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(54) SPUNBONDED NONWOVEN FABRIC

(57) This nonwoven fabric is a spunbonded nonwoven fabric composed of monocomponent fibers comprising a copolyester resin derived by copolymerizing a polyester resin with 5-40 wt.% polyethylene glycol, characterized in that the ΔMR of the spunbonded nonwoven fabric is 0.5% to 15% inclusive.

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Description

TECHNICAL FIELD

[0001] The present invention relates to a spun-bonded nonwoven fabric that is soft and excellent in sense of touch.

BACKGROUND ART

[0002] Generally, a sanitary nonwoven fabric such as a paper diaper or a sanitary napkin is required to have good texture and softness for touch on skin when it is worn.

[0003] Filament nonwoven fabrics such as spun-bonded nonwoven fabrics have been used for various applications owing to their properties such as strength, air permeability and bending resistance, and their high productivity. Various resins such as polyester based resins or polyolefin based resins have been used as the raw materials of the filament nonwoven fabrics. Among them, copolymerized polyester based resins have been considered to be used for spun-bonded nonwoven fabrics.

[0004] For example, a nonwoven fabric composed of fibers containing a thermoplastic water-absorbing resin having polyalkylene glycol copolymerized is proposed (see Patent Literature 1).

[0005] In addition, a nonwoven fabric composed of core-sheath fibers having, as a sheath component, a copolymerized polyester based resin of polyalkylene glycol and aromatic polyester and having a polyester based resin as a core component is proposed (see Patent Literature 2).

CITATION LIST

PATENT LITERATURE

[0006]

Patent Literature 1: JP-A-2006-299424
Patent Literature 2: JP-A-2003-336156

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] However, in the technique disclosed in Patent Literature 1, there is a problem that when a resin in which 45 mass % of polyethylene glycol has been copolymerized with polytetramethylene terephthalate is used as the copolymerized polyester based resin as shown in the description thereof by way of example, water absorbency of fibers containing the resin is so high that a sticky sense of touch is provided to a nonwoven fabric formed of the fibers, thereby resulting in poor texture.

[0008] On the other hand, in the technique disclosed in Patent Literature 2, there is a problem that since a rigid polyester resin is used in a core portion, the bending rigidity of fibers is so high that the softness deteriorates in a spun-bonded nonwoven fabric formed of the fibers.

[0009] Therefore, in consideration of the aforementioned problems, an object of the present invention is to provide a spun-bonded nonwoven fabric that is soft and excellent in sense of touch.

SOLUTION TO PROBLEM

[0010] The present inventors made intensive studies in order to attain the foregoing objects. As a result, the present inventors found that softness and a sense of touch can be improved on a large scale in a copolymerized polyester based resin in which a specific amount of polyethylene glycol has been copolymerized.

[0011] The present invention was completed based on the aforementioned findings. In the present invention, the following inventive configurations are provided.

[0012] A spun-bonded nonwoven fabric of the present invention is a spun-bonded nonwoven fabric including a mono-component fiber including a copolymerized polyester based resin in which 5 weight % or higher and 40 weight % or lower of a polyethylene glycol is copolymerized with a polyester based resin, in which the spun-bonded nonwoven fabric has a ΔMR of 0.5 % or higher and 15% or lower.

[0013] According to a preferred embodiment of the present invention, the polyester based resin is a polyethylene terephthalate.

ADVANTAGEOUS EFFECTS OF INVENTION

[0014] In the present invention, it is possible to obtain a spun-bonded nonwoven fabric capable of further improving softness, having a less sticky, smooth and excellent sense of touch. Further, processability into a sheet is excellent because the strength of fibers is enhanced, thereby improving productivity.

DESCRIPTION OF EMBODIMENTS

[0015] A nonwoven fabric of the present invention is a spun-bonded nonwoven fabric including a monocomponent fiber including a copolymerized polyester based resin in which 5 weight % or higher and 40 weight % or lower of a polyethylene glycol is copolymerized with a polyester based resin. The spun-bonded nonwoven fabric is characterized in that a ΔMR of the spun-bonded nonwoven fabric is 0.5 % or higher and 15% or lower.

[0016] Examples of the polyester based resin that can be used in the present invention include polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate, and polylactic acid. Particularly, for a preferred embodiment, polyethylene terephthalate is used. When polyethylene terephthalate is used, the resin can be made into fibers that have excellent softness and an excellent sense of touch. In addition, since the resin can be drawn at a high spinning speed, the fibers tend to develop orientation crystallization and also have mechanical strength.

[0017] The number-average molecular weight of the polyethylene glycol contained in the copolymerized polyester based resin used in the present invention is preferably 4,000 or more and 20,000 or less. When the number-average molecular weight of the polyethylene glycol is set at 4,000 or more and more preferably at 5,000 or more, moisture absorbency can be given to the copolymerized polyester based resin so that a nonwoven fabric having a good sense of touch can be obtained. On the other hand, when the number-average molecular weight of the polyethylene glycol is set at 20,000 or less and more preferably at 10,000 or less, the copolymerized polyester based resin has an excellent fiber-forming property. Thus, the spun-bonded nonwoven fabric has few defects. Assume that the number-average molecular weight of the polyethylene glycol contained in the copolymerized polyester resin in the present invention designates a value measured and calculated in the following method.

(1) Sampling about 0.05 g of the copolymerized polyester based resin;
(2) Adding 1 mL of 28% ammonia water to the sample, and heating the sample at 120°C for 5 hours to melt the sample;
(3) After radiational cooling, adding 1 mL of purified water and 1.5 mL of 6 mol/L hydrochloric acid, and making up a constant volume of 5 mL with purified water;
(4) Putting the solution in a centrifugal separator, and then filtrating the solution with a filter having a mesh hole diameter of 0.45 μm;
(5) Measuring a molecular weight distribution in the filtrate by GPC;
(6) Determining the number-average molecular weight of polyethylene glycol by use of a calibration curve of molecular weight prepared using a standard sample having known molecular weight; and
(7) In addition, determining the quantity of the polyethylene glycol by use of a calibration curve of solution concentration prepared by a polyethylene glycol aqueous solution, and calculating the copolymerization amount of the polyethylene glycol in the copolymerized polymer.

[0018] The copolymerization amount of the polyethylene glycol contained in the polymerized polyester based resin used in the present invention is characterized by being 5 weight % or higher and 40 weight % or lower. When the copolymerization amount of the polyethylene glycol is set at 5 weight % or higher and more preferably at 7 weight % or higher, a nonwoven fabric having excellent softness and an excellent sense of touch can be obtained. On the other hand, when the copolymerization amount of the polyethylene glycol is set at 40 weight % or lower and more preferably at 20 weight % or lower, the resin can be formed into fibers having heat resistance durable to practical use and high mechanical strength. The copolymerization amount of the polyethylene glycol contained in the copolymerized polyester resin in the present invention designates a value measured by a method which will be described in Examples.

[0019] Coloring pigment, an antioxidant, a lubricant such as polyethylene wax, a heat-resistance stabilizer, etc. can be added to the copolymerized polyester based resin used in the present invention, so long as the addition thereof does not impair the effects of the present invention.

[0020] The melting point of the copolymerized polyester based resin used in the present invention is preferably 200°C or higher and 300 °C or lower, and more preferably 220°C or higher and 280 °C or lower. When the melting point of the copolymerized polyester based resin is set preferably at 200°C or higher and more preferably at 220°C or higher, heat resistance durable to practical use can be obtained easily. On the other hand, when the melting point of the copolymerized polyester based resin is set preferably at 300°C or lower and more preferably at 280°C or lower, each yarn ejected from a spinneret can be cooled easily to inhibit fibers from being fused with each other. Thus, the obtained spun-bonded nonwoven fabric has few defects. The melting point of the copolymerized polyester based resin in the present invention

designates a value obtained from a peak top temperature in an endothermic peak obtained by measurement on the condition of a temperature rise rate of 16°C/min under nitrogen by a differential scanning calorimetry.

[0021] A method for manufacturing copolymerized polyester in the present invention is a known polymerization method such as a transesterification method or an esterification method. In the transesterification method, an ester-forming derivative of terephthalic acid and ethylene glycol are charged in a reaction vessel and brought into reaction within a range of 150°C or higher and 250°C or lower under the existence of a transesterification catalyst. After that, a stabilizer, a polycondensation catalyst, etc. are added, and heated within a range of 250°C or higher and 300°C or lower under reduced pressure of 500 Pa or lower so as to cause reaction for 3 hours or more and 5 hours or less. Thus, copolymerized polyester can be obtained.

[0022] On the other hand, in the esterification method, terephthalic acid and ethylene glycol are charged in a reaction vessel, and brought into esterification reaction at 150°C or higher and 270°C or lower under a pressurized nitrogen atmosphere. After the esterification reaction is terminated, a stabilizer, a polycondensation catalyst, etc. are added, and heated within a range of 250°C or higher and 300°C or lower under reduced pressure of 500 Pa or lower so as to cause reaction for 3 hours or more and 5 hours or less. Thus, copolymerized polyester can be obtained.

[0023] In the method for manufacturing copolymerized polyester of the present invention, the timing when the polyethylene glycol is added is not particularly limited. The polyethylene glycol may be added together with other raw materials before the esterification reaction or the transesterification reaction. Alternatively, the polyethylene glycol is added after the termination of the esterification reaction or the transesterification reaction and before the start of the polycondensation reaction.

[0024] In the method for manufacturing copolymerized polyester of the present invention, examples of the transesterification catalyst include zinc acetate, manganese acetate, magnesium acetate, and titanium tetrabutoxide. Examples of the polycondensation catalyst include antimony trioxide, germanium dioxide, and titanium tetrabutoxide.

[0025] It is essential that ΔMR of the spun-bonded nonwoven fabric of the present invention is 0.5 % or higher and 15% or lower. As a result of earnest researches, the present inventors found that there is a high correlation between ΔMR which is a parameter conventionally used as an index of a moisture absorbing-releasing property of a fiber and a sense of touch on a spun-bonded nonwoven fabric. When the ΔMR is set at 0.5 % or higher and more preferably at 2% or higher, the spun-bonded nonwoven fabric is in a state where the surface thereof moderately has absorbed moisture so that the sense of touch on the surface thereof becomes a good feeling with moist feeling. On the other hand, when the ΔMR is set at 15 % or lower, more preferably at 10% or lower and even more preferably at 7% or lower, the sense of touch is free from stickiness. In addition, when the ΔMR is set within the aforementioned range, the spun-bonded nonwoven fabric can have smoothness and softness suitable for its high-speed production. Thus, the spun-bonded nonwoven fabric can have excellent high-degree processability.

[0026] The ΔMR can be adjusted by the kind of the polyester component, the number-average molecular weight of the contained polyethylene glycol, and the copolymerization amount thereof.

[0027] Assume that the ΔMR in the present invention designates a value measured and calculated in the following method.

(1) Freezing and crushing 3 g of a sample to be measured, drying the sample in a vacuum at a drying temperature of 110°C for 24 hours, and measuring absolute dry mass (W_d) of the sample;
(2) Leaving the sample for 24 hours in a constant temperature and humidity apparatus controlled in a state of 20°C × 65% R.H., and measuring mass (W_{20}) of the sample reaching an equilibrium state; and
(3) Next, changing the settings of the constant temperature and humidity apparatus to 30°C × 90% R.H., further leaving the sample for 24 hours, then measuring mass (W_{30}) of the sample, and calculating the ΔMR based on the following equation.

$$\Delta MR=(W_{30}-W_{20})/\ W_d\ (\%)$$

[0028] It is essential that the copolymerized polyester based fibers forming the spun-bonded nonwoven fabric of the present invention are monocomponent fibers. When the fibers are monocomponent fibers, the softness belonging to the copolymerized polyester based resin is reflected on the spun-bonded nonwoven fabric so that the spun-bonded nonwoven fabric can have a soft sense of touch. Further, spinnability is improved in comparison with composite fibers. Thus, the spun-bonded nonwoven fabric has few defects.

[0029] The average single fiber diameter of the copolymerized polyester based fibers forming the spun-bonded nonwoven fabric of the present invention is preferably 10 μm or more and 16 μm or less. When the average single fiber diameter is set at 10 μm or more and more preferably at 11 μm or more, processability at the time of post-processing can be improved so that the number of defects can be reduced. On the other hand, when the average single fiber

diameter is set at 16 μm or less and more preferably at 15 μm or less, the sense of touch on the surface of the spun-bonded nonwoven fabric obtained from the copolymerized polyester based fibers becomes smooth. In addition, owing to the narrow average single-fiber diameter, reduction in sectional secondary moment is also exhibited so that the softness is further improved. However, when the average single fiber diameter is less than 10 μm, processability at the time of post-processing deteriorates to increase the number of defects. Assume that the average single fiber diameter of the copolymerized polyester based fibers in the present invention designates a value calculated as follows. That is, 10 small-piece samples are sampled at random from a nonwoven web pulled by an ejector, drawn and then collected on a net. The surfaces of the samples are photographed at a magnification of 500 to 1,000 times by a microscope, and widths of 10 fibers from each sample are measured. A value (μm) calculated from an arithmetic average value of the widths of a total of 100 fibers is regarded as the average single fiber diameter.

[0030] The spun-bonded nonwoven fabric of the present invention has preferably a bending return property of 0.2 cm^{-1} or more and 1.0 cm^{-1} or less. When the bending return property is 1.0 cm^{-1} or less, a feeling of fitting to a hand can be obtained at the time of bending return. When the bending return property is 0.2 cm^{-1} or more, moderate resistance against the return can be obtained to exhibit a natural texture. The bending return property is more preferably 0.8 cm^{-1} or less, and even more preferably 0.6 cm^{-1} or less. On the other hand, the bending return property is more preferably 0.3 cm^{-1} or more, and even more preferably 0.4 cm^{-1} or more.

[0031] The bending return property can be controlled by the aforementioned thermoplastic resin, the additives and the fiber diameter, and/or, the spinning speed, the mass per unit area, the apparent density and the bonding method which will be described later.

[0032] The bending return property of the spun-bonded nonwoven fabric in the present invention designates a value obtained in the following equation using bending rigidity (B) and bending hysteresis (2HB) in each of two directions perpendicular to each other measured by a bending tester (for example, "KES-FB2" made by Kato Tech Co., Ltd.).

$$\text{bending rigidity}=(\text{B in direction 1} + \text{B in direction 2})/2$$

$$\text{bending hysteresis}=(\text{2HB in direction 1} + \text{2HB in direction 2})/2$$

$$\text{bending return property}=\text{bending hysteresis}/\text{bending rigidity}$$

[0033] The spun-bonded nonwoven fabric of the present invention has preferably a bending rigidity of 10 $\mu N \cdot cm^2/cm$ or more and 300 $\mu N \cdot cm^2/cm$ or less. When the bending rigidity is 300 $\mu N \cdot cm^2/cm$ or less, the spun-bonded nonwoven fabric can be bent easily so that a soft sense of touch can be obtained. When the bending rigidity is 10 $\mu N \cdot cm^2/cm$ or more, moderate response to bending can be obtained. The bending rigidity is more preferably 250 $\mu N \cdot cm^2/cm$ or less, and even more preferably 200 $\mu N \cdot cm^2/cm$ or less. On the other hand, the bending rigidity is more preferably 20 $\mu N \cdot cm^2/cm$ or more, and even more preferably 30 $\mu N \cdot cm^2/cm$ or more. The bending rigidity can be controlled by the aforementioned thermoplastic resin, the additives and the fiber diameter, and/or, the spinning speed, the mass per unit area, the apparent density and the bonding method which will be described later.

[0034] The bending rigidity of the spun-bonded nonwoven fabric in the present invention designates a value obtained in the following equation using bending rigidity (B) in each of two directions perpendicular to each other measured by a bending tester (for example, "KES-FB2" made by Kato Tech Co., Ltd.).

$$\text{bending rigidity}=(\text{B in direction 1} + \text{B in direction 2})/2$$

[0035] The spun-bonded nonwoven fabric in the present invention has preferably a tensile elasticity of 5 MPa or more and 100 MPa or less. When the tensile elasticity is 100 MPa or less, the spun-bonded nonwoven fabric can be deformed easily so that a sense of touch on the spun-bonded nonwoven fabric following a hand can be obtained. When the tensile elasticity is 5 MPa or more, a sense of moderate resistance can be obtained. The tensile elasticity is more preferably 80 MPa or less, and even more preferably 60 MPa or less. On the other hand, the tensile elasticity is more preferably 7 MPa or more, and more preferably 9 MPa or more. The tensile elasticity can be controlled by the aforementioned thermoplastic resin, the additives and the fiber diameter, and/or, the spinning speed, the mass per unit area, the apparent density and the bonding method which will be described later.

[0036] The tensile elasticity of the spun-bonded nonwoven fabric in the present invention is an arithmetic average of tensile elasticities obtained in two directions perpendicular to each other by tensile testing with a distance of at least 5

cm between grips performed according to "6.3.1 Normal Time" of "6.3 Tensile Strength and Elongation Rate (ISO method)" of "General Nonwoven Fabric Testing Method" of JIS L1913: 2010. The tensile elasticity designates a value obtained as follows. That is, a curve (stress-stain curve) is obtained by a load and an elongation rate. The largest inclination (where increase of the load is large relatively to the elongation rate) in a region where the elongation rate is 20% or lower is obtained. The obtained inclination is divided by a sectional area to thereby obtain the tensile elasticity. Incidentally, the sectional area in the present invention is a product of a sample width and a thickness (T_o) measured under a load of 0.5 g/cm^2 by a compression tester (for example, "KES-FB3" made by Kato Tech Co., Ltd.).

[0037] In the spun-bonded nonwoven fabric of the present invention, the tensile strength per unit mass per unit area is preferably 0.3 (N/5 cm)/(g/m^2) or more, and 10 (N/5 cm)/(g/m^2) or less. When the tensile strength per unit mass per unit area is 0.3 (N/5 cm)/(g/m^2) or more, the spun-bonded nonwoven fabric can withstand the performance of passing through a process for manufacturing a paper diaper or the like and use as a product. When the tensile strength per unit mass per unit area is 10 (N/5 cm)/(g/m^2) or less, the spun-bonded nonwoven fabric can also have softness. The tensile strength per unit mass per unit area is more preferably 8 (N/5 cm)/(g/m^2) or less, and even more preferably 6 (N/5 cm)/(g/m^2) or less. On the other hand, the tensile strength per unit mass per unit area is more preferably 0.4 (N/5 cm)/(g/m^2) or more, and even more preferably 0.5 (N/5 cm)/(g/m^2) or more. The tensile strength per unit mass per unit area can be controlled by the aforementioned thermoplastic resin, the additives and the fiber diameter, and/or, the spinning speed, the mass per unit area, the apparent density and the bonding method which will be described later.

[0038] The tensile strength of the spun-bonded nonwoven fabric in the present invention is a value obtained by dividing, by the mass per unit area, an average of tensile strengths (strengths at which a sample is broken) obtained in two directions perpendicular to each other by tensile testing with a distance of at least 5 cm between grips performed according to "6.3.1 Normal Time" of "6.3 Tensile Strength and Elongation Rate (ISO method)" of" General Nonwoven Fabric Testing Method" of JIS L1913: 2010.

[0039] For a preferred embodiment, the bending resistance of the spun-bonded nonwoven fabric of the present invention is 70 mm or lower. When the bending resistance is set preferably at 70 mm or lower, more preferably at 67 mm or lower and even more preferably at 64 mm or lower, satisfactory softness can be obtained particularly when the spun-bonded nonwoven fabric is used as a nonwoven fabric for a sanitary material. When the bending resistance is made too low, handlability of the nonwoven fabric may deteriorate. Therefore, the lower limit of the bending resistance is preferably 10 mm or higher. The bending resistance can be adjusted by the resin, the mass per unit area, the average single-fiber diameter and embossing rolls (degree of press bonding, temperature, and linear pressure). The bending resistance in the present invention is calculated according to a "6.7.3 41.5° Cantilever Method" of "6.7 Bending Resistance" of "General Nonwoven Fabric Testing Method" of JIS L1913: 2010. A calculation method will be described. First, five test pieces each measuring 25 mm in width by 150 mm are sampled. Each test piece is placed on a horizontal table having a slope of 45° such that its short sides are aligned with a base line of a scale. Next, the test piece is manually slid along the slope. As soon as a center point of one end of the test piece touches the slope, the moving length of the position of the other end is read by the scale. Such moving lengths are measured as to the both sides of the five test pieces. An average value calculated from the moving lengths is used as the bending resistance in the present invention.

[0040] The mass per unit area of the spun-bonded nonwoven fabric of the present invention is preferably set at 5 g/m^2 or more and 50 g/m^2 or less. For a more preferred embodiment, the mass per unit area is set at 10 g/m^2 or more and 30 g/m^2 or less. When the mass per unit area is within the aforementioned range, softness can be exhibited suitably in the spun-bonded nonwoven fabric. Assume that the mass per unit area in the present invention designates a value obtained as follows. That is, in accordance with "6.2 Mass per Unit Area" of "General Nonwoven Fabric Testing Method" of JIS L1913: 2010, three test pieces each measuring 20 cm by 25 cm are sampled per sample width of 1 m, mass (g) of each test piece in a normal state is measured. An arithmetic average value of the measured masses is expressed by mass per m^2 (g/m^2). The value obtained thus is regarded as the mass per unit area.

[0041] The spun-bonded nonwoven fabric of the present invention has preferably an apparent density of 0.01 g/cm^3 or more and 0.30 g/cm^3 or less. When the apparent density is 0.01 g/cm^3 or more, form stability applicable to practical use can be obtained easily, and the bending return rate can be reduced easily. When the apparent density is 0.30 g/cm^3 or less, air permeability and softness can be obtained easily. The apparent density is more preferably 0.25 g/cm^3 or less, and even more preferably 0.20 g/cm^3 or less. On the other hand, the apparent density is more preferably 0.03 g/cm^3 or more, and even more preferably 0.05 g/cm^3 or more.

[0042] The apparent density of the spun-bonded nonwoven fabric in the present invention is a value obtained by dividing the mass per unit area by the thickness.

[0043] The spun-bonded nonwoven fabric of the present invention can be used broadly for a medical sanitary material, a living material, an industrial material, etc. The spun-bonded nonwoven fabric is excellent in softness and good in sense of touch and is also good in processability owing to few defects as a product. Therefore, the spun-bonded nonwoven fabric can be used suitably particularly for a sanitary material. Specifically, the spun-bonded nonwoven fabric can be used as a disposable diaper, a sanitary item, a base fabric of a poultice material, etc.

[0044] Next, a method for manufacturing the spun-bonded nonwoven fabric of the present invention will be described

along its specific example.

[0045] A spun-bonding method for manufacturing a spun-bonded nonwoven fabric is a manufacturing method requiring the steps of: melting a resin; spinning the resin from a spinneret; then cooling and solidifying the resin to obtain yarns; pulling the yarns by an ejector to draw the yarns; collecting the yarns on a moving net to thereby form the yarns into a nonwoven fiber web; and thermally bonding the nonwoven fiber web.

[0046] Various shapes such as round shapes or rectangular shapes can be used as the shapes of the spinneret and the ejector to be used. Among them, a combination of a rectangular spinneret and a rectangular ejector are used in a preferred embodiment because the use amount of compressed air can be comparatively reduced and the yarns can be prevented from being easily fused with each other or from easily rubbing on each other.

[0047] In the present invention, after the copolymerized polyester based rein is dried in a vacuum, the spinning temperature at which the copolymerized polyester based resin is melted and spun is preferably 240°C or higher and 320°C or lower, more preferably 250°C or higher and 310°C or lower, further preferably 260°C or higher and 300°C or lower. When the spinning temperature is set within the aforementioned range, the resin can be brought into a stable melting state to obtain excellent spinning stability.

[0048] The copolymerized polyester based resin is melted and weighed in an extruder, fed to the spinneret, and spun out as filament fibers.

[0049] Yarns of the filament fibers spun out are next cooled. Examples of methods for cooling the yarns spun out include a method for forcibly blowing cool air to the yarns, a method for naturally cooling the yarns at an atmospheric temperature around the yarns, and a method for adjusting the distance between the spinneret and the ejector. A method in which those methods are combined may be used. In addition, the cooling conditions may be suitably adjusted and used in consideration of the discharge rate per single-hole of the spinneret, the spinning temperature, the atmospheric temperature, etc.

[0050] Next, the yarns cooled and solidified are pulled and drawn by compressed air sprayed from the ejector.

[0051] The spinning speed is preferably 2,000 m/min or higher, more preferably 3,000 m/min or higher, and even more preferably 4,000 m/min or higher. When the spinning speed is set at 2,000 m/min or higher, high productivity can be provided, and the fibers develop orientation crystallization so that filament fibers with high strength can be obtained.

[0052] The mass per length of 10,000 m was calculated from the average single fiber diameter and the solid density of the resin used, and the calculated value was rounded off to the first decimal place to obtain the single-fiber fineness. The spinning speed in the present invention was calculated from the single-fiber fineness (dtex) and the discharge 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, by using the following equation.

$$\text{Spinning speed} = (10{,}000 \times \text{single-hole discharge rate})/\text{single-fiber fineness}$$

[0053] Successively, the obtained filament fibers are collected on a moving net to be formed into a nonwoven fiber web. In the present invention, the filament fibers are drawn at a high spinning speed so that the fibers ejected from the ejector can be collected on the net in a state where the fibers are controlled by a high-speed air flow. Thus, a nonwoven fabric which is highly uniform with reduced entanglement among the fibers can be obtained.

[0054] Successively, the obtained nonwoven fiber web is integrated by heat bonding. Thus, an intended spun-bonded nonwoven fabric can be obtained.

[0055] 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 upper and lower rolls each having an engraved surface (have recesses and protrusions on the surface); hot embossing rolls including a combination of a roll having a flat (smooth) surface and a roll having an engraved surface (has recesses and protrusions on the surface); and hot calendar rolls including a combination of a pair of upper and lower flat (smooth) rolls.

[0056] A proportion of an embossed bonding area in the heat bonding is preferably 5% or higher and 30% or lower. When the proportion of the bonding area is set preferably at 5% or higher and more preferably at 10% or higher, strength applicable to practical use as the spun-bonded nonwoven fabric can be obtained. Meanwhile, when the proportion of the bonding area is set preferably at 30% or less and more preferably at 20% or less, sufficient softness can be obtained particularly for use as a spun-bonded nonwoven fabric for a sanitary material.

[0057] When the heat bonding is performed by a pair of rolls each having recesses and protrusions, the bonding area herein means a proportion of parts where the protrusions of the upper roll and the protrusions of the lower roll overlap each other and abut against the nonwoven fiber web, with respect to the whole nonwoven fabric. On the other hand, when heat bonding is performed by a roll having recesses and protrusions and a flat roll, the bonding area means a proportion of parts where, of the roll having recesses and protrusions, the protrusions abut against the nonwoven fiber web, with respect to the whole nonwoven fabric.

[0058] The shape engraved in the hot embossing rolls may be any of circular, elliptic, square, rectangular, parallelogrammic, rhombic, regularly hexagonal, and regularly octagonal shapes and the like.

[0059] The linear pressure of the hot embossing rolls during the heat bonding is preferably 5 to 70 N/cm. When the linear pressure of the rolls is set preferably at 5 N/cm or higher, more preferably at 10 N/cm or higher and even more preferably at 20 N/cm or higher, sufficient heat-bonding can be performed to obtain strength applicable to practical use as a nonwoven fabric. Meanwhile, when the linear pressure of the rolls is set preferably at 70 N/cm or lower, more preferably at 60 N/cm or lower and even more preferably at 50 N/cm or lower, sufficient softness can be obtained particularly for use as a nonwoven fabric for a sanitary material.

EXAMPLES

[0060] Next, the present invention will be described specifically based on its examples. Incidentally, each physical property was measured based on a corresponding one of the aforementioned methods as long as no particular mention is made. However, the present invention is not limited to only those examples.

(1) To measure number-average molecular weight and copolymerization amount of polyethylene glycol contained in copolymerized polyester based resin

[0061] The number-average molecular weight of the polyethylene glycol was measured by the following GPC measuring apparatus and on the following conditions.

Apparatus: gel permeation chromatograph GPC
Detector: differential refractive index detector RI (RI-8020 made by Tosoh Corporation, sensitivity 128x)
Photodiode array detector (SPD-M20A made by Shimadzu Corporation)
Column: TSK gel G3000PWXL (one column) (Tosoh Corporation)
Solvent: 0.1 M sodium chloride aqueous solution
Flow rate: 0.8 mL/min
Column Temperature: 40°C
Injection volume: 0.05 mL
Standard sample: polyethylene glycol, polyethylene oxide

(2) ΔMR (%)

[0062] ΔMR was measured by use of "LHU-123" made by Espec Corp. as a constant temperature and humidity apparatus.

(3) Thickness T_o (mm)

[0063] Thickness T_o was measured by use of "KES-FB3" made by Kato Tech Co., Ltd. as a compression tester.

(4) Bending Rigidity ($\mu N \cdot cm^2/cm$), Bending Return Property (cm^{-1})

[0064] Bending rigidity and bending return property were measured by use of "KES-FB2" made by Kato Tech Co., Ltd. as a bending tester.

(5) Tensile Elasticity (MPa)

[0065] Tensile elasticity was measured by use of "AGS1KNX" made by Shimadzu Corporation as a tensile tester. Incidentally, the sample thickness T_o (mm) was measured by the same apparatus as in the aforementioned (2).

(6) Apparent Density (g/cm^3)

[0066] Apparent density was calculated by dividing mass per unit area by thickness T_o (mm). Incidentally, the sample thickness T_o (mm) was measured by the same apparatus as in the aforementioned (2).

(7) Bending Resistance (mm)

[0067] Bending resistance was calculated according to the "6.7.3 41.5° Cantilever Method" of "6.7 Bending Resistance"

of "General Nonwoven Fabric Testing Method" of JIS L1913: 2010.

[0068] Five test pieces each measuring 25 mm in width by 150 mm were sampled from the manufactured nonwoven fabric. Each test piece was placed on a horizontal table having a slope of 45° such that its short sides were aligned with a base line of a scale. The test piece was manually slid along the slope. As soon as a center point of one end of the test piece touched the slope, the moving length of the position of the other end was read by the scale. Such moving lengths were measured as to the both sides of the five test pieces. An average value was calculated from the moving lengths.

(8) Evaluation of Sense of Touch

[0069] Ten persons selected arbitrarily touched a surface of each nonwoven fabric by their hands, and made evaluation in accordance with the following criteria. The total points of the evaluation results for each nonwoven fabric was regarded as evaluation of a sense of touch on the nonwoven fabric.

3: The surface was especially smooth, and the sense of touch was very excellent.
2: The surface was smooth, and the sense of touch was excellent.
1: The surface was sticky, and the sense of touch was poor.

[Example 1]

[0070] Copolymerized polyethylene terephthalate in which the number-average molecular weight and the copolymerization amount of contained polyethylene glycol were 5,500 and 12 weight % was melted by an extruder. Yarns spun out from a rectangular spinneret having a hole diameter φ of 0.30 mm at a spinning temperature of 290°C and at a single-hole discharge rate of 0.6 g/min were cooled and solidified. The yarns were pulled and drawn by compressed air from a rectangular ejector having an ejector pressure of 0.30 MPa, and then collected on a moving net. Thus, a nonwoven fiber web composed of copolymerized polyester filament fibers was obtained. The obtained web was heat-bonded at a heat bonding temperature of 230°C and at a linear pressure of 50 N/cm by use of a pair of upper and lower heat embossing rolls. The upper embossing roll was a metallic embossing roll having polka dots engraving thereon and having a proportion of bonding area of 16%, and the lower embossing roll was a metallic flat roll. Thus, a spun-bonded nonwoven fabric having a mass per unit area of 18 g/m^2 was obtained. The obtained spun-bonded nonwoven fabric was evaluated and the results thereof are shown in Table 1.

[Example 2]

[0071] A spun-bonded nonwoven fabric was obtained in the same method as in Example 1, except that the copolymerization amount of contained polyethylene glycol was 8 weight %. The obtained spun-bonded nonwoven fabric was evaluated and the results thereof are shown in Table 1.

[Comparative Example 1]

[0072] A spun-bonded nonwoven fabric was obtained in the same method as in Example 1, except that the copolymerization amount of contained polyethylene glycol was 45 weight %. The obtained spun-bonded nonwoven fabric was evaluated and the results thereof are shown in Table 1.

[Comparative Example 2]

[0073] A spun-bonded nonwoven fabric was obtained in the same method as in Example 1, except that the copolymerization amount of contained polyethylene glycol was 2 weight %. The obtained spun-bonded nonwoven fabric was evaluated and the results thereof are shown in Table 1.

Table 1

		unit	Ex. 1	Ex. 2	Comparative Ex. 1	Comparative Ex. 2
resin		-	PET	PET	PET	PET
PEG	number-average molecular weight	-	5500	5500	5500	5500
	copolymerization ratio	weight %	12	8	45	2
average single fiber diameter		μm	11.6	11.5	13.4	11.5

(continued)

	unit	Ex. 1	Ex. 2	Comparative Ex. 1	Comparative Ex. 2
spinning speed	m/min	4114	4186	3083	4186
mass per unit area	g/m^2	18	18	18	18
ΔMR	%	2.4	0.8	18.6	0.3
bending return property	cm^{-1}	0.35	0.41	0.16	0.38
tensile elasticity	MPa	12.0	15.0	8.0	60.0
bending rigidity	$\mu N \cdot cm^2/cm$	90	100	68	520
apparent density	g/cm^3	0.15	0.15	0.15	0.15
bending resistance	mm	62	64	63	80
evaluation of sense of touch	-	2.8	2.5	1.3	2.0

[0074] Examples 1 and 2 had an excellent sense of touch and high softness.

[0075] On the other hand, when the copolymerization amount of polyethylene glycol was too large as in Comparative Example 1, the softness was indeed provided but there arose a problem that the surface of the nonwoven fabric was sticky, and the sense of touch was extremely poor. On the other hand, when the copolymerization amount was too small as in Comparative Example 2, the bending resistance was so high that the sheet was hard and poor in texture.

[0076] The present invention has been described in detail and with reference to its specific embodiments, but it is obvious for those in the art that various changes or modifications can be made without departing from the spirit and scope of the present invention. The present application is based on a Japanese patent application (Japanese Patent Application No. 2018-010254) filed on January 25, 2018, and a Japanese patent application (Japanese Patent Application No. 2018-183755) filed on September 28, 2018, the contents of which are incorporated herein by reference.

Claims

1. A spun-bonded nonwoven fabric comprising a monocomponent fiber comprising a copolymerized polyester based resin in which 5 weight % or higher and 40 weight % or lower of a polyethylene glycol is copolymerized with a polyester based resin,
wherein the spun-bonded nonwoven fabric has a ΔMR of 0.5 % or higher and 15% or lower.

2. The spun-bonded nonwoven fabric according to claim 1, wherein the polyester based resin is a polyethylene terephthalate.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/002142

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. D04H3/14(2012.01)i, D01F6/92(2006.01)i, D04H3/011(2012.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. C08G63/00-64/42, D01F1/00-6/96, D01F9/00-9/04, D04H1/00-18/04

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	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JSTPlus/JMEDPlus/JST7580 (JDreamIII)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-329429 A (TORAY INDUSTRIES, INC.) 27 November 2001, claims, paragraph [0031], examples & US 2003/0088012 A1, claims, paragraphs [0053], [0054], examples & EP 1288350 A1 & CN 1380917 A	1, 2
X	JP 56-043321 A (TOYOBO CO., LTD.) 22 April 1981, claims, page 4, upper left column, lines 7-11, example 1 (Family: none)	1, 2
A	JP 2006-299424 A (ASAHI KASEI FIBERS CORP.) 02 November 2006 (Family: none)	1, 2
A	JP 03-023646 B2 (TEIJIN LTD.) 29 March 1991, & US 4745142 A & EP 220576 A1 & KR 10-1991-0007559 B	1, 2

☐ 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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04.04.2019	16.04.2019
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2006299424 A **[0006]**
- JP 2003336156 A **[0006]**
- JP 2018010254 A **[0076]**
- JP 2018183755 A **[0076]**