, which causes a problem of large environmental load due to consumption of resources and an increase in waste. As a response to such a problem, thinning and weight reduction of products have been promoted.

[0003] Even in a spun-bonded nonwoven fabric used as a main material of a paper diaper, efforts have been made to reduce the basis weight from before. For example, a spunbond/meltblown laminated nonwoven fabric including a polypropylene spun-bonded nonwoven fabric having a fineness of 0.7 to 1.5 dtex and a polypropylene meltblown non-
15 woven fabric having a fiber diameter of 1 to 3 μm and having a 5% modulus index in a specific range has been proposed as a nonwoven fabric having excellent water resistance, high softness, and tensile strength even at a low basis weight (refer to Patent Document 1).

PRIOR ART DOCUMENTS

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PATENT DOCUMENTS

[0004] Patent Document 1: Japanese Patent No. 4245970

25 SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

30 **[0005]** However, in the method disclosed in Patent Document 1, the effect of increasing the strength is limited, and it is difficult to achieve the strength that can be put to practical use at the level of low basis weight required in recent years.

[0006] Therefore, an object of the present invention is to provide a spun-bonded nonwoven fabric having excellent strength, excellent flexibility, and touch feeling even at a low basis weight.

SOLUTIONS TO THE PROBLEMS

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[0007] The spun-bonded nonwoven fabric of the present invention has the following configuration.

[1] A spun-bonded nonwoven fabric comprising a core-sheath composite fiber containing a polypropylene-based resin as a main component, wherein the spun-bonded nonwoven fabric has a bonding area and a non-bonding area,
40 and a ratio (O_s/O_c) of an orientation parameter O_s of a sheath component of the core-sheath composite fiber in the non-bonding area to an orientation parameter O_c of a core component of the core-sheath composite fiber in the non-bonding area is 0.10 to 0.90.

[2] The spun-bonded nonwoven fabric according to claim 1, wherein the orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area is 1.0 or more and 8.0 or less.

45 [3] The spun-bonded nonwoven fabric according to [1] or [2], wherein the spun-bonded nonwoven fabric has a single melting peak temperature T_m ($^{\circ}\text{C}$) in a differential scanning calorimetry method.

[4] The spun-bonded nonwoven fabric according to any one of [1] to [3], wherein a tensile strength and elongation product per basis weight of the spun-bonded nonwoven fabric is 1.20 (N/50 mm)/(g/m²) or more.

50 [5] The spun-bonded nonwoven fabric according to any one of claims [1] to [4], wherein a melt flow rate of polyolefin-based resin of a sheath component is larger than a melt flow rate of polyolefin-based resin of a core component by 10 g/10 min to 200 g/10 min.

EFFECTS OF THE INVENTION

55 **[0008]** The present invention can provide a spun-bonded nonwoven fabric having excellent strength, excellent flexibility, and touch feeling even at a low basis weight. From these properties, the spun-bonded nonwoven fabric of the present invention can be suitably used particularly for sanitary material uses.

EMBODIMENTS OF THE INVENTION

[0009] The spun-bonded nonwoven fabric of the present invention is a spun-bonded nonwoven fabric made of a core-sheath composite fiber containing a polypropylene-based resin as a main component, in which the spun-bonded nonwoven fabric has a bonding area and a non-bonding area, and a ratio (O_s/O_c) of an orientation parameter O_s of a sheath component of the core-sheath composite fiber in the non-bonding area to an orientation parameter O_c of a core component of the core-sheath composite fiber in the non-bonding area is 0.10 to 0.90.

[0010] This makes it possible to provide a spun-bonded nonwoven fabric having excellent strength, excellent flexibility, and touch feeling even at a low basis weight.

[0011] Hereinafter, these constituent elements of the present invention will be described in detail, but the present invention is not limited to the scope described below at all without departing from the gist thereof.

[Polypropylene-based resin]

[0012] The core-sheath composite fiber constituting the spun-bonded nonwoven fabric of the present invention contains a polypropylene-based resin as a main component. The polypropylene-based resin is suitable because of being excellent in spinnability and strength properties as compared with other polyolefin-based resins such as polyethylene-based resins. In the present invention, the "polypropylene-based resin" refers to a resin in which the mole fraction of the propylene unit in the repeating unit is 60 mol% to 100 mol%. The same applies to the "polyethylene-based resin". Examples of the polypropylene-based resin used in the present invention include homopolymers of propylene and copolymers of propylene and various α -olefins. Herein, the "main component" means that it occupies 50 % by mass or more relative to the entire core-sheath composite fiber.

[0013] In the polypropylene-based resin to be used in the present invention, a percentage of the homopolymer of the propylene is preferably 60 % by mass or more, more preferably 70 % by mass or more, and still more preferably 80 % by mass or more. Accordingly, good spinnability can be maintained and the strength can be improved.

[0014] A material constituting the composite fiber used in the present invention (hereinafter, sometimes referred to as a "thermoplastic resin") may be a mixture of two or more types containing a polypropylene-based resin and another resin may be used. As the mixture, there can be used a resin composition containing other olefin-based resins such as polyethylene and poly-4-methyl-1-pentene, a thermoplastic elastomer, and the like.

[0015] To the polypropylene-based resin used in the present invention, there can be added additives such as an antioxidant, a weather-resistant stabilizer, a light-resistant stabilizer, a heat-resistant stabilizer, an antistatic agent, a charge aid, an antifog agent, an antiblocking agent, a lubricant containing a polyethylene wax, a crystal nucleating agent, and a pigment, or other polymers, which are typically used, as necessary in order to further enhance the effect of the present invention or to impart other properties without impairing the effect of the present invention.

[0016] The melting point (T_{mr}) of the polypropylene-based resin used in the present invention is preferably 120°C to 200°C. Setting this melting point (T_{mr}) to preferably 120°C or more, more preferably 130°C or more, and still more preferably 140°C or more can easily provide heat resistance that can put to practical use. Further, setting the melting temperature to preferably 200°C or less, more preferably 180°C or less, and still more preferably 170°C or less can facilitate cooling of yarns discharged from a spinneret, suppress bonding of the fiber to another, and facilitate stable spinning even with a thin fiber diameter. Herein, the melting point (T_{mr}) of the polypropylene-based resin refers to the maximum (highest) melting peak temperature obtained by measuring the polypropylene-based resin by differential scanning calorimetry (DSC).

[0017] The melt flow rate (hereinafter, sometimes abbreviated as MFR) of the polypropylene-based resin as a core component of the spun-bonded nonwoven fabric including the core-sheath composite fiber of the present invention is preferably 10 g/10 min to 100 g/10 min. Setting the MFR of the polypropylene-based resin to preferably 10 g/10 minutes or more, more preferably 20 g/10 minutes or more, and still more preferably 30 g/10 minutes or more allows stable spinning even with a thin fiber diameter, allowing to provide a spun-bonded nonwoven fabric having an excellent touch feeling and a uniform texture. On the other hand, setting the MFR of the polypropylene-based resin of the core component to preferably 100 g/10 min or less, more preferably 80 g/10 min or less, and still more preferably 60 g/10 min or less can suppress a decrease in single yarn strength, allowing to provide a spun-bonded nonwoven fabric excellent in strength.

[0018] The MFR of the polypropylene-based resin of the sheath component of the spun-bonded nonwoven fabric including the core-sheath composite fiber of the present invention is preferably larger than the MFR of the polypropylene-based resin as the core component by 10 g/10 min to 200 g/10 min. Setting the MFR of the polypropylene-based resin of the sheath component to be larger than the MFR of the polypropylene-based resin of the core component by preferably 10 g/10 min or more, more preferably 15 g/10 min or more, and still more preferably 20 g/10 min or more can concentrate the spinning stress on the core component during the spinning, promote orientation of the core component, and suppress orientation of the sheath component. On the other hand, in a case where the MFR of the polypropylene-based resin of the sheath component is larger than the MFR of the polypropylene-based resin of the core component by more than

200 g/10 min, the single yarn strength of the core-sheath composite fiber decreases, and the operational problems such as the tendency of the excessive softening and the sticking to the heat roll during the thermal adhesion occurs, which is not preferable. The MFR of the polypropylene-based resin of the sheath component is more preferably not higher than 150 g/10 min than the MFR of the polypropylene-based resin of the core component, and still more preferably not higher than 100 g/10 min than the MFR of the polypropylene-based resin of the core component.

[0019] When measuring and interpreting the MFR of the polypropylene-based resin of the core component or the sheath component of the sea-island composite fiber, the measurement and the like are performed by replacing "sheath component" with "sea component" and "core component" with "island component".

[0020] As for the MFR of the polypropylene-based resin according to the present invention, a value to be measured according to ASTM D1238 (A method) is adopted. According to the standard, it is defined that the polypropylene-based resin is measured at a load of 2.16 kg and a temperature of 230°C.

[0021] Certainly, the MFR of the polypropylene-based resin to be used in the present invention can also be adjusted by blending two or more resins having different MFRs at a desired percentage. In this case, the MFR of the resin to be blended with the main polypropylene-based resin (refers to a polypropylene-based resin that accounts for the largest % by mass in the polypropylene-based resin) is preferably 10 g/10 min to 1000 g/10 min, more preferably 20 g/10 min to 800 g/10 min, and still more preferably 30 g/10 min to 600 g/10 min. Accordingly, occurrence of partial viscosity unevenness can be prevented in the polypropylene-based resin blended, the single-fiber diameter and the single-fiber fineness can be made uniform, and the stable spinning can be performed even with thin fibers.

[0022] In a preferred embodiment of the spun-bonded nonwoven fabric of the present invention, a fatty acid amide compound having 23 or more and 50 or less carbon atoms is contained in the entire core-sheath composite fiber containing a polypropylene-based resin as a main component or a sheath component in order to improve slippage and flexibility.

[0023] Setting the carbon number of the fatty acid amide compound to be mixed with the polypropylene-based resin to preferably 23 or more, and more preferably 30 or more can suppress excessive exposure of the fatty acid amide compound on a surface of the fiber, make spinnability and processing stability excellent, and maintain high productivity. On the other hand, setting the carbon number of the fatty acid amide compound to preferably 50 or less, and more preferably 42 or less can facilitate movement of the fatty acid amide compound to the surface of the fiber, and impart slippage and flexibility to the spun-bonded nonwoven fabric.

[0024] Examples of the fatty acid amide compound having the carbon number of 23 or more and 50 or less to be used in the present invention include a saturated fatty acid monoamide compound, a saturated fatty acid diamide compound, an unsaturated fatty acid monoamide compound, and an unsaturated fatty acid diamide compounds.

[0025] Specific examples of the fatty acid amide compound having 23 or more and 50 or less carbon atoms include tetradecanoic acid amide, hexadecanoic acid amide, octadecanoic acid amide, nervonic acid amide, tetracosapentaenoic acid amide, nicinic acid amide, ethylene bislauric acid amide, methylene bislauric 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, and a plurality of these can be used in combination.

[0026] In the present invention, among these fatty acid amide compounds, ethylene bisstearic acid amide, which is a saturated fatty acid diamide compound, is particularly preferably used. Ethylene bis-stearic acid amide is excellent in thermal stability and thus can be melt-spun, and fibers containing a polypropylene-based resin containing ethylene bis-stearic acid amide can provide a spun-bonded nonwoven fabric excellent in slippage and flexibility while maintaining high productivity.

[0027] In the present invention, it is a preferred embodiment that the amount of the fatty acid amide compound added is 0.01 % by mass to 5.0 % by mass. Setting the addition amount of the fatty acid amide compound to preferably 0.01% by mass to 5.0% by mass, more preferably 0.1% by mass to 3.0% by mass, and still more preferably 0.1% by mass to 1.0% by mass can impart proper slippage and flexibility while maintaining the spinnability.

[0028] The amount added referred to herein refers to the mass percentage of the fatty acid amide compound added to the entire thermoplastic resin mainly composed of the polypropylene-based resin constituting the spun-bonded nonwoven fabric of the present invention. For example, even in a case where the fatty acid amide compound is added only to the sheath component constituting the core-sheath composite fiber, an addition percentage with respect to a total amount of the core component and the sheath component is calculated.

[0029] Examples of a method for measuring the amount of the fatty acid amide compound added to the fiber containing the polypropylene-based resin include a method in which an additive is extracted from the fiber with a solvent and subjected to quantitative analysis by using, for example, liquid chromatograph mass spectrometry (LS/MS). At this time, an extractant is appropriately selected according to a type of the fatty acid amide compound, but for example, in a case of the ethylene bis-stearamide, a method using, for example, a chloroform-methanol mixed solution is exemplified.

[Core-sheath composite fiber containing polypropylene-based resin as main component]

[0030] As a composite form of the core-sheath composite fiber constituting the spun-bonded nonwoven fabric of the present invention, a composite form such as a concentric core-sheath, an eccentric core-sheath, and a sea-island can be used. Among them, it is preferable to form a core-sheath composite form, that is, the composite fiber is preferably a core-sheath composite fiber, and it is more preferable to form a concentric core-sheath composite form, that is, the composite fiber is more preferably a core-sheath composite fiber of a concentric core-sheath type, because of being excellent in spinnability and allowing fibers uniformly bonded to each other by thermal adhesion.

[0031] The core-sheath composite fiber constituting the spun-bonded nonwoven fabric of the present invention preferably has an average single-fiber fineness of 0.5 dtex to 3.0 dtex. Setting the average single-fiber fineness to preferably 0.5 dtex or more, more preferably 0.6 dtex or more, and still more preferably 0.7 dtex or more can make the spun-bonded nonwoven fabric that prevents a decrease in the spinnability and is excellent in production stability. On the other hand, setting the average single-fiber fineness to preferably 3.0 dtex or less, more preferably 2.0 dtex or less, and still more preferably 1.5 dtex or less can make the spun-bonded nonwoven fabric that is excellent in touch feeling, uniform in texture, and is excellent in strength. The average single-fiber fineness can be controlled according to, for example, a spinning temperature, a single hole discharge amount, and a spinning speed to be described later.

[0032] The core-sheath composite fiber constituting the spun-bonded nonwoven fabric of the present invention preferably has an average single-fiber diameter of 8 μm to 20 μm . Setting the average single-fiber diameter to preferably 8 μm or more, more preferably 9 μm or more, and still more preferably 10 μm or more can make the spun-bonded nonwoven fabric that prevents the decrease in the spinnability and is excellent in production stability. On the other hand, setting the average single-fiber diameter to preferably 20 μm or less, more preferably 17 μm or less, and still more preferably 14 μm or less can make the spun-bonded nonwoven fabric that is excellent in touch feeling, uniform in texture, and is excellent in strength. The average single-fiber diameter can be controlled according to, for example, the spinning temperature, the single hole discharge amount, and the spinning speed to be described later.

[0033] In the present invention, as for the average single-fiber diameter (μm) of the core-sheath composite fiber constituting the spun-bonded nonwoven fabric, a value to be calculated according to procedures below is adopted.

(1) Ten small piece samples (100 $\times$ 100 mm) are randomly collected from the spun-bonded nonwoven fabric.

(2) A surface photograph is taken with the microscope or the scanning electron microscope at the magnification of 500 to 2000, and a width (a diameter) of each of 100 core-sheath composite fibers in the non-bonding area in total, 10 fibers from each sample, is measured. In the case where the cross section of the core-sheath composite fiber is deformed, a cross-sectional area of the section is measured, and a diameter of a perfect circle having the same cross-sectional area is determined.

(3) An average value of the diameters of the 100 fibers measured is rounded off to one decimal place to obtain an average single-fiber diameter (μm).

[0034] In the core-sheath composite fiber constituting the spun-bonded nonwoven fabric in the present invention, a mass ratio of the sheath component is preferably 20% by mass to 80% by mass. The mass ratio of the sheath component is preferably 20 mass% or more, more preferably 30 mass% or more, and still more preferably 40 mass% or more, thereby firmly bonding the sheath component to each other during the thermal adhesion, and allowing to provide the spun-bonded nonwoven fabric having the sufficient strength that can put to practical use. On the other hand, since the ratio of the sheath component is preferably 80 mass% or less, more preferably 70 mass% or less, and still more preferably 60 mass% or less, it is possible to make the spun-bonded nonwoven fabric that increases a percentage of the core component highly oriented, improves the single yarn strength of the core-sheath composite fiber, and has the sufficient strength to put to practical use.

[0035] As a cross-sectional shape of the core-sheath composite fiber constituting the spun-bonded nonwoven fabric of the present invention, a round cross section, a flat cross section, and a heteromorphic cross section such as a Y-shape or a C-shape can be used. Among them, a round cross section is a preferable aspect because a spun-bonded nonwoven fabric having no difficulty in bending due to a structure such as a flat cross section or a heteromorphic cross section and excellent flexibility. Further, a hollow cross section can also be applied as the cross-sectional shape, but a solid cross section is a preferable aspect, since the spinnability is excellent and the stable spinning can be performed even with the thin fiber diameter.

[Spun-bonded nonwoven fabric]

[0036] The spun-bonded nonwoven fabric of the present invention is a spun-bonded nonwoven fabric made of a core-sheath composite fiber containing the polypropylene-based resin as a main component, in which the spun-bonded nonwoven fabric has a bonding area and a non-bonding area, and a ratio (O_s/O_c) of an orientation parameter O_s of a

sheath component of the core-sheath composite fiber in the non-bonding area to an orientation parameter O_c of a core component of the core-sheath composite fiber in the non-bonding area is 0.10 to 0.90. This makes it possible to provide a spun-bonded nonwoven fabric having excellent strength, excellent flexibility, and touch feeling even at a low basis weight.

[0037] The spun-bonded nonwoven fabric of the present invention first has the bonding area and the non-bonding area. This makes it possible to provide a spun-bonded nonwoven fabric having sufficient strength to put to practical use while maintaining flexibility and touch feeling. The bonding area refers to a part where the core-sheath composite fiber is bonded to another, and the non-bonding area refers to a part where the core-sheath composite fiber is not bonded to another and the cross-sectional shape is maintained.

[0038] In the spun-bonded nonwoven fabric of the present invention, the orientation ratio (O_s/O_c) is 0.10 to 0.90. The orientation ratio (O_s/O_c) is preferably 0.10 or more, more preferably 0.15 or more, and still more preferably 0.20 or more, thereby allowing to prevent excessive concentration of drawing stress on the fiber inner layer during spinning and deterioration of spinning stability. On the other hand, the orientation ratio (O_s/O_c) is preferably 0.90 or less, more preferably 0.85 or less, and still more preferably 0.80 or less, thereby allowing only the fiber surface layer to be softened at the time of thermal adhesion. Among them, it is preferably 0.70 or less, and particularly preferably 0.50 or less. The orientation parameter can be determined from intensities of Raman bands around 810 cm^{-1} and 840 cm^{-1} in a Raman spectrum obtained by Raman spectroscopy, for example, in the case of polypropylene. In the case of a polypropylene, it is known that Raman bands around 810 cm^{-1} and 840 cm^{-1} exhibit strong anisotropy with respect to polarization of incident light. These are respectively assigned to a coupling mode of CH_2 bending vibration and C-C stretching vibration, and a CH_2 bending vibration mode. Of these, for the 810 cm^{-1} Raman band, the principal axis of the Raman tensor of the oscillation mode is parallel to the main chain direction of the molecule, while it is orthogonal for the 840 cm^{-1} Raman band. Therefore, the orientation of the molecular chain is obtained from the band intensity ratio in the polarization direction of these Raman bands.

[0039] The orientation parameter I referred to in the present invention is obtained as a value of I_{810}/I_{840} (I_{810} : Raman band intensity around 810 cm^{-1} , I_{840} : Raman band intensity around 840 cm^{-1}).

[0040] In the present invention, setting the orientation ratio as described above can firmly thermally adhere the fibers to each other while the molecular orientation of the fiber inner layer remains, thus allowing to provide a spun-bonded nonwoven fabric having strength that can be put to practical use. Reducing the orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area can provide a spun-bonded nonwoven fabric excellent in flexibility.

[0041] Herein, the orientation parameter of the core-sheath composite fiber in the present invention is an index (no unit) indicating that molecular chains are oriented in a specific direction as the numerical value increases, and indicating that the molecular chains of polypropylene-based resin constituting the core-sheath composite fiber are randomly oriented as the numerical value decreases. The orientation parameter is 1.0 when the molecular chains are oriented in a completely random manner.

[0042] In the present invention, the orientation parameter O_s for the sheath component and the orientation parameter O_c for the core component of the core-sheath composite fiber in the non-bonding area of the spun-bonded nonwoven fabric are measured by the following method. In the present invention, the sea-island composite fiber is also included in the core-sheath composite fiber, and in the case of the sea-island composite fiber, as in the case of the core-sheath composite fiber, when the orientation parameters O_s and O_c are measured and interpreted, the "sheath component" is replaced with the "sea component", and the "core component" is replaced with the "island component", and then the measurement or the like is performed.

(1) A core-sheath composite fiber in the vicinity of the center of the non-bonding area (a portion substantially equidistant from the surrounding bonding area) is sampled, and a fiber piece sample is embedded in a bisphenol-based epoxy resin.

(2) The resin is cut into pieces by a microtome after the resin is cured. A thickness of each of the pieces is $2\text{ }\mu\text{m}$. At this time, the resin is cut while being inclined from a fiber axis to make a cutting surface in an elliptical shape, and thereafter, a part where a thickness of a minor axis of the elliptical shape is shown to be constant is selected and measured. Setting a cutting angle to be within 4° , the cutting surface can be regarded as being parallel to the fiber axis within a film thickness of $2\text{ }\mu\text{m}$.

(3) Polarized light in a fiber axis direction (parallel direction) and a direction orthogonal to the fiber axis direction (perpendicular direction) is incident from a fiber surface layer to a central portion of a section of the core-sheath composite fiber in the non-bonding area, and line measurement of a Raman spectrum is performed.

(4) At each position of the core component and the sheath component of the core-sheath composite fiber in the non-bonding area, the Raman band intensities I_{810} and I_{840} near 810 cm^{-1} and near 840 cm^{-1} are calculated for each of the parallel direction and the vertical direction, and the intensity ratio I_{810}/I_{840} is calculated.

(5) The orientation parameter is calculated based on the following formula (a). In a case where the core component

is divided into a plurality of independent regions, the orientation parameters are measured in all the regions, and a highest value is adopted.

Orientation parameter =

$$(I_{810}/I_{840})_{\text{parallel}} / (I_{810}/I_{840})_{\text{perpendicular}} \dots (a)$$

(6) A similar measurement is performed on three different parts in a fiber axial direction of the core-sheath composite fiber, and an average value of orientation parameters is calculated and rounded off to one decimal place.

[0043] If it is difficult to sample the core-sheath composite fiber in the vicinity of the center of the non-bonding area (a portion substantially equidistant from the surrounding bonding area), the measurement can also be performed by the following procedure.

- (1) A sample of the spun-bonded nonwoven fabric is embedded in the bis-phenol-based epoxy resin.
- (2) After the resin is cured, the resin is cut into pieces by the microtome to make a vicinity of a center of the non-bonding area of the spun-bonded nonwoven fabric (a part substantially equidistant from the bonding area around) a cutting surface. A thickness of each of the pieces is 2 μm . A part that has a cutting angle within 4° from the fiber axis is selected, and subjected to subsequent measurement.
- (3) Polarized light in a fiber axis direction (parallel direction) and a direction orthogonal to the fiber axis direction (perpendicular direction) is incident from a fiber surface layer to a central portion of a section of the core-sheath composite fiber in the non-bonding area, and line measurement of a Raman spectrum is performed.
- (4) At each position of the core component and the sheath component of the core-sheath composite fiber in the non-bonding area, the Raman band intensities I_{810} and I_{840} near 810 cm^{-1} and near 840 cm^{-1} are calculated for each of the parallel direction and the vertical direction, and the intensity ratio I_{810}/I_{840} is calculated.
- (5) The orientation parameter is calculated based on the following formula (a). In a case where the core component is divided into a plurality of independent regions, the orientation parameters are measured in all the regions, and a highest value is adopted

Orientation parameter =

$$(I_{810}/I_{840})_{\text{parallel}} / (I_{810}/I_{840})_{\text{perpendicular}} \dots (a)$$

(6) A similar measurement is performed at three parts on a different non-bonding area of the spun-bonded nonwoven fabric, and an average value of orientation parameters is calculated and rounded off to one decimal place.

[0044] In the spun-bonded nonwoven fabric of the present invention, the orientation parameter O_s of the sheath component in the core-sheath composite fiber of the non-bonding area is preferably 1.0 to 8.0. The orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area is preferably 1.0 or more, more preferably 1.5 or more, and still more preferably 2.0 or more, thereby allowing to prevent occurrence of an operational problem such as excessive softening of the fiber surface layer during thermal adhesion and sticking to a heat roll. On the other hand, the orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area is preferably 8.0 or less, more preferably 6.0 or less, and still more preferably 5.0 or less, thereby allowing to improve the flexibility, easily softening the fiber surface layer at the time of thermal adhesion, and firmly thermally adhering fibers to each other, so that a spun-bonded nonwoven fabric having excellent strength can be obtained. The orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area can be controlled by the MFR of the polypropylene-based resin, the melting point, the additive, the mass ratio of the sheath component of the core-sheath composite fiber, and/or the spinning temperature, the spinning speed, and the like described later.

[0045] In the spun-bonded nonwoven fabric of the present invention, the orientation parameter O_c of the core component of the core-sheath composite fiber in the non-bonding area is preferably 4.0 or more, more preferably 5.0 or more, and still more preferably 6.0 or more. Among them, 8.0 to 20.0 is preferable. The orientation parameter O_c of the core component of the core-sheath composite fiber of the non-bonding area is typically 4.0 or more, preferably 5.0 or more, more preferably 6.0 or more, still more preferably 8.0 or more, particularly preferably 9.0 or more, and most preferably 10.0 or more, thereby improving the strength of the fiber inner layer to provide a spun-bonded nonwoven fabric having strength that can be practical to use after thermal adhesion. Further, it is possible to prevent the occurrence

of the operational problems such as the sticking of the surface layer of the fiber to the heat roll due to the excessive softening during the thermal adhesion. On the other hand, the orientation parameter O_c of the core component of the core-sheath composite fiber in the non-bonding area is preferably 20.0 or less, more preferably 19.0 or less, and still more preferably 18.0 or less, thereby allowing to improve the flexibility, suppressing the excessive concentration of drawing stress on the fiber inner layer during spinning, and improving the spinning stability. The orientation parameter O_c of the core component of the core-sheath composite fiber in the non-bonding area can be controlled by the MFR of the polypropylene-based resin, the melting point, the additive, the mass ratio of the sheath component of the core-sheath composite fiber, and/or the spinning temperature, the spinning speed, and the like described later.

[0046] The spun-bonded nonwoven fabric of the present invention preferably has a single melting peak temperature T_m (°C) in differential scanning calorimetry (DSC). In the present invention, "the spun-bonded nonwoven fabric has a single melting peak temperature T_m (°C) in the differential scanning calorimetry" means that substantially only one melting endothermic peak described in (3) of a measurement method below is observed. Accordingly, the fibers can be subjected to the thermal adhesion firmly to each other at a sufficient temperature without the occurrence of the operational problems such as sticking of a low melting point component to the heat roll due to melting of the component during the thermal adhesion, and thus the spun-bonded nonwoven fabric having the strength that can be put to practical use is easily obtained.

[0047] Herein, as the melting peak temperature T_m (°C) of the spun-bonded nonwoven fabric obtained by differential scanning calorimetry (DSC), a value calculated by the following procedure is adopted.

- (1) A fiber piece of the spun-bonded nonwoven fabric is sampled in a sample amount of 0.5 to 5 mg.
- (2) A temperature is raised from a normal temperature to 200°C at a rising speed of 20°C/min to obtain a DSC curve by using the differential scanning calorimetry (DSC).
- (3) A peak top temperature of the melting endothermic peak is read from the DSC curve and taken as the melting peak temperature T_m (°C) of the spun-bonded nonwoven fabric.

[0048] In the spun-bonded nonwoven fabric of the present invention, a surface roughness SMD of at least one side by a KES method is preferably 1 μm to 3 μm . Since the surface roughness SMD by the KES method is preferably 1.0 μm or more, more preferably 1.3 μm or more, and still more preferably 1.6 μm or more, it is possible to prevent the spun-bonded nonwoven fabric from being excessively densified to deteriorate the texture or to impair the flexibility. On the other hand, since the surface roughness SMD by the KES method is preferably 3.0 μm or less, more preferably 2.8 μm or less, and still more preferably 2.5 μm or less, it is possible to make the spun-bonded nonwoven fabric that has a smooth surface, a slight rough feeling, and is excellent in touch feeling. The surface roughness SMD by the KES method can be controlled by appropriately adjusting, for example, the average single-fiber diameter of the core-sheath composite fiber, the texture of the spun-bonded nonwoven fabric, and/or thermal adhesion conditions (for example, a shape, a compression bonding rate, a temperature, and a linear pressure of an adhesion portion) to be described later.

[0049] In the present invention, a value measured as follows is adopted as the surface roughness SMD by the KES method.

- (1) From the spun-bonded nonwoven fabric, three test pieces having a width of 200 mm $\times$ 200 mm are collected at equal intervals in a width direction of the spun-bonded nonwoven fabric.
- (2) The test pieces are set on the sample stand.
- (3) A surface of each of the test pieces is scanned with a contactor (material: ϕ 0.5 mm piano wire, contact length: 5 mm) for surface roughness measurement to which a load of 10 gf (0.098 N) is applied, and an average deviation of an irregular shape of the surface is measured.
- (4) The measurement described above is performed in the machine direction (a longitudinal direction of the nonwoven fabric) and the cross direction (a width direction of the nonwoven fabric) of all the test pieces, and an average deviation of six points in total is averaged and rounded off to one decimal place to obtain the surface roughness SMD (μm).

[0050] The longitudinal direction (machine direction) of the spun-bonded nonwoven fabric refers to a direction in which the spun-bonded nonwoven fabric is taken up by the winding device in the production process of the spun-bonded nonwoven fabric, and is also referred to as a machine direction. The cross direction refers to the width direction of the spun-bonded nonwoven fabric with respect to the longitudinal direction.

[0051] The friction coefficient MIU of the spun-bonded nonwoven fabric of the present invention by the KES method is preferably 0.01 to 0.30. The friction coefficient MIU is preferably 0.30 or less, more preferably 0.20 or less, and still more preferably 0.15 or less, allowing to provide the spun-bonded nonwoven fabric that improves the slippage of the surface of the nonwoven fabric, and is excellent in touch feeling. On the other hand, the friction coefficient MIU is preferably 0.01 or more, more preferably 0.03 or more, and still more preferably 0.05 or more, allowing to prevent sliding

between the yarns and deterioration of texture uniformity when the yarns spun are collected on the collection conveyor. The friction coefficient MIU by the KES method can be controlled by appropriately adjusting, for example, the additive of the polypropylene-based resin, the average single-fiber diameter of the core-sheath composite fiber, the texture of the spun-bonded nonwoven fabric, and/or the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0052] In the present invention, a value measured as follows is adopted as the friction coefficient MIU by the KES method.

(1) From the spun-bonded nonwoven fabric, three test pieces having a width of 200 mm × 200 mm are collected at equal intervals in a width direction of the spun-bonded nonwoven fabric.

(2) The test pieces are set on the sample stand.

(3) A surface of each of the test pieces is scanned with a friction contactor (material: φ 0.5 mm piano wire (20 in parallel), contact area: 1 cm²) to which a load of 50 gf (0.49 N) is applied, and a friction coefficient is measured.

(4) The measurement described above is performed in the machine direction (the longitudinal direction of the nonwoven fabric) and the cross direction (the width direction of the nonwoven fabric) of all the test pieces, and average deviation of six points in total is averaged and rounded off to three decimal places to obtain the friction coefficient MIU.

[0053] The MFR of the spun-bonded nonwoven fabric of the present invention is preferably 10 g/10 min to 300 g/10 min. The MFR of the spun-bonded nonwoven fabric is preferably 10 g/10 min or more, more preferably 15 g/10 min or more, and still more preferably 20 g/10 min or more, thereby allowing to provide the spun-bonded nonwoven fabric that can be stably spun even with the thin fiber diameter, is excellent in touch feeling, uniform in texture, and is excellent in strength. On the other hand, the MFR of the spun-bonded nonwoven fabric is preferably 300 g/10 min or less, more preferably 200 g/10 min or less, and still more preferably 100 g/10 min or less, thereby allowing to prevent a decrease in the strength is suppressed, and the occurrence of the operational problems such as the tendency of the excessive softening and the sticking to the heat roll during the thermal adhesion.

[0054] As for the MFR of the spun-bonded nonwoven fabric according to the present invention, a value to be measured by ASTM D1238 (the A method) is adopted. According to the standard, it is defined that the polypropylene-based resin is measured at a load of 2.16 kg and a temperature of 230°C.

[0055] The basis weight of the spun-bonded nonwoven fabric of the present invention is preferably 10 g/m² to 100 g/m². The basis weight is preferably 10 g/m² or more, more preferably 13 g/m² or more, and still more preferably 15 g/m² or more, thereby allowing to provide the spun-bonded nonwoven fabric having the sufficient strength that can be put to practical use. On the other hand, the basis weight is preferably 100 g/m² or less, more preferably 50 g/m² or less, and still more preferably 30 g/m² or less, thereby allowing to provide the spun-bonded nonwoven fabric having the flexibility suitable for use as the nonwoven fabric for sanitary materials.

[0056] In the present invention, as for the basis weight of the spun-bonded nonwoven fabric, a value to be measured by procedures below in accordance with "6.2 Mass per unit area" in "General Test Method for Nonwoven Fabric" of JIS L1913:2010.

(1) Three test pieces of 20 cm × 25 cm are collected per 1 m of width of a sample.

(2) A mass (g) of each of the test pieces in a standard state is measured.

(3) An average value of the mass is expressed as a mass per 1 m² (g/m²).

[0057] The thickness of the spun-bonded nonwoven fabric of the present invention is preferably 0.05 mm to 1.5 mm. The thickness is preferably 0.05 mm to 1.5 mm, more preferably 0.08 mm to 1.0 mm, and still more preferably 0.10 mm to 0.8 mm, allowing to provide the spun-bonded nonwoven fabric that has the flexibility and a moderate cushioning property, and is suitable for use particularly in paper diaper uses as the spun-bonded nonwoven fabric for sanitary materials.

[0058] In the present invention, as for the thickness (mm) of the spun-bonded nonwoven fabric, a value to be measured by procedures below in accordance with "5.1" in "General Test Method for Long-Fiber nonwoven Fabric" of JIS L1906: 2000 is adopted.

(1) Thicknesses are measured at 10 points per 1 m at equal intervals in the width direction of the nonwoven fabric at a load of 10 kPa in a unit of 0.01 mm by using a pressurizer having a diameter of 10 mm.

(2) An average value of the thicknesses at the 10 points is rounded off to two decimal places.

[0059] Further, an apparent density of the spun-bonded nonwoven fabric of the present invention is preferably 0.05 g/cm³ to 0.30 g/cm³. The apparent density is preferably 0.30 g/cm³ or less, more preferably 0.25 g/cm³ or less, and still

more preferably 0.20 g/cm³ or less, thereby allowing to prevent the fiber from being densely packed to impair the flexibility of the spun-bonded nonwoven fabric. On the other hand, the apparent density is preferably 0.05 g/cm³ or more, more preferably 0.08 g/cm³ or more, and still more preferably 0.10 g/cm³ or more, thereby allowing to provide the spun-bonded nonwoven fabric that suppresses occurrence of fluffing and delamination, and has the sufficient strength and handleability that can put to practical use. The apparent density can be controlled by appropriately adjusting, for example, the average single-fiber diameter of the core-sheath composite fiber, and/or the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0060] In the present invention, the apparent density (g/cm³) is calculated based on an expression below from the basis weight and the thickness before the rounding described above, and is rounded off to two decimal places.

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

[0061] A bending resistance of the spun-bonded nonwoven fabric of the present invention preferably is 65 mm or less. The bending resistance is preferably 65 mm or less, more preferably 60 mm or less, and still more preferably 55 mm or less, thereby allowing to provide excellent flexibility suitable for use particularly in the paper diaper uses as the spun-bonded nonwoven fabric for sanitary materials. Further, the bending resistance is extremely low and the handleability is inferior, and thus the bending resistance is preferably 10 mm or more. The bending resistance can be controlled by appropriately adjusting, for example, the MFR of the polypropylene-based resin, the additive, the average single-fiber diameter of the core-sheath composite fiber, the basis weight of the spun-bonded nonwoven fabric, a ratio (Os/Oc) of the orientation parameter Os of the sheath component of the core-sheath composite fiber in the non-bonding area to the orientation parameter Oc of the core component of the core-sheath composite fiber in the non-bonding area, and/or the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0062] The tensile strength and elongation product per basis weight of the spun-bonded nonwoven fabric of the present invention is preferably 1.20 (N/50 mm)/(g/m²) or more, and more preferably 1.20 (N/50 mm)/(g/m²) to 10.0 (N/50 mm)/(g/m²). The tensile strength and elongation product per basis weight is preferably 1.20 (N/50 mm)/(g/m²) or more, more preferably 1.3 (N/50 mm)/(g/m²) or more, still more preferably 1.4 (N/50 mm)/(g/m²) or more, thereby allowing to provide a spun-bonded nonwoven fabric that is flexible, has a good touch and texture, and has excellent strength even at a low basis weight. On the other hand, the tensile strength and elongation product per basis weight is preferably 10.0 (N/50 mm)/(g/m²) or less, thereby allowing to prevent the flexibility of the spun-bonded nonwoven fabric from being deteriorated or the texture from being impaired. The tensile strength and elongation product per basis weight can be controlled by appropriately adjusting, for example, the MFR of the polypropylene-based resin, the additive, the average single-fiber diameter of the core-sheath composite fiber, the ratio Os/Oc of the orientation parameter Os of the sheath component of the core-sheath composite fiber in the non-bonding area of the spun-bonded nonwoven fabric to the orientation parameter Oc of the core component of the core-sheath composite fiber in the non-bonding area, and/or the spinning speed and the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0063] In the present invention, as for the tensile strength and elongation product of the spun-bonded nonwoven fabric per basis weight, a value to be measured by procedures below in accordance with "6.3 Tensile strength and elongation rate (ISO method)" in "General Test Method for nonwoven Fabric" of JIS L1913:2010 is adopted.

(1) Three test pieces each having a size of 50 mm × 300 mm are taken per 1 m of the width of the nonwoven fabric in each of directions in which one long side is in the machine direction (the longitudinal direction of the nonwoven fabric) and the cross direction (the width direction of the nonwoven fabric) of the nonwoven fabric.

(2) Each test piece is set in a tensile tester at a grip interval of 200 mm.

(3) A tensile test is performed at a tensile rate of 100 mm/min, and the maximum strength and the elongation at the maximum strength are measured. Herein, the elongation is not converted into 100 fraction (%).

(4) The average value of the maximum strength and the elongation at the maximum strength measured for each test piece is obtained, and the tensile strength and elongation product per basis weight is calculated based on the following formula, and rounded off to two decimal places.

$$\text{Tensile strength and elongation product per basis weight ((N/50 mm) / [g/m}^2\text{)])} = [\text{average value of maximum strength (N/50 mm)}] \times [\text{average value of elongation at maximum strength (-)}] / \text{basis weight (g/m}^2\text{)}$$

[0064] The tensile strength of the spun-bonded nonwoven fabric of the present invention in the cross direction (width

direction of the nonwoven fabric) per basis weight is preferably 0.40 (N/25 mm)/(g/m²) or more, and more preferably 0.40 (N/25 mm)/(g/m²) to 2.00 (N/25 mm)/(g/m²). The tensile strength per basis weight is preferably 0.40 (N/25 mm)/(g/m²) or more, more preferably 0.60 (N/25 mm)/(g/m²) or more, and still more preferably 0.80 (N/25 mm)/(g/m²) or more, thereby allowing to provide the spun-bonded nonwoven fabric having the strength that can put to practical use. On the other hand, the tensile strength in the cross direction per basis weight is preferably 2.00 (N/25 mm)/(g/m²) or less, thereby allowing to prevent the decrease in the flexibility of the spun-bonded nonwoven fabric or impairment in the texture. Although the tensile strength of the spun-bonded nonwoven fabric is in the machine direction (longitudinal direction of the nonwoven fabric) and the cross direction (width direction of the nonwoven fabric), in general, the tensile strength in the cross direction is smaller than the tensile strength in the machine direction. Therefore, the tensile strength in the cross direction per basis weight is 0.4 to 2.00 (N/25 mm)/(g/m²), thereby allowing to provide the spun-bonded nonwoven fabric having the strength that can put to practical use in the machine direction. The tensile strength in the cross direction per basis weight can be controlled by appropriately adjusting, for example, the MFR of the polypropylene-based resin, the additive, the average single-fiber diameter of the core-sheath composite fiber, the ratio Os/Oc of the orientation parameter Os of the sheath component of the core-sheath composite fiber in the non-bonding area of the spun-bonded nonwoven fabric to the orientation parameter Oc of the core component of the core-sheath composite fiber in the non-bonding area, and/or the spinning speed and the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0065] In the present invention, as for the tensile strength of the spun-bonded nonwoven fabric in the cross direction per basis weight, a value to be measured by procedures below in accordance with "6.3 Tensile strength and elongation rate (ISO method)" in "General Test Method for nonwoven Fabric" of JIS L1913:2010 is adopted.

(1) Three test pieces of 25 mm × 200 mm are collected per 1 m of the width of the nonwoven fabric to make a long side in the cross direction of the nonwoven fabric (the width direction of the nonwoven fabric).

(2) The test pieces are set in a tensile testing machine at a grip interval of 100 mm.

(3) A tensile test is performed at a tensile speed of 100 mm/min to measure a maximum strength.

(4) An average value of the maximum strength measured with each of test pieces is determined, and a tensile strength per basis weight is calculated based on an expression below and rounded off to two decimal places.

Tensile strength in cross direction per basis weight ((N/25 mm) / (g/m²)) = [average value of maximum strength (N/25 mm)] / basis weight (g/m²)

[0066] The stress at 5% elongation of the spun-bonded nonwoven fabric of the present invention in the machine direction per basis weight is preferably 0.40 (N/25 mm)/(g/m²) or more, and more preferably 0.40 (N/25 mm)/(g/m²) to 2.00 (N/25 mm)/(g/m²). The stress at 5% elongation in the machine direction per basis weight is preferably 0.40 (N/25 mm)/(g/m²) or more, more preferably 0.50 (N/25 mm)/(g/m²) or more, and still more preferably 0.60 (N/25 mm)/(g/m²) or more, thereby allowing to suppress elongation due to tension during production of the spun-bonded nonwoven fabric or during processing for the sanitary material uses, and stably produce the spun-bonded nonwoven fabric at a high yield. Further, the stress at 5% elongation in the machine direction per basis weight is preferably 2.00 (N/25 mm)/(g/m²) or less, allowing to prevent the decrease in the flexibility of the spun-bonded nonwoven fabric or the impairment in the texture. The stress at 5% elongation in the machine direction per basis weight can be controlled by appropriately adjusting, for example, the MFR of the polypropylene-based resin, the additive, the average single-fiber diameter of the core-sheath composite fiber, the ratio (Os/Oc) of the orientation parameter Os of the sheath component of the core-sheath composite fiber in the non-bonding area of the spun-bonded nonwoven fabric to the orientation parameter Oc of the core component of the core-sheath composite fiber in the non-bonding area, and/or the spinning speed and the thermal adhesion conditions (for example, the shape, the compression bonding rate, the temperature, and the linear pressure of the adhesion portion) to be described later.

[0067] In the present invention, as for the stress at 5% elongation of the spun-bonded nonwoven fabric in the machine direction per basis weight, a value to be measured by procedures below in accordance with "6.3 Tensile strength and elongation rate (ISO method)" in "General Test Method for Nonwoven Fabric" of JIS L1913:2010 is adopted.

(1) Three test pieces of 25 mm × 200 mm are collected per 1 m of the width of the nonwoven fabric to make the long side in the machine direction of the nonwoven fabric (the longitudinal direction of the nonwoven fabric).

(2) The test pieces are set in a tensile testing machine at a grip interval of 100 mm.

(3) The tensile test is performed at the tensile speed of 100 mm/min, and a stress during 5% elongation (a stress at 5% elongation) is measured.

(4) An average value of the stress at 5% elongation measured for each test piece is determined, the stress at 5% elongation in the machine direction per basis weight is calculated based on an expression below, and rounded off to two decimal places.

5 Stress at 5% elongation in machine direction per basis weight $((N/25 \text{ mm}) / (g/m^2)) = [\text{average value of stress at 5\% elongation (N/25 mm)}] / \text{basis weight (g/m}^2\text{)}$

10 [Method for producing spun-bonded nonwoven fabric]

[0068] Next, a preferred aspect of the method for producing the spun-bonded nonwoven fabric of the present invention will be specifically described.

15 **[0069]** The spun-bonded nonwoven fabric of the present invention is a long-fiber nonwoven fabric to be produced by a spun-bond method. The spun-bond method is excellent in productivity and mechanical strength, and can suppress fluffing and falling of the fiber, which are likely to occur in a short-fiber nonwoven fabric. In addition, stacking a plurality of layers of the collected spun-bonded nonwoven fiber web or the thermocompression-bonded spun-bonded nonwoven fabric (both are denoted as S) with SS, SSS, and SSSS improves productivity and texture uniformity, which is a preferred aspect.

20 **[0070]** In the spun-bond method, a thermoplastic resin is first spun from a spinning spinneret as long fibers, the long fibers are suction-drawn with compressed air by an ejector, and then the fibers are collected on a moving net to obtain a nonwoven fiber web. Moreover, the nonwoven fiber web obtained is subjected to a thermal adhesion treatment to obtain the spun-bonded nonwoven fabric.

25 **[0071]** A shape of the spinning spinneret or the ejector is not particularly limited, but for example, various shapes such as a round shape and a rectangular shape can be adopted. Among the shapes, a combination of a rectangular spinneret and a rectangular ejector is preferably used, since an amount of the compressed air used is relatively small, energy cost is low, bonding and scraping of the yarns hardly occurs, and opening of the yarns is easy.

30 **[0072]** In the present invention, the thermoplastic resin is melted in an extruder, weighed, supplied to a spinneret for a core-sheath composite fiber to be produced, and spun as a long fiber. A spinning temperature when the thermoplastic resin is molten and spun is preferably 180°C to 250°C, more preferably 200°C to 240°C, and still more preferably 220°C to 230°C. Setting the spinning temperature within a range described above can provide a stable molten state and the excellent spinning stability.

35 **[0073]** Long fiber yarns spun are then cooled. Examples of a method for cooling the yarns spun include a method in which cold air is forcibly blown to the yarns, a method in which the yarns are naturally cooled at an ambient temperature around the yarns, and a method in which a distance between the spinning spinneret and the ejector is adjusted, or a method in which these methods are combined can be adopted. Further, cooling conditions can be appropriately adjusted and adopted in consideration of, for example, a discharge amount of the spinning spinneret per single hole, the spinning temperature, and the ambient temperature.

[0074] Next, yarns cooled and solidified are pulled and drawn by the compressed air ejected from the ejector.

40 **[0075]** The spinning speed is preferably 3000 m/min to 6000 m/min, more preferably 3500 m/min to 5500 m/min, and still more preferably 4000 m/min to 5000 m/min. Setting the spinning speed to 3000 m/min to 6000 m/min can provide the high productivity, and in addition, orientation crystallization of the fiber proceeds, allowing to provide the long fibers having a high strength. As described before, the core-sheath composite fiber containing the polypropylene-based resin of the present invention as the main component is excellent in spinning stability and can be stably produced even at a high spinning speed.

45 **[0076]** Subsequently, the long fibers obtained are collected on the moving net to form the nonwoven fiber web.

50 **[0077]** In the present invention, it is also a preferred aspect that a heat flat roll is brought into contact with the nonwoven fiber web from one side thereof on the net and a temporary adhesion. Accordingly, it is possible to prevent the surface layer of the nonwoven fiber web from being turned over or blown off during conveyance on the net and the deterioration of the texture, and improve a conveyance ability from yarns collection to thermocompression bonding.

[0078] Subsequently, the nonwoven fiber web obtained is bonded to form the bonding area, and an intended spun-bonded nonwoven fabric can be obtained.

55 **[0079]** A method for bonding the nonwoven fiber web is not particularly limited, and examples thereof include a method in which the nonwoven fiber web is thermally bonded by various rolls, such as a heat embossing roll in which upper and lower roll surfaces in pair are each engraved (to be an uneven portion), a heat embossing roll formed by a combination of a roll in which one roll surface is flat (smooth) and a roll in which another roll surface is engraved (to be an uneven portion), and a heat calender roll formed by a combination of upper and lower flat (smooth) rolls in pair; a method in which the nonwoven fiber web is thermally bonded by ultrasonic vibration of a horn; and a method in which the nonwoven

fiber web is penetrated with hot air to soften or melt the surface of the core-sheath composite fiber, and fiber intersections are thermally bonded to each other.

[0080] Among the rolls, it is preferable to use the heat embossing roll in which the upper and lower roll surfaces in pair are each engraved (to be the uneven portion), or the heat embossing roll including the combination of the roll in which the one roll surface is flat (smooth) and the roll in which the other roll surface is engraved (to be uneven portion). Accordingly, it is possible to provide a bonding area that is good in productivity and improves the strength of the spun-bonded nonwoven fabric, and a non-bonding area that improves the texture and the touch feeling.

[0081] As a surface material of the heat embossing roll, it is a preferred aspect that a metal roll and another metal roll are made into a pair to obtain a sufficient thermocompression bonding effect and prevent the engraving (the uneven portion) of one embossing roll from being transferred to the other roll surface.

[0082] An embossing adhesion area rate by such heat embossing rolls is preferably 5 to 30%. Setting the adhesion area to preferably 5% or more, more preferably 8% or more, and still more preferably 10% or more can provide the strength that can be put to practical use as the spun-bonded nonwoven fabric. On the other hand, setting the adhesion area rate to preferably 30% or less, more preferably 25% or less, and still more preferably 20% or less can provide a proper flexibility suitable for use particularly in the paper diaper uses as the spun-bonded nonwoven fabric for the sanitary materials. The adhesion area rate is preferably in a similar range even in a case of using ultrasonic adhesion.

[0083] The adhesion area referred to herein refers to a percentage of the adhesion portion to the entire spun-bonded nonwoven fabric. Specifically, in a case of the thermal adhesion with a pair of uneven rolls, the adhesion area refers to a percentage of a portion (an adhesion portion) where a convex portion of an upper roll and a convex portion of a lower roll overlap each other and come into contact with the nonwoven fiber web to the entire spun-bonded nonwoven fabric. Further, in a case of the thermal adhesion with the uneven roll and the flat roll, the adhesion area refers to a percentage of a portion (an adhesion portion) where the convex portion of the uneven roll comes into contact with the nonwoven fiber web to the entire spun-bonded nonwoven fabric. Further, in the case of the ultrasonic adhesion, the adhesion area refers to a percentage of a portion (an adhesion portion) to be heat-sealed by ultrasonic processing to the entire spun-bonded nonwoven fabric. In a case where sufficient heat is applied to the adhesion portion during the thermal adhesion and the entire core-sheath composite fiber of the adhesion portion is bonded, areas of the adhesion portion and the bonding area can be considered to be equal.

[0084] Although a shape of the adhesion portion by the heat embossing roll and the ultrasonic adhesion is not particularly limited, for example, a circular shape, an elliptical shape, a square shape, a rectangular shape, a parallelogram shape, a rhombus shape, a regular hexagon shape, and a regular octagon shape can be used. Further, the adhesion portion is preferably present in a uniform manner at regular intervals in each of the longitudinal direction (a conveyance direction) and the width direction of the spun-bonded nonwoven fabric. Accordingly, it is possible to reduce variations in the strength of the spun-bonded nonwoven fabric.

[0085] It is a preferred aspect that the surface temperature of the thermal embossing roll during thermal adhesion is set to a temperature lower by 30°C to higher by 10°C than the melting point (hereinafter, may be described as T_{ms} (°C)) of the thermoplastic resin constituting the sheath component being used (that is, ($T_{ms} - 30^\circ\text{C}$) to ($T_{ms} + 10^\circ\text{C}$)). Setting the surface temperature of the heat roll to preferably -30°C and or more (that is, ($T_{ms} - 30^\circ\text{C}$) and so on) or more, more preferably -20°C or more (($T_{ms} - 20^\circ\text{C}$) or more), and still more preferably -10°C or more (($T_{ms} - 10^\circ\text{C}$) or more) relative to the melting point of the thermoplastic resin can provide a spun-bonded nonwoven fabric that is firmly thermally bonded and has strength that can be put to practical use. In addition, setting the surface temperature of the thermal embossing roll to preferably +10°C or less (($T_{ms} + 10^\circ\text{C}$) or less), more preferably +5°C or less (($T_{ms} + 5^\circ\text{C}$) or less), and still more preferably +0°C or less (($T_{ms} + 0^\circ\text{C}$) or less) relative to the melting point of the thermoplastic resin suppresses excessive thermal adhesion and can provide moderate flexibility suitable for use particularly in paper diaper applications as a spun-bonded nonwoven fabric for sanitary materials.

[0086] The linear pressure of the heat embossing roll during the thermal adhesion is preferably 50 N/cm to 500 N/cm. Setting the linear pressure of the roll to preferably 50 N/cm or more, more preferably 100 N/cm or more, and still more preferably 150 N/cm or more provides firm thermal adhesion and can provide the spun-bonded nonwoven fabric having the strength that can put to practical use. On the other hand, setting the linear pressure of the heat embossing roll to preferably 500 N/cm or less, more preferably 400 N/cm or less, and still more preferably 300 N/cm or less can provide moderate flexibility suitable for use particularly in the paper diaper uses as the spun-bonded nonwoven fabric for the sanitary materials.

[0087] Further, in the present invention, the thermocompression bonding can be performed with the heat calender roll including the upper and lower flat rolls in pair before and/or after the thermal adhesion with the heat embossing roll described above for a purpose of adjusting the thickness of the spun-bonded nonwoven fabric. The upper and lower flat rolls in pair are metal rolls or elastic rolls with no concave and convex portions on the surfaces of the rolls, and one metal roll and another metal roll can be used in pair, or one metal roll and another elastic roll can be used in pair.

[0088] Further, here, the elastic roll refers to a roll made of an elastic material as compared to the metal roll. Examples of the elastic roll include a so-called paper roll such as paper, cotton, and aramid paper, and a resin roll made of a

urethane-based resin, an epoxy-based resin, a silicon-based resin, a polyester-based resin, hard rubber, and a mixture thereof.

[0089] The spun-bonded nonwoven fabric of the present invention is excellent in flexibility and touch feeling, uniform in texture, has the sufficient strength that can put to practical use, and is excellent in productivity, and thus can be widely used for the sanitary materials, medical materials, daily life materials, industrial materials, or the like. In particular, the fabric can be suitably used as, for example, a base fabric of the paper diaper, physiological articles and a poultice material in a case of the sanitary materials, and as, for example, a protective garment and a surgical gown in a case of medical materials.

EXAMPLES

[0090] Next, the spun-bonded nonwoven fabric of the present invention will be specifically described based on examples. However, the present invention is not limited only to these examples. Unless otherwise described, each physical property is measured based on the methods described before.

[Measurement methods]

(1) Melt flow rate (MFR) of resin (g/10 min)

[0091] The MFR of the resin was measured by the above method under the conditions of a load of 2.16 kg and a temperature of 230°C.

(2) Average single-fiber diameter (μm) of core-sheath composite fiber constituting spun-bonded nonwoven fabric

[0092] Measurement was performed through the method described before by using an electron microscope "VHX-D 500" manufactured by KEYENCE CORPORATION.

(3) Spinning speed (m/min)

[0093] A mass per length of 10000 m was calculated by being rounded off to one decimal place as the average single-fiber fineness (dtex) from the average single-fiber diameter described above and the solid density of the resin (0.91 g/cm³). The spinning speed was calculated as two significant digits based on a formula below from average single-fiber fineness and a discharge amount (hereinafter, abbreviated as a single hole discharge amount) (g/min) of the resin to be discharged from a single hole of the spinning spinneret, the discharge amount being set under each condition.

Spinning speed (m/min) = (10000 × [single hole discharge amount (g/min)]) / [average single-fiber fineness (dtex)]

(4) Orientation parameter of core-sheath composite fiber of non-bonding area of spun-bonded nonwoven fabric

[0094] Measurement was performed through the method described before by using a triple Raman spectrometer "T-64000" manufactured by Atago Bussan Co., Ltd. Measurement conditions were as follows.

- Measurement mode: microscopic Raman (polarization measurement)
- Objective lens: ×100
- Beam diameter: 1 μm
- Light source: Ar⁺ laser/514.5 nm
- Laser power: 60 mW
- Diffraction grating: Single 1800 gr/mm
- Cross slit: 100 μm
- Detector: CCD/Jobin Yvon 1024 ×256

(5) Melting peak temperature T_m (°C) of spun-bonded nonwoven fabric

[0095] Measurement was performed through the method described before by using "DSC8500" manufactured by PerkinElmer, Inc. as a measurement apparatus. Measurement conditions were as follows.

- Atmosphere in apparatus: nitrogen (20 mL/min)
- Temperature/heat calibration: high purity indium ($T_m = 156.61^\circ\text{C}$, and $\Delta H_m = 28.70 \text{ J/g}$)
- Temperature range: 20°C to 200°C
- Rising speed: 20°C/min
- Sample amount: about 0.5 to 4 mg
- Sample container: standard container made of aluminum

[0096] When a single melting peak temperature T_m ($^\circ\text{C}$) was observed in the spun-bonded nonwoven fabric in the table, the value was described, and when a plurality of melting peak temperatures T_m ($^\circ\text{C}$) was observed, the values were described.

[0097] For the melting point of the polypropylene-based resin used in Examples, the melting peak temperature was measured in the same manner as in the measurement method of the melting peak temperature except that the polypropylene-based resin to be used was sampled, and was set to the maximum (highest) melting peak temperature to be obtained.

(6) Bending resistance (mm) of spun-bonded nonwoven fabric in machine direction

[0098] The bending resistance of the spun-bonded nonwoven fabric was measured in the machine direction (the longitudinal direction) of the nonwoven fabric in accordance with a method described in "6.7.4 Gurley method" in "6.7 Bending resistance (JIS method and ISO method)" in "General Test Methods for Nonwoven Fabric" of JIS L1913:2010. In any spun-bonded nonwoven fabric, the bending resistance in the machine direction (the longitudinal direction) was larger than the bending resistance in the cross direction (the width direction). As the bending resistance was smaller in the machine direction, the flexibility was better, and 65 mm or less was regarded as acceptable.

(7) Tensile strength per basis weight of spun-bonded nonwoven fabric ($\text{N/25 mm}/(\text{g/m}^2)$)

[0099] Measurement was performed through the method described before by using "RTG-1250" manufactured by A & D Company, Limited as a measurement apparatus. The tensile strength in the machine direction was also higher as the tensile strength per basis weight in the cross direction was higher, but $0.80 (\text{N/25 mm})/(\text{g/m}^2)$ or more was regarded as acceptable.

(8) Tensile strength and elongation product per basis weight of spun-bonded nonwoven fabric ($\text{N/50 mm}/(\text{g/m}^2)$)

[0100] Measurement was performed through the method described before by using "RTG-1250" manufactured by A & D Company, Limited as a measurement apparatus. As the tensile strength and elongation product per basis weight was larger, the spun-bonded nonwoven fabric was softer and more excellent in balance between touch feeling, texture, and strength, but $1.20 (\text{N/50 mm})/(\text{g/m}^2)$ or more was regarded as acceptable.

(Example 1)

[0101] Using a polypropylene resin composed of a homopolymer having a melt flow rate (MFR) of 35 g/10 min and a melting point of 163°C as a core component and a polypropylene resin composed of a homopolymer having an MFR of 60 g/10 min and a melting point of 163°C as a sheath component, each of the resins was melted by an extruder, and a concentric core-sheath composite fiber having a sheath component ratio of 30% by mass was spun from a spinning spinneret having a hole diameter ϕ of 0.40 mm and a hole depth of 0.8 mm at a spinning temperature of 235°C and a single hole discharge amount of 0.40 g/min. Yarns spun were cooled and solidified, then were pulled and drawn by the compressed air in the ejector, and collected on the moving net to form a spun-bonded nonwoven fiber web formed by polypropylene-based long fibers. Properties of the core-sheath composite fiber constituting the nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour.

[0102] Subsequently, the formed nonwoven fiber web was thermally adhered under conditions of a linear pressure of 500 N/cm and a thermal adhesion temperature of 140°C using a pair of upper and lower thermal embossing rolls including the following upper roll and lower roll to provide a spun-bonded nonwoven fabric having a basis weight of 15 g/m^2 with a bonding area and a non-bonding area.

(Upper roll): An embossing roll that is made of metal, engraved with a dotted pattern, and has an adhesion area rate of 11%

(Lower roll): A metal flat roll

[0103] The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 2)

[0104] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that the basis weight was 10 g/m². The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 3)

[0105] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that the basis weight was 30 g/m². The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 4)

[0106] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that the ratio of the sheath component was 50% by mass and the thermal adhesion temperature was 145°C. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 5)

[0107] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that the pressure of the compressed air was adjusted in the ejector. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 11.2 μm, and the spinning speed converted therefrom was 4400 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 6)

[0108] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that a polypropylene resin composed of a homopolymer having an MFR of 170 g/10 min and a melting point of 161°C was used as a sheath component. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Example 7)

[0109] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that a polypropylene resin composed of a homopolymer having an MFR of 30 g/10 min and a melting point of 148°C was used as a sheath component, and the thermal adhesion temperature by a pair of upper and lower thermal embossing rolls was 130°C. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown

in Table 1.

(Example 8)

[0110] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that a polypropylene resin composed of a homopolymer having an MFR of 20 g/10 min and a melting point of 163°C was used as a core component. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. The spun-bonded nonwoven fabric obtained was uniform in texture and excellent in touch feeling. Evaluation results are shown in Table 1.

(Comparative Example 1)

[0111] A spun-bonded nonwoven fabric having a bonding area and non-bonding area was obtained by the same method as in Example 1 except that a single-component fiber using only a polypropylene resin composed of a homopolymer having a melt flow rate (MFR) of 35 g/10 min and a melting point of 163°C was used, and the thermal adhesion temperature was 150°C. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. As for the spinnability, the yarn breakage occurred twice in the spinning for 1 hour. Evaluation results of the spun-bonded nonwoven fabric obtained are shown in Table 1. The thermal adhesion temperature was set to 155°C, causing a problem that the sheet end was stuck to the heat roll, and conveyance was poor.

(Comparative Example 2)

[0112] A spun-bonded nonwoven fabric having a bonding area and a non-bonding area was obtained by the same method as in Example 1 except that a polypropylene resin composed of a homopolymer having an MFR of 45 g/10 min and a melting point of 163°C was used as a sheath component, and the thermal adhesion temperature was 150°C. The properties of the fiber constituting the spun-bonded nonwoven fiber web formed were that the average single-fiber diameter was 14.0 μm, and the spinning speed converted therefrom was 2900 m/min. The spinnability was favorable as yarn breakage was not observed in the spinning for one hour. Evaluation results of the spun-bonded nonwoven fabric obtained are shown in Table 1.

[Table 1-1]

	Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
MFR of polypropylene-based resin	g/10 minutes	(Core) 35 (Sheath) 60	(Core) 35 (Sheath) 60	(Core) 35 (Sheath) 60	(Core) 35 (Sheath) 60	(Core) 35 (Sheath) 60	(Core) 35 (Sheath) 170
Ratio of sheath component	% by mass	30	30	30	50	30	30
Average single-fiber diameter	μm	14.0	14.0	14.0	14.0	11.2	14.0
Spinning speed	m/min	2900	2900	2900	2900	4400	2900
Basis weight	g/m ²	15	10	30	15	15	15
Orientation parameter of fiber in non-bonding area (Core: Oc, Sheath: Os)	-	(Core) 10.9 (Sheath) 4.1	(Core) 10.9 (Sheath) 4.1	(Core) 10.9 (Sheath) 4.1	(Core) 11.0 (Sheath) 5.7	(Core) 13.7 (Sheath) 3.6	(Core) 12.1 (Sheath) 5.0
Orientation ratio of sheath component to core component of fiber in non-bonding area (Os/Oc)	-	0.38	0.38	0.38	0.52	0.26	0.41

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(continued)

	Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Melting peak temperature (T _m) by DSC	°C	163	163	163	163	163	162
Bending resistance in machine direction	mm	64	56	91	63	68	60
Tensile strength in cross direction per basis weight	N/25 mm/ (g/m ²)	0.92	0.81	1.05	0.86	0.81	0.80
Tensile strength and elongation product per basis weight	N/50 mm/ (g/m ²)	1.84	1.23	3.00	1.75	2.21	1.53

[Table 1-2]

	Unit	Example 7	Example 8	Comparative Example 1	Comparative Example 2
MFR of polypropylene-based resin	g/10 minutes	(Core) 35 (Sheath) 30	(Core) 20 (Sheath) 60	35	(Core) 35 (Sheath) 45
Ratio of sheath component	% by mass	30	30	-	30
Average single-fiber diameter	μm	14.0	14.0	14.0	14.0
Spinning speed	m/min	2900	2900	2900	2900
Basis weight	g/m ²	15	15	15	15
Orientation parameter of fiber in non-bonding area (Core: Oc, Sheath: Os)	-	(Core) 11.6 (Sheath) 3.2	(Core) 6.2 (Sheath) 4.7	9.7	(Core) 9.8 (Sheath) 9.0
Orientation ratio of sheath component to core component of fiber in non-bonding area (Os/Oc)	-	0.28	0.76	-	0.92
Melting peak temperature (T _m) by DSC	°C	163, 148	163	163	163
Bending resistance in machine direction	mm	64	62	66	65
Tensile strength in cross direction per basis weight	N/25 mm/ (g/m ²)	0.83	0.94	0.76	0.78
Tensile strength and elongation product per basis weight	N/50 mm/ (g/m ²)	1,70	1,85	1.13	1.17

[0113] The spun-bonded nonwoven fabric of Examples 1 to 8, which was composed of a core-sheath composite fiber containing a polypropylene-based resin as a main component, in which the ratio (Os/Oc) of the orientation parameter Os of the sheath component of the core-sheath composite fiber in the non-bonding area to the orientation parameter Oc of the core component of the core-sheath composite fiber in the non-bonding area satisfied 0.10 to 0.90, had excellent strength even at a low basis weight, and was excellent in flexibility and touch feeling.

[0114] On the other hand, the spun-bonded nonwoven fabric composed of a single polypropylene resin of Comparative

Example 1 and the spun-bonded nonwoven fabric of Comparative Example 2 having O_s/O_c of more than 0.90 were poor in strength and flexibility.

5 **Claims**

1. A spun-bonded nonwoven fabric comprising a core-sheath composite fiber including a polypropylene-based resin as a main component,

10 wherein the spun-bonded nonwoven fabric has a bonding area and a non-bonding area, and
a ratio (O_s/O_c) of an orientation parameter O_s of a sheath component of the core-sheath composite fiber in the non-bonding area to an orientation parameter O_c of a core component of the core-sheath composite fiber in the non-bonding area is 0.10 to 0.90.

15 2. The spun-bonded nonwoven fabric according to claim 1, wherein the orientation parameter O_s of the sheath component of the core-sheath composite fiber in the non-bonding area is 1.0 or more and 8.0 or less.

3. The spun-bonded nonwoven fabric according to claim 1 or 2, wherein the spun-bonded nonwoven fabric has a single melting peak temperature T_m (°C) in a differential scanning calorimetry.

20 4. The spun-bonded nonwoven fabric according to claim 1 or 2, wherein a tensile strength and elongation product per a basis weight of the spun-bonded nonwoven fabric is 1.20 (N/50 mm)/(g/m²) or more.

25 5. The spun-bonded nonwoven fabric according to claim 1 or 2, wherein a melt flow rate of polypropylene-based resin of the sheath component is larger than a melt flow rate of polypropylene-based resin of the core component by 10 g/10 min to 200 g/10 min.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/041494

A. CLASSIFICATION OF SUBJECT MATTER <i>D04H 3/16</i> (2006.01)i; <i>D04H 3/007</i> (2012.01)i; <i>D04H 3/147</i> (2012.01)i FI: D04H3/16; D04H3/147; D04H3/007 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; D01F8/00-8/18; A61F13/15-13/84 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2023 Registered utility model specifications of Japan 1996-2023 Published registered utility model applications of Japan 1994-2023 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)															
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>WO 2018/092444 A1 (TORAY INDUSTRIES, INC.) 24 May 2018 (2018-05-24) claims 1-2, paragraphs [0001], [0023]-[0069], example 5</td> <td>1-5</td> </tr> <tr> <td>A</td> <td>JP 2005-350835 A (KAO CORP.) 22 December 2005 (2005-12-22) claims, paragraphs [0001], [0010]-[0036]</td> <td>1-5</td> </tr> <tr> <td>A</td> <td>JP 11-61620 A (UNITIKA LTD.) 05 March 1999 (1999-03-05) claims</td> <td>1-5</td> </tr> <tr> <td>P, X</td> <td>JP 2022-132044 A (TORAY INDUSTRIES, INC.) 07 September 2022 (2022-09-07) claims, paragraphs [0026]-[0151]</td> <td>1-5</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	WO 2018/092444 A1 (TORAY INDUSTRIES, INC.) 24 May 2018 (2018-05-24) claims 1-2, paragraphs [0001], [0023]-[0069], example 5	1-5	A	JP 2005-350835 A (KAO CORP.) 22 December 2005 (2005-12-22) claims, paragraphs [0001], [0010]-[0036]	1-5	A	JP 11-61620 A (UNITIKA LTD.) 05 March 1999 (1999-03-05) claims	1-5	P, X	JP 2022-132044 A (TORAY INDUSTRIES, INC.) 07 September 2022 (2022-09-07) claims, paragraphs [0026]-[0151]	1-5	☐ 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
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A	WO 2018/092444 A1 (TORAY INDUSTRIES, INC.) 24 May 2018 (2018-05-24) claims 1-2, paragraphs [0001], [0023]-[0069], example 5	1-5														
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A	JP 11-61620 A (UNITIKA LTD.) 05 March 1999 (1999-03-05) claims	1-5														
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Date of the actual completion of the international search 23 January 2023	Date of mailing of the international search report 07 February 2023															
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/041494

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO	2018/092444	A1	24 May 2018	TW 201829868 A	
				whole document	
JP	2005-350835	A	22 December 2005	(Family: none)	
JP	11-61620	A	05 March 1999	(Family: none)	
JP	2022-132044	A	07 September 2022	(Family: none)	

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