(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 022 877 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
11.02.2009 Bulletin 2009/07

(21) Application number: **07743519.6**

(22) Date of filing: **10.05.2007**

(51) Int Cl.:
D01F 8/14 *(2006.01)* ***D02J 1/22*** *(2006.01)*
D04H 1/54 *(2006.01)*

(86) International application number:
PCT/JP2007/060084

(87) International publication number:
WO 2007/132905 (22.11.2007 Gazette 2007/47)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK RS

(30) Priority: **12.05.2006 JP 2006133794**

(71) Applicant: **Teijin Fibers Limited**
Osaka-shi, Osaka 541-0054 (JP)

(72) Inventor: **GODA, Hironori**
Matsuyama-shi, Ehime 791-8041 (JP)

(74) Representative: **Hallybone, Huw George**
Carpmaels & Ransford
43-45 Bloomsbury Square
London WC1A 2RA (GB)

(54) HEAT-BONDABLE COMPOSITE FIBER AND PROCESS FOR PRODUCING THE SAME

(57) An essential object of the invention is to provide a low-modulus, self-extensible thermal-adhesive bicomponent fiber comprising polyethylene terephthalate as the fiber-forming resin component thereof and capable of producing a nonwoven fabric or a fiber structure that has a high adhesive strength and is bulky and well drapable.

The object of the invention is attained by a self-extensible thermal-adhesive bicomponent fiber that comprises a fiber-forming resin component and a thermal-adhesive resin component and is **characterized in that** the fiber-forming resin component comprises polyethylene terephthalate, that the thermal-adhesive resin component comprises a crystalline thermoplastic resin having a melting point lower by at least 20°C than that of the fiber-forming resin component, and that its breaking elongation is from 130 to 600 %, its 100 % elongation tensile strength is from 0.3 to 1.0 cN/dtex and its 120°C dry heat shrinkage is smaller than -1.0 %; and by a method for producing it.

EP 2 022 877 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a self-extensible thermal-adhesive bicomponent fiber, which has a low modulus and is self-extensible in thermal adhesion and which has a soft feel when formed into a thermal-adhesive nonwoven fabric, and to a method for producing it.

BACKGROUND ART

[0002] In general, a thermal-adhesive bicomponent fiber such as typically a core/sheath thermal-adhesive bicomponent fiber that comprises a thermal-adhesive resin component as the sheath and a fiber-forming resin component as the core is used as a nonwoven fabric by forming a fiber web according to a carding method, an air-laid method or a wet sheet-making method and then melting the thermal-adhesive resin component through hot air drier treatment or hot roll treatment to thereby form fiber-fiber bonding to give a nonwoven fabric. Specifically, this does not use an adhesive comprising an organic solvent, and its advantage is that the amount of a harmful substance such as an organic solvent to be released from it is small. In addition, since its other advantages of high producibility and cost reduction are great, it has been widely used as fiber structures such as fiber cushions (hard cotton) and bed mats, and as nonwoven fabrics.

[0003] Above all, a thermal-adhesive nonwoven fabric typically for sanitary materials such as paper diapers and sanitary napkins is required to have softness and drapability like a fabric and have a suitable, non-paperlike bulkiness, since the nonwoven fabric may be kept in direct contact with users' skin. Continued investigations of nonwoven fabrics having such characteristics are made from the past.

[0004] As one method of thermally adhering a web obtained from thermal-adhesive fibers, there is known a heat-roll method comprising thermally pressing and softening a part of the web by the use of an embossing roll and melt-sealing it. According to the method, the nonwoven fabric may be readily folded at the boundary between the heat-sealed region and the non-heat-sealed region, and the obtained nonwoven fabric may have excellent drapability. However, since the fibers in the heat-sealed region are pressed and flattened, the heat-sealed part may become hard and may lose the bulkiness of nonwoven fabric, and therefore the obtained nonwoven fabric may have a paperlike feel.

[0005] On the other hand, as another method of thermally adhering a web obtained from thermal-adhesive fibers, there is known an air-through method that comprises applying a hot air jet to the whole of a web to thereby soften or melt the intersections of the fibers. According to the method, the applied hot air runs through the web while the bulkiness of the web is left as such in some degree, and therefore the obtained nonwoven fabric is bulky, not having a partly hardened region, and the touch of its surface is smooth. On the other hand, when the nonwoven fabric is folded, it may have irregular folds and may lose drapability.

[0006] For solving the problems, a method is disclosed in Patent Reference 1. Specifically, according to a high-speed spinning method, the orientation index of a thermal-adhesive resin component is made to be at most 25 % and the orientation index of a fiber-forming resin component is made to be at least 40 %, thereby giving a thermal-adhesive bicomponent fiber having a strong adhering point strength, melt-fusible at a lower temperature and having a small degree of thermal shrinkage. The disclosed technique comprises adhering a blended web of the thermal-adhesive bicomponent fibers and non-thermal-adhesive fibers according to an air-through method, thereby producing a nonwoven fabric having drapability and bulkiness and having a sufficient nonwoven fabric strength. However, in the current process for production of staple fibers, the process stability of the high-speed spinning method could not as yet be said sufficient, and the yield in the method is low. Further, in consideration of the property of the obtained staple fibers, it may be said that the cost performance is not sufficient and that there may be still many difficult problems in commercial-base production of staple fibers according to the high-speed spinning method. Moreover, in case where a thermal-adhesive nonwoven fabric is formed of only thermal-adhesive bicomponent fibers, the number of the adhering intersections in the nonwoven fabric may increase, and therefore, a nonwoven fabric having a soft feel may be difficult to obtain and a nonwoven fabric having poor drapability may be obtained. Accordingly, in general, for the purpose of reducing the number of the adhering intersections, non-thermal-adhesive fibers are mixed to produce a nonwoven fabric, but in this case, since the number of the adhering intersections in the nonwoven fabric decreases, the nonwoven fabric strength may lower. Accordingly, the nonwoven fabric strength and the soft feel could not always be on a sufficient level.

[0007] Further, an example to demonstrate a thermal-adhesive bicomponent fiber, in which the core component is a fiber-forming resin component and the core component is polyethylene terephthalate (hereinafter referred to as PET), is not disclosed in Patent Reference 1. When the core component of a thermal-adhesive bicomponent fiber is PET, then the melting point of the core component in the fiber may be sufficiently higher than the melting point of the sheath component therein, as compared with a thermal-adhesive bicomponent fiber in which the core component is polypropylene (hereinafter referred to as PP), and therefore, the thermal-adhesive strength of the obtained nonwoven fabric may be further improved. In addition, since the bicomponent fiber in which the core component is PET is relatively highly

rigid, it has a potential to give a nonwoven fabric having higher bulkiness. However, even though the bicomponent fibers undrawn at a low draw ratio or the undrawn bicomponent fibers described in Patent Reference 1 are formed into nonwoven fabrics, the thermal shrinkage of the fabrics is still large since the orientation crystallinity of the core component of the bicomponent fibers used is insufficient. Moreover, when the high-speed spinning described in Patent Reference 1 is applied to bicomponent fibers in which the core component is PET, then the melting temperature of the sheath component of the bicomponent fibers must be inevitably elevated in accordance with the melting temperature of the core component of the bicomponent fibers in spinning the fibers, for the purpose of preventing rapid solidification of the core component. This involves a problem of frequent fiber breakage in spinning since the polymer to constitute the sheath component may deteriorate and the spinning draft may be large.

(Patent Reference 1) JP-A-2005-350836

DISCLOSURE OF THE INVENTION

PROBLEMS THAT THE INVENTION IS TO SOLVE

[0008] The invention has been made under the background of the above-mentioned prior art techniques, and its object is to provide a low-modulus, self-extensible thermal-adhesive bicomponent fiber comprising polyethylene terephthalate as the fiber-forming resin component thereof and capable of producing a nonwoven fabric or a fiber structure that has a high adhesive strength and is bulky and well drapable.

MEANS FOR SOLVING THE PROBLEMS

[0009] The present inventors have assiduously investigated for the purpose of solving the above-mentioned problems, and as a result, have invented a low-modulus, self-extensible thermal-adhesive bicomponent fiber that comprises PET as the fiber-forming resin component thereof and satisfies high adhesive strength, sufficient bulkiness and drapability, using a crystalline thermoplastic resin having a lower melting point than PET by at least 20°C, as the thermal-adhesive resin component of the fiber, and cold-drawing an undrawn yarn of the fiber taken out at a spinning speed of not higher than 1300 m/min, by from 1.05 times to 1.30 times under no heat or with cooling in a coolant, followed by relaxing and thermally shrinking it at a temperature higher by at least 10°C than both the glass transition point of the thermal-adhesive resin component and the glass transition point of the fiber-forming resin component.

[0010] More concretely, the above-mentioned problems can be solved by the invention of a self-extensible thermal-adhesive bicomponent fiber that comprises a fiber-forming resin component and a thermal-adhesive resin component and is characterized in that the fiber-forming resin component comprises polyethylene terephthalate (PET), that the thermal-adhesive resin component comprises a crystalline thermoplastic resin having a melting point lower by at least 20°C than that of the fiber-forming resin component, and that its breaking elongation is from 130 to 600 %, its 100 % elongation tensile strength is from 0.3 to 1.0 cN/dtex and its 120°C dry heat shrinkage is smaller than -1.0 %. In addition, the above-mentioned problems can be solved by the invention of a method for producing the thermal-adhesive bicomponent fiber, which comprises cold-drawing an undrawn yarn of a bicomponent fiber taken out at a spinning speed of not higher than 1300 m/min, by from 1.05 to 1.30 times, and then relaxing and thermally shrinking it at a temperature higher by at least 10°C than both the glass transition point of the thermal-adhesive resin component and the glass transition point of the fiber-forming resin component.

EFFECT OF THE INVENTION

[0011] A nonwoven fabric formed of the low-modulus, self-extensible thermal-adhesive bicomponent fiber of the invention can have a soft feel based on the low-modulus characteristic and the self-extensibility of the thermal-adhesive bicomponent fiber itself. In addition, the nonwoven fabric may have a high adhesive strength intrinsic to a thermal-adhesive nonwoven fabric formed of only thermal-adhesive bicomponent fibers.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] Embodiments of the invention are described in detail hereinunder. First, the invention is a bicomponent fiber comprising a fiber-forming resin component and a thermal-adhesive resin component. More precisely, the invention is a low-modulus, self-extensible thermal-adhesive bicomponent fiber that comprises PET as the fiber-forming resin component thereof and a crystalline thermoplastic resin having a melting point lower by at least 20°C than that of PET as the thermal-adhesive resin component thereof. When the melting point difference between PET and the thermal-adhesive resin component is less than 20°C, then it is unfavorable since the fiber-forming resin component may also melt in a

step of melting and adhering the thermal-adhesive resin component and since a nonwoven fabric or a fiber structure having a high adhesive strength could not be produced. Preferably, the melting point difference range is from 20 to 180°C.

[0013] Using a known melting method and spinneret for bicomponent fibers, the bicomponent fiber may be produced by obtaining an undrawn yarn of the fiber at a spinning speed of from 100 to 1300 m/min, then cold-drawing it by from 1.05 to 1.30 times, and further relaxing and thermally shrinking it at a temperature higher by at least 10°C than both the glass transition point (hereinafter this is referred to as Tg) of PET and Tg of the thermoplastic crystalline resin constituting the thermal-adhesive resin component and lower by at least 10°C than the melting point of the thermal-adhesive resin component, preferably at a temperature higher by at least 20°C than Tg of the two and lower by at least 20°C than the melting point of the thermal-adhesive resin component. Concretely, the temperature higher than both Tg of PET and Tg of the thermoplastic crystalline resin of the thermal-adhesive resin component is, in many cases, a temperature higher than Tg (about 70°C) of PET. Accordingly, it is desirable that the relaxing and thermal-shrinking treatment is effected at a temperature not lower than 80°C, more preferably not lower than 90°C. Even more preferably, the temperature is not lower than 100°C. The relaxing and thermal-shrinking treatment may be attained in hot air or in hot water. This is because, in the invention, the melting point of the crystalline thermoplastic resin that constitutes the thermal-adhesive resin component is lower by at least 20°C than the melting point of PET, as so mentioned in the above, and therefore Tg of the thermoplastic crystalline resin constituting the thermal-adhesive resin component is mostly lower than Tg of PET. When the temperature in the relaxing and thermal-shrinking treatment is lower than the above temperature range, then it is unfavorable since the shrinkage in thermal adhesion of the bicomponent fiber may increase. When the temperature in the relaxing and thermal-shrinking treatment is extremely higher than the temperature range, then the resin of the thermal-adhesive resin component may soften into pseudo-fusion. The relaxing and thermal-shrinking treatment may be attained according to a method of leading a drawn tow to pass through hot air under no tension at all, or according to a method of overfeeding it in hot air at from 0.5 to 0.85 times under no tension given thereto.

[0014] Through the above-mentioned relaxing and thermal-shrinking treatment, the low-drawn fiber may form crystals having a crystal axis inclined in random directions from the fiber axis direction, while shrunk in the fiber axis direction by the residual strain therein. Further, when the fiber is heated, then the crystal size of the crystals constituting it increases, and therefore when the crystals existing near to each other are kept in contact with each other, the crystal size may further increase. Accordingly, there may occur a phenomenon that the fiber would seemingly extend. This phenomenon is referred to as self-extension, and the bicomponent fiber of the invention exhibit the self-extensibility.

[0015] This phenomenon is more remarkable in high-speed spinning at a spinning speed of not lower than 2000 m/min. The present inventors' investigations have revealed that, when an undrawn yarn obtained at a spinning speed of not higher than 1300 m/min is drawn at a slight draw ratio and then relaxed and thermally-shrunk, then its self-extension degree may be enlarged, and have reached the present invention. For example, in case where a core/sheath bicomponent fiber in which the core component is PET (intrinsic viscosity: IV = 0.64 dL/g) and the sheath component is high-density polyethylene (MFR = 20 g/10 min) is taken out at a spinning speed of 1150 m/min, the self-extension degree of the fiber increases when the draw ratio is higher than 1.00 time, and the self-extension degree thereof reaches a maximum level when the draw ratio is 1.20 times. For expressing the self-extensibility of the fiber, it may be a key point how the orientation of the crystals constituting the fiber could be kept random relative to the fiber axis before the crystals grow thick, and for it, therefore, the fiber may well be greatly shrunk before its crystallization. Accordingly, in a step of drawing it, when the fiber is cold-drawn by from 1.05 to 1.30 times at a drawing temperature further lower than the drawing temperature in hot drawing treatment to be effected by the use of hot water, steam or a plate heater, then the residual strain in the amorphous part of the fiber may be increased with inhibiting the orientation crystallization by the drawing, and therefore this is favorable for obtaining the bicomponent fiber of the invention. "Cold-drawing" as referred to herein includes not only drawing at room temperature but also drawing in an atmosphere positively cooled to a temperature lower than room temperature. Concretely, it includes a method of drawing under no heat at room temperature, or in a coolant cooled to a temperature lower than room temperature. More concretely, a method of cold-drawing in air or drawing in a cold water bath is preferred. The coolant includes not only air and water mentioned above, but also vapors such as rare gas, nitrogen or carbon dioxide inert to the fiber-forming resin component and the thermal-adhesive resin component that form the bicomponent fiber of the invention without swelling or dissolving them, as well as other liquids such as various oils not dissolving PET and the thermal-adhesive resin component; and the coolant may be suitably selected from them. The temperature of the coolant in cold-drawing may be from 0 to 30°C, preferably from 10 to 25°C.

[0016] Accordingly, in order that the self-extension degree at 120°C of the bicomponent fiber could be more than 1.0 %, or that is, the dry heat shrinkage at 120°C of the bicomponent fiber could be smaller than -1.0 %, and that the 100 % elongation tensile strength of the bicomponent fiber could be from 0.3 to 1.0 cN/dtex, the draw ratio must fall within a range of from 1.05 to 1.30 times. When the draw ratio is lower than 1.05 times, then the 100 % elongation tensile strength of the bicomponent fiber could be at most 1.0 cN/dtex but the self-extension degree thereof is less than 1.0 % and the fiber could not attain the object of the invention. When the draw ratio is more than 1.30 times, then the 100 % elongation tensile strength is more than 1.0 cN/dtex. When a thermal-adhesive nonwoven fabric is formed of a web of completely, 100-percentage the thermal-adhesive bicomponent fibers of the type, then the nonwoven fabric could not

have the excellent drapability that is the object of the invention. When the fiber is drawn at the above-mentioned draw ratio, then the drawing temperature is preferably lower; and when cold water is used as the coolant, then the drawing temperature is more preferably from 0°C to 25°C. The drawing operation at such a low temperature greatly contributes to increasing the thermal shrinkage of the obtained bicomponent fiber, since the crystallization of the fiber owing to orientation and heat generation may be prevented by removing the heat generated by the bicomponent fiber during drawing. As mentioned in the above, the 100 % elongation tensile strength of the bicomponent fiber of the invention must be from 0.3 to 1.0 cN/dtex. When the 100 % elongation tensile strength is smaller than 0.3 cN/dtex, then it is unfavorable since the nonwoven tensile strength may be insufficient and the texture of the nonwoven fabric may worsen; and when larger than 1.0 cN/dtex, then it is also unfavorable since the self-extensibility and the softness (drapability) may be poor.

[0017] In producing the bicomponent fiber of the invention, the spinning speed must be at most 1300 m/min, preferably at most 1200 m/min, even more preferably from 100 to 1100 m/min. When the spinning speed is higher than 1300 m/min, then the orientation of the undrawn yarn may increase but the effect of expressing a high self-extension degree through low-drawing treatment, which is a characteristic of the bicomponent fiber of the invention, may decrease.

[0018] Regarding its profile, the low-modulus, self-extensible thermal-adhesive bicomponent fiber of the invention may be in any form of a side-by-side laminated bicomponent fiber of a fiber-forming resin component and a thermal-adhesive resin component, or a core-sheath bicomponent fiber where the core component is a fiber-forming resin component and the sheath component is a thermal-adhesive resin component. However, preferred is a core-sheath bicomponent fiber where the core component is a fiber-forming resin component and the sheath component is a thermal-adhesive resin component, since the thermal-adhesive resin component may be disposed in all directions vertical to the fiber axis direction of the fiber. The core-sheath bicomponent fiber includes a concentric core-sheath bicomponent fiber and an eccentric core-sheath bicomponent fiber.

[0019] For the thermal-adhesive resin component, a crystalline thermoplastic resin must be selected. When an amorphous thermoplastic resin is selected for it, then the molecular chains oriented during spinning may be disoriented while melted and therefore the fiber may thereby greatly shrink. Preferred examples of the crystalline thermoplastic resin are polyolefin resin and crystalline copolyester.

[0020] Examples of the polyolefin resin are crystalline polyolefin resins such as crystalline polypropylene, high-density polyethylene, middle-density polyethylene, low-density polyethylene, linear low-density polyethylene. Further, the crystalline thermoplastic resin to constitute the thermal-adhesive resin component may be a copolyolefin prepared through copolymerization of the above-mentioned polyolefin with at least one unsaturated compound selected from ethylene, propylene, butene-1, pentene-1, or acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, isocrotonic acid, mesaconic acid, citraconic acid or himic acid or their esters or acid anhydrides.

[0021] Preferred examples of the crystalline copolyester for the thermal-adhesive resin component are mentioned below. Preferred for it are copolyesters prepared through copolymerization of an alkylene terephthalate with any of substituted or sulfonic acid group-having aromatic dicarboxylic acids such as isophthalic acid, naphthalene-2,6-dicarboxylic acid, sodium 5-sulfoisophthalate or potassium 5-sulfoisophthalate, aliphatic dicarboxylic acids such as adipic acid or sebacic acid, alicyclic dicarboxylic acids such as 1,4-cyclohexamethylene-dicarboxylic acid, ω-hydroxyalkylcarboxylic acid, aliphatic diols such as polyethylene glycol or polytetramethylene glycol, or alicyclic diols such as cyclohexamethylene-1,4-dimethanol, so that the formed copolyester may have an intended melting point. The alkylene terephthalate may be a polyester obtained starting from 1 to 3 combinations selected from terephthalic acid or its ester-forming derivatives as the essential dicarboxylic acid component, and ethylene glycol, diethylene glycol, trimethylene glycol, tetramethylene glycol, hexamethylene glycol or their derivatives as the essential diol component. The ester-forming derivative includes lower dialkyl esters having from 1 to 6 carbon atoms, and a lower diaryl esters having from 6 to 10 carbon atoms. Preferably, the ester-forming derivative is are dimethyl ester or diphenyl ester. It is desirable that the copolymerization ratio of these components is variously regulated, depending on the copolymerization components, so that the formed copolymer may have a desired melting point. Preferably, it is from 5 to 50 mol%. In the invention, when the fiber-forming resin component is PET, then the thermal-adhesive resin component may be a polymer blend of at least two crystalline thermoplastic resins having a melting point lower than that of PET by at least 20°C, and it may contain an amorphous thermoplastic resin and a crystalline thermoplastic resin of which the melting point difference between PET is less than 20°C within a range not greatly interfering with the adhesiveness and the low thermal shrinkability of the fiber.

[0022] The breaking elongation of the low-modulus, self-extensible thermal-adhesive bicomponent fiber of the invention must be within a range of from 130 to 600 %, preferably from 170 to 450 %. When the breaking elongation of the bicomponent fiber of the invention is less than 130 %, then the orientation of the thermal-adhesive resin component is too high and the adhesiveness of the fiber may be poor and therefore the nonwoven fabric strength lowers. When the breaking elongation of the bicomponent fiber of the invention is more than 600 %, then the strength of the bicomponent fiber is substantially too low and the strength of the thermal-adhesive nonwoven fabric could not be increased.

[0023] For controlling the breaking elongation of the bicomponent fiber to fall within a range of from 130 to 600 %,

herein employable is a method of suitably selecting the nozzle orifice diameter through which the polymer is spun out and the spinning speed, though varying depending the type of the polymers to be combined and on the melt viscosity thereof. Above all, the method of suitably selecting the spinning speed is more effective. Further in the invention, in order that the breaking elongation is controlled to fall within the above-mentioned range, it is desirable that the spinning speed is controlled within a range of from 100 to 1300 m/min, though depending on the type of the polymers and the combination thereof. When the spinning speed is higher, then the breaking elongation may be smaller; and when the spinning speed is lower, then the breaking elongation may be higher.

[0024] The low-modulus, self-extensible thermal-adhesive bicomponent fiber of the invention is characterized in that its 120°C dry heat shrinkage is smaller than -1.0 %. Not specifically defined, the lowermost limit of the dry heat shrinkage may be -20.0 % or so. When a thermal-adhesive nonwoven fabric is produced, the bicomponent fibers therein may self-extend before thermal adhesion, thereby further increasing the thickness thereof in the thickness direction and, in addition, the low-modulus fibers may be oriented in the thickness direction of the nonwoven fabric, and therefore, when the compression in the thickness direction thereof is taken into consideration, then the nonwoven fabric may have a soft feel, and when it is used as the surface component of sanitary materials, then the pressing feel to users' skin in the vertical direction of the fabric may be reduced and further the drapability of the fabric may be bettered.

[0025] Regarding its cross section, the thermal-adhesive bicomponent fiber of the invention preferably has a concentric core/sheath cross section or an eccentric core/sheath cross section. When the bicomponent fiber has a side-by-side cross section and when it is formed into a web, then the web may crimp three-dimensionally and may be thereby greatly shrunk. In such a case, in addition, the web adhesion strength may be small and the effect of the invention may be reduced in some degree. Regarding its cross-sectional profile, the bicomponent fiber may be a solid fiber or a hollow fiber. Not limited to a round cross section, it may have a modified cross section, for example, an oval cross section, a multi-leaved cross section such as a 3- to 8-leaved cross section, or a multi-angular cross section such as 3- to 8-angular cross section. The multi-leaved cross section is meant to indicate a cross-sectional profile that has plural protruding leaves extending from the center part toward the outer peripheral direction.

[0026] The fineness of the thermal-adhesive bicomponent fiber of the invention may be selected depending on the object of the fiber. Not specifically limited, it may be generally from 0.01 to 500 dtex or so. By controlling the diameter of the orifice through which resin is jetted out in spinning, the fiber fineness range may be attained.

[0027] Not specifically defined, the ratio of the fiber-forming resin component and the thermal-adhesive resin component may be selected in accordance with the necessary strength, bulkiness or thermal shrinkage of the intended nonwoven fabric or fiber structure. Preferably, the ratio by weight of the fiber-forming resin component to the thermal-adhesive resin component is from 10/90 to 90/10 or so.

[0028] Regarding its morphology, the fiber may be in any form of multifilament, monofilament, staple fiber, chop or tow, depending on the use and the object thereof. In case where the thermal-adhesive bicomponent fiber of the invention is used as a staple fiber that requires a carding step, the fiber is preferably crimped to a suitable degree in order to make the fiber have good card-through runnability. When formed into a nonwoven fabric, the thermal-adhesive bicomponent fiber of the invention is especially effective for improving the drapability the nonwoven fabric having a random fiber structure. Accordingly, the self-extensible thermal-adhesive bicomponent fibers of the invention may be formed into a nonwoven fabric by themselves. If desired, they may be mixed with any other fibers to produce a nonwoven fabric. For producing a nonwoven fabric, employable is any of a carding method, an air-laid method or a wet sheet-making method, in which the fibers are formed into a web, and then predetermined heat is applied thereto in a hot air drier or by an embossing roll, thereby thermally adhering the fibers together to give a soft thermal-adhesive nonwoven fabric of good drapability having a cantilever value of at most 10 cm.

EXAMPLES

[0029] The invention is described further concretely with reference to the following Examples, but the invention is not limited at all by these. In the Examples, the physical data were determined according to the following methods.

(1) Intrinsic Viscosity (IV):

[0030] The intrinsic viscosity of the polyester was determined as follows : A predetermined amount of the polymer was weighed, then dissolved in o-chlorophenol to have a concentration of 0.012 g/ml, and its viscosity was determined at 35°C according to an ordinary method.

(2) Melt Flow Rate (MFR):

[0031] The melt flow rate was determined according to JIS K-7210, Condition 4 (temperature 190°C, load 21.18 N). Briefly, polymer pellets before melt spinning were sampled, and the melt flow rate of the sample was measured.

(3) Melting Point (Tm), Glass Transition Point (Tg):

[0032] The melting point and the glass transition point of the polymer were measured, using TA Instrument Japan's Thermal Analyst 2200, at a heating rate of 20°C/min.

(4) Fineness:

[0033] The fineness of the bicomponent fiber was measured according to the method described in JIS L-1015:2005, 8.5.1A Method.

(5) Breaking Tensile Strength, Breaking Elongation, 100 % Elongation Tensile Strength:

[0034] The breaking tensile strength, the breaking elongation and the 100 % elongation tensile strength of the bicomponent fiber were measured according to the method described in JIS L-1015:2005, 8.7.1 Method. Depending on the efficiency in constant-length heat treatment thereof, the breaking tensile strength, the breaking elongation and the 100 % elongation tensile strength of the bicomponent fiber of the invention may vary; and therefore, when the breaking tensile strength, the breaking elongation and the 100 % elongation tensile strength of the fiber are measured as a single yarn thereof, then the number of the points of the sample to be analyzed must increase. The number of the points for measurement is preferably at least 50. Accordingly, in this, the number of the points for measurement was 50, and the data of all those points were averaged to give a mean value for the intended physical data. In determination of the breaking tensile strength and the breaking elongation, the tensile strength at a point of 100 % elongation in the load-stress curve is read, and this is the 100 % elongation tensile strength value.

(6) Number of Crimps, Percentage of Crimps:

[0035] The number of crimps and the percentage of crimps of the bicomponent fiber were determined according to the method described in JIS L-1015:2005, 8.12.1 and 8.12.2 Methods.

(7) 120°C Dry Heat Shrinkage:

[0036] The 120°C dry heat shrinkage of the bicomponent fiber was measured according to JIS L-1015:2005, 8.15 b) , at 120°C.

(8) Web Area Shrinkage:

[0037] The bicomponent fiber web area shrinkage was determined according to the following method: A card web having a basis weight of 30 g/m^2 was produced, comprising 100 % thermal-adhesive bicomponent staple fibers cut to have a fiber length of 51 mm; and the web was cut into a 25 cm x 25 cm piece. Next, the thus-cut web was heat-treated, as left in a hot air drier (Satake Chemical Machinery's hot air circulating constant-temperature drier: 41-S4) kept at 150°C, for 2 minutes, thereby thermally adhering the bicomponent fibers together. After thus adhered, the length and the width dimension of the web were measured, and these were multiplied to compute the area A_1. According to the following formula, the area shrinkage was obtained.

$$\text{Area Shrinkage (\%)} = [(A_0 - A_1)/A_0] \times 100$$

wherein A_0 = 5 cm $\times$ 5 cm = 625 (cm^2).

(9) Nonwoven Fabric Strength (adhesion strength):

[0038] From the thermal-adhered web (thickness 5 mm) obtained in the above-mentioned method, a test piece having a width of 5 cm and a length of 20 cm was cut out in the machine direction (in the direction in which the fiber or web runs in the nonwoven fabric production process), and its tensile strength was measured at a pulling rate of 20 cm/min. In this, the chuck distance was 10 cm. The adhesion strength is obtained by dividing the tensile breaking strength by the weight of the test piece.

(10) Bending Resistance (cantilever value):

[0039] From the thermal-adhered web (thickness 5 mm) obtained in the above-mentioned method, a test piece having a width of 2.5 cm and a length of 25 cm was cut out in the machine direction, and this was tested according to the method of JIS L-1086 : 1983, 6.12.1. The cantilever value is only in the machine direction of the sample.

[0040] Concretely, the cantilever value was measured according to the following method: On a horizontal bed having a surface smooth and having a 45-degree inclined surface at its one end, the sample test piece is put along the bed. Next, one end of the test piece is accurately registered to one end of the horizontal bed on its inclined side (joint part of the 45-degree inclined surface and the horizontal bed), and the position of the other end of the test piece is measured as the length thereof from one end of the 45-degree inclined surface of the bed. Since the length of the test piece is 25 cm, this should be 25 cm. Next, the test piece is gradually slid in the inclined direction according to a suitable method, and when the center point of one end of the test piece has reached the same surface as the inclined surface, then the position of the other end is measured as the length from one end of the 45-degree inclined surface. This value is referred to as A. The difference between 25 cm and A is the cantilever value of the sample. 5 sample pieces are thus analyzed on both their surface and back, and the mean value of the obtained data indicates the cantilever value of the test sample. Test samples having a larger cantilever value are harder, and their drapability are worse; and those having a smaller cantilever value are softer, and their drapability are better.

Example 1:

[0041] As the core component (fiber-forming resin component), used was polyethylene terephthalate (PET) having IV = 0.64 dL/g, Tg = 70°C and Tm = 256°C; and as the sheath component (thermal-adhesive resin component), used was high-density polyethylene (HDPE) having MFR = 20 g/10 min and Tm = 131°C (Tg was lower than 0°C). These resins were melted at 290°C and 250°C, respectively. Using a known core/sheath bicomponent fiber spinneret, these were formed into a bicomponent fiber in a ratio by weight, core component/sheath component of 50 wt. %/50 wt.%, and then spun out under the condition of a jetting rate of 0.70 g/min/orifice and a spinning rate of 1150 m/min, thereby obtaining an undrawn yarn. The undrawn yarn was cold-drawn by 1.20 times, and then the cold-drawn yarn was dipped in an aqueous solution of an oily agent of potassium lauryl phosphate/polyoxyethylene-modified silicone of 80 wt.%/20 wt.%. Then, using a staffing box-equipped forced crimper, this was mechanically crimped at 11 crimps/25 mm. Further, the crimped yarn was subj ected to relaxing and thermal shrinkage treatment and drying treatment with hot air at 110°C, higher by 40°C than the glass transition point of the core component, under no tension, and then cut into pieces having a fiber length of 51 mm. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.4 dtex, the breaking tensile strength thereof was 0.76 cN/dtex, the breaking elongation thereof was 442 %, the 100 % elongation tensile strength thereof was 0.37 cN/dtex, and the 120°C dry heat shrinkage thereof was -2.6 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -7.5 %, the nonwoven fabric strength thereof was 15.1 kg/g, and the cantilever value thereof was 8.50 cm.

Comparative Example 1:

[0042] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the undrawn yarn obtained in Example 1 was drawn by 2.5 times in hot water at 70°C, and then further drawn by 1. 2 times in hot water at 90°C. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 2.6 dtex, the breaking tensile strength thereof was 2.49 cN/dtex, the breaking elongation thereof was 37.1 %, and the 120°C dry heat shrinkage thereof was 2.5 %. Since the elongation of the thermal-adhesive bicomponent fiber was less than 100 %, the 100 % elongation tensile strength thereof could not be measured. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was 5 %, the nonwoven fabric strength thereof was 20.5 kg/g, and the cantilever value thereof was 12.90 cm.

Comparative Example 2:

[0043] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the undrawn yarn was not drawn. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.47 dtex, the breaking tensile strength thereof was 0.60 cN/dtex, the breaking elongation thereof was 460.3 %, the 100 % elongation tensile strength thereof was 0.37 cN/dtex, and the 120°C dry heat shrinkage thereof was -0.7 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -1.45 %, the nonwoven fabric strength thereof was 14.5 kg/g, and the cantilever value thereof was 7.90 cm.

Example 2:

[0044] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the draw ratio in cold drawing was 1.1 times. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.41 dtex, the breaking tensile strength thereof was 0.65 cN/dtex, the breaking elongation thereof was 424.1 %, the 100 % elongation tensile strength thereof was 0.41 cN/dtex, and the 120°C dry heat shrinkage thereof was -1.9 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -5.6 %, the nonwoven fabric strength thereof was 16.5 kg/g, and the cantilever value thereof was 8.10 cm.

Example 3:

[0045] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the draw ratio in cold drawing was 1.30 times. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.22 dtex, the breaking tensile strength thereof was 0.72 cN/dtex, the breaking elongation thereof was 381.8 %, the 100 % elongation tensile strength thereof was 0.46 cN/dtex, and the 120°C dry heat shrinkage thereof was -2.0 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -6.1 %, the nonwoven fabric strength thereof was 17.1 kg/g, and the cantilever value thereof was 8.90 cm.

Comparative Example 3:

[0046] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the draw ratio in cold drawing was 1.4 times. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.14 dtex, the breaking tensile strength thereof was 0.75 cN/dtex, the breaking elongation thereof was 346.8 %, the 100 % elongation tensile strength thereof was 0.53 cN/dtex, and the 120°C dry heat shrinkage thereof was -0.6 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -1.8 %, the nonwoven fabric strength thereof was 18.4 kg/g, and the cantilever value thereof was 10.1 cm.

Example 4:

[0047] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the undrawn yarn was cold-drawn while cooled in a water bath having a controlled temperature of 20°C. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.52 dtex, the breaking tensile strength thereof was 0.65 cN/dtex, the breaking elongation thereof was 459.3 %, the 100 % elongation tensile strength thereof was 0.39 cN/dtex, and the 120°C dry heat shrinkage thereof was -3.2 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -9.5 %, the nonwoven fabric strength thereof was 15.3 kg/g, and the cantilever value thereof was 8.13 cm.

Example 5:

[0048] A bicomponent fiber was produced under the same condition as in Example 1, for which, however, the yarn was subjected to relaxing and thermal shrinking treatment and heat treatment in a hot water bath at 95°C with overfeeding it at 0.7 times, but thereafter it was not dried with hot air. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 6.58 dtex, the breaking tensile strength thereof was 0.68 cN/dtex, the breaking elongation thereof was 443.3 %, the 100 % elongation tensile strength thereof was 0.41 cN/dtex, and the 120°C dry heat shrinkage thereof was -3.9 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers was -11.4 %, the nonwoven fabric strength thereof was 14.9 kg/g, and the cantilever value thereof was 8.90 cm.

Example 6:

[0049] As the core component (fiber-forming resin component), used was polyethylene terephthalate (PET) having IV = 0.64 dL/g, Tg = 70°C and Tm = 256°C; and as the sheath component (thermal-adhesive resin component), used was crystalline copolyester (polyethylene terephthalate prepared through copolymerization with 20 mol% of isophthalic acid and 50 mol% of tetramethylene glycol) having MFR = 40 g/10 min, Tm = 152°C and Tg = 43°C. These resins were melted at 290°C and 255°C, respectively. Using a known core/sheath bicomponent fiber spinneret, these were formed into a bicomponent fiber in a ratio by weight, core component/sheath component of 50 wt.%/50 wt.%, and then spun out under the condition of a jetting rate of 0.71 g/min/orifice and a spinning rate of 1250 m/min, thereby obtaining an undrawn yarn. The undrawn yarn was cold-drawn by 1.2 times, and then the cold-drawn yarn was dipped in an aqueous solution of an oily agent of potassium lauryl phosphate/polyoxyethylene-modified silicone of 80 wt.%/20 wt.%. Then,

using a staffing box-equipped forced crimper, this was mechanically crimped at 11 crimps/25 mm. Further, the crimped yarn was subj ected to drying treatment and relaxing and thermal shrinkage treatment with hot air at 90°C under no tension, and then cut into pieces having a fiber length of 51 mm. The single yarn fineness of the thus-obtained thermal-adhesive bicomponent fiber was 5.7 dtex, the breaking tensile strength thereof was 0.94 cN/dtex, the breaking elongation thereof was 392 %, the 100 % elongation tensile strength thereof was 0.35 cN/dtex, and the 120°C dry heat shrinkage thereof was -3.8 %. The web area shrinkage of the web of 100 % the thermal-adhesive bicomponent fibers (however, the thermal-adhering temperature was changed to 180°C) was -11.2 %, the nonwoven fabric strength thereof was 12.3 kg/g, and the cantilever value thereof was 8.30 cm.

INDUSTRIAL APPLICABILITY

[0050] The low-modulus, self-extensible thermal-adhesive bicomponent fiber of the invention comprises PET as the fiber-forming resin component, and since the spinning speed in producing it is low, fiber breakage frequency during spinning is extremely low. Further, when the bicomponent fiber is used in producing a nonwoven fabric, then the produced nonwoven fabric is bulky and has high adhesiveness, high drapability and good feel.

Claims

1. A self-extensible thermal-adhesive bicomponent fiber comprising a fiber-forming resin component and a thermal-adhesive resin component, which is **characterized in that** the fiber-forming resin component comprises polyethylene terephthalate, that the thermal-adhesive resin component comprises a crystalline thermoplastic resin having a melting point lower by at least 20°C than that of the fiber-forming resin component, and that its breaking elongation is from 130 to 600 %, its 100 % elongation tensile strength is from 0.3 to 1.0 cN/dtex and its 120°C dry heat shrinkage is smaller than -1.0 %.

2. The thermal-adhesive bicomponent fiber as claimed in claim 1, which is a core/sheath bicomponent fiber and in which the fiber-forming resin component constitutes the core component and the thermal-adhesive resin component constitutes the sheath component thereof.

3. The thermal-adhesive bicomponent fiber as claimed in claim 1, wherein the thermal-adhesive resin component is a polyolefin resin.

4. The thermal-adhesive bicomponent fiber as claimed in claim 1, wherein the thermal-adhesive resin component is a crystalline copolyester.

5. A method for producing a thermal-adhesive bicomponent fiber of claim 1, which comprises cold-drawing an undrawn yarn taken out at a spinning speed of not higher than 1300 m/min, by from 1.05 to 1.30 times, and then relaxing and thermally shrinking it at a temperature higher by at least 10°C than both the glass transition point of the thermal-adhesive resin component and the glass transition point of the fiber-forming resin component.

6. The method for producing a thermal-adhesive bicomponent fiber as claimed in claim 5, wherein the relaxing and thermal shrinking treatment is effected in hot air.

7. The method for producing a thermal-adhesive bicomponent fiber as claimed in claim 5, wherein the relaxing and thermal shrinking treatment is effected in hot water.

8. A thermal-adhesive nonwoven fabric comprising only self-extensible thermal-adhesive bicomponent fibers of any one of claims 1 to 4 and having a cantilever value of at most 10 cm.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/060084

A. CLASSIFICATION OF SUBJECT MATTER
D01F8/14(2006.01)i, *D02J1/22*(2006.01)i, *D04H1/54*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D01F8/00-8/18, D02J1/22, D04H1/00-18/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 10-60740 A (Unitika Ltd.), 03 March, 1998 (03.03.98), Full text (Family: none)	1-4,8 5-7
Y A	JP 6-228821 A (Unitika Ltd.), 16 August, 1994 (16.08.94), Full text (Family: none)	1-4,8 5-7
Y A	WO 2006/11652 A1 (TEIJIN FIBERS LTD.), 02 February, 2006 (02.02.06), Description, page 12, lines 12 to 25 & JP 2006-37315 A	1-4,8 5-7

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 July, 2007 (17.07.07)	31 July, 2007 (31.07.07)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/060084

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2005-350836 A (Kao Corp.), 22 December, 2005 (22.12.05), Claims; Par. No. [0037] (Family: none)	1-4,8 5-7
E,Y E,A	WO 2007/66599 A1 (KAO CORP.), 14 June, 2007 (14.06.07), Claims; Par. No. [0028] (Family: none)	1-4,8 5-7
A	JP 57-167418 A (Kuraray Co., Ltd.), 15 October, 1982 (15.10.82), Full text (Family: none)	1-8
A	JP 2003-119625 A (Ube-Nitto Kasei Co., Ltd.), 23 April, 2003 (23.04.03), Full text (Family: none)	1-8
P,A	JP 2006-316399 A (Daiwabo Co., Ltd.), 24 November, 2006 (24.11.06), Full text (Family: none)	1-8

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/060084

Claims 1-4 and 8 involve all self-expandable heat-bondable composite fibers made from a heat-bondable resin ingredient which have desired properties including a specific elongation at break, a specific dry-heat shrinkage, etc. However, the fibers which can realize such properties and are specifically disclosed in the description are limited to ones obtained from a combination of specific resin ingredients using the specific spinning conditions and low-stretch-ratio conditions described in the description and through the subsequent specific heat treatment described in the description. The claims hence lack a support in the meaning of Article 6 of the PCT.

Form PCT/ISA/210 (extra sheet) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2005350836 A **[0007]**