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(54) **CONJUGATE FIBER HAVING LOW-TEMPERATURE PROCESSABILITY, NONWOVEN FABRIC AND FORMED ARTICLE USING THE CONJUGATE FIBER**

BEI NIEDRIGER TEMPERATUR VERARBEITBARE KONJUGATFASER, VLIES UND MIT DER KONJUGATFASER HERGESTELLTER ARTIKEL

FIBRE CONJUGUÉE AYANT UNE APTITUDE À LA TRANSFORMATION À BASSE TEMPÉRATURE, NON TISSÉ ET ARTICLE NON TISSÉ UTILISANT LA FIBRE CONJUGUÉE

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(56) References cited:

EP-A1- 0 696 655 EP-A2- 0 395 336
US-A- 4 269 888 US-A- 5 418 045
US-A1- 2002 009 941 US-A1- 2007 014 987
US-B1- 6 454 989

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Description**Technical Field**

[0001] The present invention relates to a conjugate fiber that demonstrates low-temperature processability during heat processing and excellent heat adhesiveness without shrinking significantly. The present invention also relates to a nonwoven fabric and formed article that use the conjugate fiber and have excellent bulkiness and excellent feeling.

Background Art

[0002] Various conjugate fibers having low-temperature processability have conventionally been proposed, and ethylene- α -olefin copolymer has been used as a component forming these conjugate fibers, for the reason that the melting point of the component can be easily controlled by using it. For example, there is proposed a sheath-core and side-by-side conjugate fiber in which a "mixture" of a polyethylene resin having a low melting point of 90 to 125°C and a polyethylene resin having a high melting point of 120 to 135°C is used as one of conjugate components (see, for example, Patent Literature 1). There is also proposed a latently crimpable conjugate fiber in which a component containing an ethylene- α -olefin copolymer and a component containing a polyester resin are "each" used as one of conjugate components (see, for example, Patent Literature 2).

[0003] However, the conventional conjugate fibers having low-temperature processability practically have a lot of room yet to improve. The conjugate fiber proposed in Patent Literature 1, for example, does not necessarily have sufficient low-temperature processability because the polyethylene resin having a low melting point of 90 to 125°C is used and at the same time the polyethylene resin having a high melting point of 120 to 135°C is "mixed" into the abovementioned low-melting point polyethylene resin in an amount of, substantially, 30 % by weight or more in order to achieve stable productivity, and because the mixture of these polyethylene resins is used as one component of the conjugate fiber. Moreover, as described in Patent Literature 2 which relates to a latently crimpable conjugate fiber that utilizes a characteristic that the conjugate fiber containing an ethylene- α -olefin copolymer as a component shrinks easily during heat processing, such a latently crimpable conjugate fiber is not suitable for obtaining a nonwoven fabric that does not shrink but has excellent uniformity.

[0004] Moreover, such a latently crimpable conjugate fiber utilizes a difference in shrinkage characteristics between the plurality of constituents, and hence peeling occurs easily in these components after heat processing. When the melting adhesive component and the other non-melting component are peeled when processing the latently crimpable conjugate fiber into a nonwoven fabric, the fiber composed of the adhesive component and the fiber composed of the other non-melting component are almost mixed within the nonwoven fabric. As a result that a number of such fibers composed of the non-melting component which cannot contribute toward enhancing the nonwoven fabric generate, the strength of the nonwoven fabric cannot be exhibited.

[0005] As described above, those fibers with low-temperature processability that hitherto have been proposed need to be improved in the low-temperature processability thereof and uniformity and strength of the obtained nonwoven fabrics.

[Patent Literature 1] International Publication No. 00/36200

[Patent Literature 2] Japanese Patent Application Publication No. 2006-233381

Disclosure of the Invention

[0006] An object of the present invention is to provide a conjugate fiber, which has low-temperature processability, is prevented from shrinking, has excellent heat adhesiveness and excellent card passability when processing the conjugate fiber into a nonwoven fabric and particularly when performing card processing, and is capable of obtaining a bulky nonwoven fabric with excellent uniformity. Another object of the present invention is to provide bulky nonwoven fabric and formed article of them having excellent uniformity and excellent low-temperature processability.

[0007] As a result of keen study, the inventors have found that the above objects can be achieved by a conjugate fiber that forms a specific side-by-side cross section that has a first component containing a specific ethylene- α -olefin copolymer as a component for contributing to low-temperature processability of the conjugate fiber, i.e., a component having a lower melting point and softened and molten when heated, in a specific amount or more, and a second component containing a crystalline polypropylene.

[0008] Therefore, the present invention is a conjugate fiber as specified in claim 1.

[0009] In an embodiment of the present invention, examples of the ethylene- α -olefin copolymer to be used include an ethylene- α -olefin copolymer having a molecular weight distribution (Mw/Mn) of 1.5 to 2.5, a density of 0.87 to 0.91 g/cm³, and a melt index (MI) of 10 to 35 g/10 min as measured under conditions with a temperature of 190°C and a load of 21.2 N based on ASTM D-1238.

[0010] The above conjugate fiber can show a heat shrinkage percentage of 50% or lower when subjected to heat processing at 100°C for five minutes.

[0011] The conjugate fiber of the present invention can be processed into a nonwoven fabric to produce a nonwoven fabric, and the conjugate fiber of the present invention can be processed or the nonwoven fabric obtained from the conjugate fiber of the present invention can be processed to obtain a shaped article.

[0012] Therefore, the present invention is also intended for a nonwoven fabric obtained by processing the conjugate fiber into a nonwoven fabric, a formed article obtained using the conjugate fiber, and a formed article obtained using the nonwoven fabric.

[0013] Examples of the processing into a nonwoven fabric include a hot-air adhesion method and a hot-water adhesion method.

[0014] The conjugate fiber of the present invention has a side-by-side cross section in which a first component containing 75 % by weight of an ethylene - α -olefin copolymer having a melting point of 70 to 100°C accounts for 55 to 90% of an outer periphery of the fiber in a fiber cross section perpendicular to a fiber axis, a borderline between the first component and the second component forms a curve bulging toward the first component, and in which an area ratio between the first component and the second component (first component/second component) is in a range of 70/30 to 30/70. Because the first component containing the ethylene - α -olefin copolymer covers mainly the surface of the fiber, the first component shows an excellent heat adhesiveness at a heat processing temperature of 100°C or lower. Specifically, excellent low-temperature processability is obtained. Furthermore, because the second component containing a crystalline polypropylene is exposed to a part of the surface of the fiber, the second component can reduce the intensity of the surface friction particular to the ethylene - α -olefin copolymer, and can also be produced stably in a fiber manufacturing process even without adding lubricant at all or by adding a little lubricant. Particularly when performing card processing, excellent fiber passability can be obtained during the card processing.

[0015] A problem in the cross-sectional shape of a general two-component side-by-side conjugate fiber having a combination of half-moon-shaped components is the peeling of the components. The side-by-side cross section of the conjugate fiber of the present invention is configured such that the first component containing ethylene - α -olefin copolymer accounts for 55 to 90% of the length of the outer periphery, the borderline between the first component and the second component forms a curve bulging toward the first component, and such that the area ratio between the first component and the second component (first component/second component) is in a range of 70/30 to 30/70. For this reason, peeling hardly occurs between the components, and preferable workability can be exerted in, particularly, the card processing, without impairing the fiber passability obtained during the card processing and the intensity of the nonwoven fabric obtained after processing the conjugate fiber into a nonwoven fabric. Moreover, although the cross-sectional shape of the general two-component side-by-side conjugate fiber having a combination of half-moon-shaped components shrinks easily when subjected to heat processing, it is considered that the conjugate fiber of the present invention can effectively prevent shrinkage by adopting a specific fiber cross-sectional shape with a specific ethylene - α -olefin copolymer used as the first component.

[0016] The nonwoven fabric obtained using the conjugate fiber of the present invention is bulky and soft, has less width reduction (reduction of the width in relation to a direction of flow of the nonwoven fabric) due to small shrinkage when subjected to heat processing, hence excellent productivity and excellent uniformity can be achieved. Moreover, because the conjugate fiber of the present invention has, as an effective component, a component that contains an ethylene - α -olefin copolymer having a melting point of 70 to 100°C, heat processing can be performed thereon at 100°C or lower. Therefore, when processing the conjugate fiber of the present invention into a nonwoven fabric or a formed article, a medium such as steam and hot water also can be used so that appropriate conditions for obtaining a nonwoven fabric or a formed article can be selected from a wide range of choice in accordance with the use application, environment and circumstances.

Brief Description of Drawings

[0017] [Fig. 1] A schematic diagram showing an example of the side-by-side cross-sectional shape of a conjugate fiber of the present invention.

Best Mode for Carrying Out the Invention

[0018] The conjugate fiber of the present invention has a first component containing an ethylene - α -olefin copolymer. This ethylene α -olefin copolymer comprises ethylene and α -olefin units. Examples of the α -olefin include, specifically, linear α -olefins such as propylene, butene-1, pentene-1, hexene-1, heptene-1, and octene-1. Butene-1 and octene-1 are preferred but octene-1 is more preferred. The α -olefin content of the ethylene - α -olefin copolymer is 20 mol% or less. The α -olefin content is normally 1 mol% or more. The content in this case is expressed in molar ratio percentage ((α -olefin)/(α -olefin + ethylene)). Excessive α -olefin content delays solidification during the fiber manufacturing process

and causes fusion between fibers and thereby a possible damage the productivity. When the α -olefin content is 30 mol% or less, sufficient rigidity of the fiber can be obtained and, particularly when performing card processing, excellent fiber passability can be obtained during the card processing.

[0019] The melting point of the ethylene α -olefin copolymer to be used is 70 to 100°C, and preferably 80 to 100°C. The melting point of at least 70 °C can prevent fusion between fibers, and, for example, when drying an antistatic agent or other treatment agent applied to the surface of the fiber during the fiber manufacturing process, fusion between the fibers can be prevented and excellent productivity can be exerted. Furthermore, when the melting point of 100°C or lower, not only is it possible to set the temperature for processing the fiber into a nonwoven fabric or a formed article at 100°C or lower, but also a medium such as steam and hot water can be used for heat processing, and a processing method in which a comparatively low-temperature medium is used can be selected. In addition, this 100°C or less melting point is preferred as it is not necessary to concern about the influence on other components of the fiber that are essentially not molten.

[0020] The melting point described here is a melting peak temperature that is obtained when the ethylene α -olefin copolymer is measured using a differential scanning calorimeter (DSC). When a plurality of melting peaks are confirmed the temperature of the largest melting peak is taken as the melting point, and when a plurality of close melting peaks are confirmed the lower temperature of those is taken as the melting point.

[0021] The molecular weight distribution (Mw/Mn), which is the ratio between the weight-average molecular weight (Mw) of the ethylene α -olefin copolymer and the number average molecular weight (Mn), is preferably 1.5 to 2.5 and more preferably 1.7 to 2.3. When the molecular weight distribution (Mw/Mn) is in a range of 1.5 to 2.5, excellent spinnability is obtained in the fiber manufacturing process, and thus this molecular weight distribution is preferred in terms of the fabric property in order to obtain a strong conjugate fiber.

[0022] The density of the ethylene α -olefin copolymer is preferably 0.87 to 0.91 g/cm³ and particularly preferably 0.88 to 0.90 g/cm³. When the density of the ethylene α -olefin copolymer is at least 0.87 g/cm³, appropriate surface viscosity can be obtained when processing the copolymer into a fiber, and agglutination hardly occurs during fiber manufacture. Therefore, this density is suitable for using the ethylene α -olefin copolymer as a main component of the fiber. When, on the other hand, the density is 0.91 g/cm³ or lower, the melting point of the ethylene α -olefin copolymer is comparatively as low as 100°C or lower, and thus this ethylene α -olefin copolymer is suitable as the ethylene α -olefin copolymer to be used in the present invention.

[0023] The melt index (MI) of the ethylene α -olefin copolymer is preferably 10 to 35 g/10 min and more preferably 15 to 30 g/10 min in consideration of achieving stable production during the fiber manufacturing process. The MI described here is a value that is measured under conditions with a temperature of 190°C and a load of 21.2 N based on ASTM D-1238.

[0024] The ethylene α -olefin copolymer to be used may be a mixture of one kind or two or more types.

[0025] Variety of additives can be compounded into the ethylene α -olefin copolymer used in the present invention. Preferred examples of the additives include lubricant, heat-resistant stabilizer, antioxidant, weatherproof stabilizer, anti-static agent, colorant and the like. Preferred used as a lubricant includes fatty acid amides such as oleic amide and erucic acid amide, fatty acid esters such as butyl stearate, polyolefin waxes such as polyethylene wax and polypropylene wax, and metallic soap such as calcium stearate, and the like. More preferred examples include fatty acid amides such as oleic amide, erucic acid amide, stearic acid amide, behen acid amide and the like.

[0026] The first component contained in the conjugate fiber of the present invention needs to include the abovementioned ethylene α -olefin copolymer in an effective amount so as to be involved in heat adhesion at low temperature and so that steam or hot water can be used as a heat medium particularly when processing the conjugate fiber into a nonwoven fabric or performing the processing of formed article. The ethylene α -olefin copolymer content is 100% as a resin raw material. It is preferred that the ethylene α -olefin copolymer be at least 75% in the first component so that the performance of the ethylene α -olefin copolymer can be realized subjectively.

[0027] For example, low-density polyethylene, high-density polyethylene, ethylene-vinyl acetate copolymer, propylene copolymer and the like can be the resin raw materials that the first component may contain in addition to the ethylene α -olefin copolymer under the condition that at least 75% of the ethylene α -olefin copolymer is contained in relation to the weight of the first component. A method for uniformly mixing the resins and using them or a method for inserting the other resin from a feed port provided on the way of kneading process where the ethylene α -olefin copolymer has been kneaded and already is in molten state.

[0028] The conjugate fiber of the present invention contains a crystalline polypropylene as the second component. This crystalline polypropylene is a propylene homopolymer or a copolymer of propylene and a small amount of α -olefin (normally 2 % by weight or less), and examples of such a crystalline polypropylene include a general-purpose polypropylene that is obtained by using a Ziegler-Natta catalyst or a metallocene catalyst.

[0029] The crystalline polypropylene of the present invention preferably has a melting point of 150 to 165°C and more preferably 155 to 165°C, and preferably has a melt mass flow rate (MFR = 230°C, 21.2N) in a range of 0.1 to 80 g/10 min and more preferably 3 to 40 g/10 min.

[0030] As the second component forming the conjugate fiber of the present invention, which contains the crystalline

polypropylene, a mixture of the crystalline polypropylene and propylene - α -olefin copolymer, or a mixture of crystalline polypropylenes having different properties such as the melt mass flow rate (MFR) and molecular weight distribution (Mw/Mn) can be used suitably as long as the effect of the conjugate fiber is not damaged significantly. Moreover, it is not a problem to compound other thermoplastic resin, inorganic substances such as titanium dioxide, calcium carbonate and magnesium hydroxide, or various additives (fire-retardant, heat-resistant stabilizer, antioxidant, weatherproof stabilizer, antistatic agent, colorant and the like). It is appropriate that at least 75 % by weight of the crystalline polypropylene is generally contained in the second component forming the conjugate fiber of the present invention.

[0031] In the conjugate fiber of the present invention, the first component containing the ethylene - α -olefin copolymer and the second component containing the crystalline polypropylene form a side-by-side cross section having a specific structure.

[0032] In the fiber cross section perpendicular to a fiber axis, the first component containing the ethylene - α -olefin copolymer accounts for 55 to 90% of an outer periphery of the fiber, and the second component containing the crystalline polypropylene accounts for 45 to 10% of the same. Because the first component containing a specific ethylene - α -olefin copolymer accounts for 55% or more of the outer periphery of the fiber, heat processing can be performed at 100°C or lower. Also, because the second component containing the crystalline polypropylene accounts for 10% or more of the outer periphery of the fiber, the crystalline polypropylene continuously appear on the fiber, not only is it possible to reduce the friction between fibers or friction to a metal but also viscosity that occurs when the ethylene - α -olefin copolymer is used on the surface of the fiber, and excellent spinnability and card processability can be obtained when performing the card processing. It is particularly preferred that the first component containing the ethylene - α -olefin copolymer account for 60 to 80% of the outer periphery of the fiber and that the second component containing the crystalline polypropylene account for 40 to 20% of the same.

[0033] In the fiber cross section perpendicular to the fiber axis in the conjugate fiber of the present invention, the borderline between the first component and the second component forms a curve bulging toward the first component. By providing the conjugate fiber with this structure, the borderline between the first component and the second component becomes longer compared to the conjugate fiber having a general side-by-side cross-sectional structure where half-moon-shaped components are joined together. Specifically, the joint area between the both components is increased and, by providing the conjugate fiber of the present invention with a structure where the first component wraps the second component, the second component can be prevented from being released from this conjugate fiber.

[0034] Suppose that two intersections of the outer periphery of the fiber and the borderline between the first component and the second component are taken as point a and point b, the borderline forming a curve bulging toward the first component, and that a point where the segment ab is halved is taken as point c, and a point where the borderline between the first component and the second component intersects with a straight line that extends in a direction perpendicular to a line ab through point c is taken as point d, and a point where said straight line that extends in a direction perpendicular to a line ab through point c intersects with the outer periphery of the fiber on the second component side as point e. It is particularly preferred that the fiber cross section perpendicular to the fiber axis has a structure where the borderline forms a curve bulging toward the first component such that the relationship between the length of a segment cd and a segment ce satisfy a relationship of $cd \geq 0.8 ce$. When satisfying the relationship of $cd \geq ce$, more preferably $cd \geq 1.5 ce$, or particularly preferably $cd \geq 2ce$, excellent un-releasability between the conjugate components and heat shrinkability are obtained when performing heat processing and forming processing.

[0035] Furthermore, when the borderline between the first component and the second component that forms a curve bulging toward the first component is considered to take up a part of the outer periphery of a circle or an ellipse formed by an outer periphery of the second component, it is preferred that the length (g) of the borderline exceed 50% or more preferably at least 60% of the entire outer peripheral length (h) of the circle or ellipse formed by the second component. Especially when both ends of the diameter or long axis of the circle or ellipse formed by the second component exists within the fiber cross section perpendicular to the fiber axis of the conjugate fiber, and when the length of the diameter or long axis is f, a conjugate structure where the second component produces an anchoring function against the first component can be formed in the case where the relationship between the f and the length of the segment ab satisfies $f > ab$, the segment ab obtained by the two intersections point a and point b where the borderline between the first component and the second component intersect with the outer periphery of the fiber. Therefore, the effect of preventing the second component from being released can be enhanced extremely effectively.

[0036] It is preferred that the ratio between the two components that form the conjugate fiber of the present invention be, in the fiber cross section perpendicular to the fiber axis, first component/second component = 70/30 to 30/70, in order to maintain the configuration of the cross section to obtain stability during fiber manufacture and a balance between the strength and degree of elongation that is obtained when processing the conjugate fiber into a nonwoven fabric. More preferably, the ratio is 60/40 to 40/60.

[0037] The conjugate fiber of the present invention can be manufactured using a conventionally known side-by-side conjugate spinneret. The conjugate fiber of the present invention can be manufactured using a side-by-side conjugate spinneret, for example, Japanese Patent Application Publication S48-11417 or Japanese Patent Application Publication

S52-74011.

[0038] In order to form the cross-sectional shape of the conjugate fiber of the present invention by using the side-by-side spinneret, it is necessary to obtain a balance in the flowability (viscosity or the like) of the molten first component containing the ethylene- α -olefin copolymer and the molten second component containing the crystalline polypropylene, and the flowability is adjusted under a fiber manufacturing condition in consideration of the melt index (MI) and melt mass flow rate (MFR) of these two components. For example, for the first component containing the ethylene- α -olefin copolymer, the flowability (viscosity) thereof that is measured when melting it at some temperature selected in the range about 190°C, and a temperature range in which the flowability (viscosity) enabling the fiber to be manufactured is selected based on fluctuation of melt flowability (melt viscosity) to obtain an extrusion temperature as the fiber manufacturing condition. Similarly, for the second component containing the crystalline polypropylene, when the flowability (viscosity) thereof is measured by melting the second component at about 230°C, to select an extrusion temperature. When selecting an extrusion temperature such that the melt flowability (melt viscosity) of the first component is relatively greater than the melt flowability (melt viscosity) of the second component, and when extruding both components with the pressure, the proportion of the first component covering the peripheral surface of the fiber relatively increases. For example, the cross-sectional configuration of the conjugate fiber of the present invention can be formed easily when the ratio of the melt index (MI) of the first component to the melt mass flow rate (MFR) of the second component is 1.5 to 3 times, although it is not possible to say definitely because temperature dependence of the flowability (uptrend of viscosity) varies depending on the resins used. More preferably, this ratio is in a range of 1.8 to 2.5. The larger this ratio, the easier to obtain the configuration where the first component wraps the second component, thus the proportion of the second component taking up the outer periphery of the fiber is reduced. Also, by changing the ratio of discharging amount of both components, the proportions of the first component and the second component on the fiber cross section in relation to the outer periphery of the fiber can be increased or decreased even if the extrusion temperature and the melt viscosity are not changed. This means that the area ratio between the components on the fiber cross section perpendicular to the fiber axis is changed, and thus, for example, when the area ratio of the second component taking up the cross section perpendicular to the fiber axis is relatively high, the proportion of the second component in relation to the outer periphery of the fiber increases easily under the same manufacturing condition.

[0039] When manufacturing the conjugate fiber of the present invention, it is possible to adopt a normal melt spinning method with selection of such the extrusion temperature or resin discharge amount as the above.

[0040] A treatment agent may be applied to a surface of the conjugate fiber of the present invention in order to improve processing stability when manufacturing the fiber. The treatment agent is mainly an antistatic agent, but is also a hydrophilic agent capable of improving wettability of the surface of the fiber. Examples of the components of these antistatic agent and hydrophilic agent include alkyl phosphate, ethylene oxide adduct thereof, sorbitan fatty acid ester ethylene oxide adduct, polyglycerol fatty acid ester, polyoxyethylene modified silicone and the like. A single component selected from these components or a mixture of any of the components is used as the treatment agent.

[0041] The heat shrinkage percentage of the conjugate fiber of the present invention that is obtained when heat-processing the conjugate fiber at 100°C for five minutes is 50% or lower, preferably 30% or lower, and more preferably 20% or lower.

[0042] The heat shrinkage percentage described here, which is expressed in percentage (%), is a difference in size (reduced amount) between the conjugate fibers that are and are not subjected to heat processing, the conjugate fibers being obtained by inserting the conjugate fiber of the present invention, staple fiber, into a card machine, cutting the fibrous web that is thus extracted from a card outlet (the web is in the form of a sheet with entangled fibers) into a certain shape, and then performing the heat processing thereon at 100°C for five minutes.

[0043] Specifically, the heat shrinkage percentage of the present invention is obtained by cutting the conjugate fiber of the present invention into any length such as 30 to 65 mm to obtain a staple fiber, and inserting this staple fiber into a miniature card machine to create a fibrous web having a mass per unit area of 200 g/m². This fibrous web is cut along a pattern of 250 mm × 250 mm in a flow direction (MD) of the fiber and a direction perpendicular to this flow direction (CD). This fibrous web is left stand for ten minutes, thereafter the length of the MD of this cut fibrous web is measured immediately before performing the heat processing, and then the fibrous web is subjected to the heat processing in a circulating hot air oven at 100°C for five minutes. After the heat processing, the length of MD is measured again, and the value of the heat shrinkage percentage is obtained by the following equation.

$$\text{Heat Shrinkage Percentage (\%)} = \{(L_0 - L)/L_0\} \times 100$$

L_0 : The length of MD before the heat processing

L: The length of MD after the heat processing

[0044] Here, the lower this value, the smaller the shrinkage of the fibrous web when processing the conjugate fiber into a nonwoven fabric, hence stable processing can be performed and a nonwoven fabric with excellent uniformity can be obtained.

[0045] Note that conditions for measuring the heat shrinkage described here are not specified/limited to the conditions for processing the conjugate fiber of the present invention, the heat processing conditions, the conditions for processing the conjugate fiber into a nonwoven fabric, and usage of the conjugate fiber.

[0046] In a conjugate fiber that has a conventionally known side-by-side cross-sectional structure, crimps are generated easily during the heat processing for manufacturing the fiber, due to the cross-sectional structure of the conjugate fiber and the resin configuration thereof, hence, as a result, the effect of improving bulkiness of the fiber can be exerted. Particularly, as in the fibrous web for use in processing the conjugate fiber into a nonwoven fabric, the fibrous web being an assembly of fibers that are cut into a predetermined length to process the conjugate fiber into a nonwoven fabric, when performing the heat processing, the fiber itself shrinks easily, because of existing freely each other in the web. Therefore, although bulkiness was realized when the fibrous web was obtained, the fiber would shrink significantly after processing the fiber into a nonwoven fabric, and consequently the realized bulkiness could not be maintained. Moreover, although various things were tried in order to obtain uniform mass per unit area of the fibrous web, weight unevenness cannot be eliminated completely and the freedom of the fiber within the fibrous web ranges slightly variously. Therefore, the part having higher freedom tends to shrink easily when performing the heat processing to process the conjugate fiber into a nonwoven fabric. For this reason, the part that shrinks easily pulls and gathers the fibers existing in the surroundings to form a clump, and the part that has lost fibers due to this gathering is reduced in mass per unit area, whereby weight unevenness becomes extremely noticeable in the entire nonwoven fabric, making it difficult to obtain a nonwoven fabric having excellent uniformity.

[0047] On the other hand, the conjugate fiber of the present invention has the side-by-side cross-sectional structure composed of two components, but has a cross-sectional shape in which the first component containing the ethylene - α -olefin copolymer accounts for 55 to 90% of the outer periphery of the fiber and wraps the second component containing the crystalline polypropylene. Moreover, by using an ethylene - α -olefin copolymer having a melting point of 70 to 100°C, or preferably an ethylene α -olefin copolymer having a molecular weight distribution (Mw/Mn) of 1.5 to 2.5, a density of 0.87 to 0.91 g/cm³, and a melt index (MI) of 10 to 35 g/10 min, shrinkage properties obtained during the heat processing can be retained at 50% or lower where the processing into a nonwoven fabric and the processing into a formed article can be stably performed, while taking the advantage of the bulk improving effect obtained from latent crimps by adopting the side-by-side cross-sectional structure.

[0048] It is unknown as to why such an excellent shrinkage retaining mechanism can be realized by the conjugate fiber of the present invention that has a combination of a specific resin structure and a specific conjugate structure. It is unexpected that, while surprisingly preventing shrinkage by using the specific ethylene - α -olefin copolymer and combining it with the crystalline polypropylene to obtain a fiber that further has a specific fiber cross-sectional configuration, it is possible to obtain a nonwoven fabric that has excellent bulkiness, which is generally considered to be a conflicting performance, excellent feeling, and excellent heat processing properties at a low temperature of 100°C.

[0049] The fineness of the conjugate fiber of the present invention is not particularly limited. A conjugate fiber that is suitably processed into a nonwoven fabric or formed article may be selected in consideration of the properties of the components forming the conjugate fiber and of processing stability when manufacturing the fiber. For example, a fiber having a fineness of 1 to 5 dtex is preferably selected when using the conjugate fiber in a powder puff or a medicine sheet that comes into direct contact with a human skin. A fiber having a fineness of 1 to 10 dtex is suitable for use in a liquid retaining material such as an ink cartridge of a printer. In addition, a fiber having a fineness of 1 to 20 dtex is suitable for use in a liquid volatilizing material such as an aromatic substance core of home fragrance.

[0050] The length of the conjugate fiber of the present invention is not particularly limited, and hence may be long or short. When cutting into a short fiber, the cut length can be appropriately selected in accordance with the fineness of the conjugate fiber, the method of processing the conjugate fiber, and the use application of the conjugate fiber. When the staple fiber is subjected to the card processing, it is preferred that the staple fiber be cut into 20 to 125 mm. In order to obtain excellent card passability and uniformity of the fibrous web, it is preferred that the staple fiber be cut into 25 to 75 mm. Moreover, when processing the conjugate fiber of the present invention into nonwoven fabric by using an air-laid method, it is preferred that the conjugate fiber be chopped into 3 to 25 mm with the air-laid method.

[0051] The conjugate fiber of the present invention preferably has crimps in order to spread the fiber bundle and obtain a bulky fibrous web and nonwoven fabric. The number of crimps to be obtained or the type of crimps can be selected appropriately in accordance with the fineness and cut length of the conjugate fiber, the method for processing the conjugate fiber, and the use application of the conjugate fiber. For example, when a conjugate fiber (staple fiber) having a fineness of 3.3 to 6.6 dtex and a cut length of 38 to 45 mm is processed into a fibrous web by a carding method, it is preferred that the number of crimps be 10 to 25 peaks/25 mm. When a conjugate fiber (chop for air-laid method) having a fineness of 3.3 to 6.6 dtex and a cut length of 3 to 6 mm is processed into a fibrous web by the air-laid method, it is preferred that the number of crimps be 5 to 15 peaks/25 mm. The crimps can be, for example, in a zigzag shape or a

spiral structure.

[0052] In order to process the conjugate fiber of the present invention into a nonwoven fabric, preferably the fibrous web is formed first, the heat processing is performed thereon, and then the method for processing into a nonwoven fabric is used. Examples of a fibrous web formation method include a carding method for passing a card machine and an air-laid method for inserting fibers into a cylindrical drum provided with a slit and accumulating the fibers on a belt conveyor by rotating the drum, but the fibrous web formation method is not limited to these methods. When using these formation methods, other fibers can be blended as long as the effects of the present invention are not impaired significantly. Examples of the fibers that can be blended include rayon and cotton for improving the water retention ability, polyethylene terephthalate for making an obtained nonwoven fabric bulkier, and other hollow fibers.

[0053] In order to heat-process a fibrous web into a nonwoven fabric after forming this fibrous web having a desired mass per unit area by means of these fibrous web formation method, a span lace method or a needle punching method for entangling the fibers within the fibrous web by means of a water stream, compressed air, a needle or the like can be used before performing the heat processing, to improve the strength of the fibrous web and change the feeling.

[0054] Examples of the heat processing method include a hot-air adhesion method, a hot-water adhesion method, hot-roll adhesion method and the like. Above all, the hot-air adhesion method or the hot-water adhesion method is preferred as the heat processing method to be performed after forming the conjugate fiber of the present invention into the fibrous web.

[0055] The hot-air adhesion method is a method for softening and melting a low-melting point component of the conjugate fiber by passing heated air through the fibrous web and adhering the fibers at their contact point. Because this adhesion method does not impair the bulkiness by compressing a certain area unlike the hot-roll adhesion method, this adhesion method is suitable for providing a bulky nonwoven fabric having excellent uniformity and excellent feeling, which is the object of the present invention.

[0056] This hot-air adhesion method is suitable for obtaining a bulky nonwoven fabric having excellent feeling. Therefore, particularly when the hot-air adhesion method is used to heat-process a conjugate fibrous web that has short fibers each having a general side-by-side cross section with two half-moon-shaped components, large shrinkage occur easily compared to when other adhesion methods are used, due to high freedom of the fibrous web on the conveyor, and thus a nonwoven fabric with excellent uniformity and excellent feeling cannot be obtained easily. The conjugate fiber of the present invention, on the other hand, is designed to effectively prevent shrinkage caused by heat-processing the conjugate fiber into a nonwoven fabric, and thus can be used suitably in this hot-air adhesion method in particular. Therefore, the conjugate fiber of the present invention can provide a nonwoven fabric having an excellent feeling, while keeping the advantage of bulkiness that is essentially provided by the hot-air adhesion method.

[0057] The hot-water adhesion method is a method for softening and melting a low-melting point component of the conjugate fiber by passing heated water or steam through the fibrous web and adhering the fibers at their contact point. In the conjugate fiber of the present invention, because the first component containing the ethylene- α -olefin copolymer having a melting point of 70 to 100°C accounts for the majority of the peripheral surface of the fiber, a hot-water adhesion method that performs the heat processing at 100°C or lower can be essentially applied. Hot water, steam or other comparatively inexpensive medium that does not require any special equipment is used in this adhesion method. By performing the processing with such a medium, most treatment agent applied onto the surface of the conjugate fiber of the present invention can be washed away while processing the conjugate fiber into a nonwoven fabric. The treatment agent applied onto the surface of the fiber is essential in the conjugate fiber (staple fiber, chop for air-laid method and the like) manufacturing process, but is not necessary or is rather an obstruction after processing the fiber into a nonwoven fabric or formed article, depending on the use application. Examples of said use application include a food protection sheet such as a packing material and a plastic tray that come into direct contact with food, a powder puff impregnated in a cosmetic item, and a stick for applying a medical agent to an affected part of the body. There is also a method for configuring the treatment agent of the fiber surface by selecting a safe element such as a food additive or a corresponding component, or a method for performing cleansing to wash away the treatment agent after forming the fiber into a nonwoven fabric or formed article. However, configuring the treatment agent using a human-friendly component does not eliminate the effect of the treatment agent on the cosmetic item or medical agent, and thus it is desired that the treatment agent does not remain on the nonwoven fabric or formed article in order to keep the stable performance. Furthermore, performing the cleansing after processing the fiber into a nonwoven fabric or formed article requires equipment and time and thus is disadvantageous in terms of cost.

[0058] Therefore, the conjugate fiber of the present invention in which the hot-water adhesion method can be adopted is industrially very significant because the present invention can efficiently provide, for the abovementioned use application and at low cost, a bulky nonwoven fabric or formed article that has almost no treatment agent thereon or on which the amount of the treatment agent attached to the fiber is so small that it does not cause the above problems. It is most preferred that the conjugate fiber of the present invention be processed into a nonwoven fabric or formed article by means of the hot-water adhesion method, or that a heat-processed nonwoven fabric obtained by the hot-air adhesion method be processed into a formed article by means of the hot-water adhesion method.

[0059] The mass per unit area of the nonwoven fabric that is obtained when processing the conjugate fiber of the present invention into a nonwoven fabric can be appropriately selected based on the purpose of use. For example, the mass per unit area is preferably in a range of 20 to 50 g/m² for a food packing material, 30 to 150 g/m² for a powder puff or a medicine sheet, and 50 to 250 g/m² for a stick for applying a medical agent.

[0060] Moreover, the bulkiness of the nonwoven fabric that is obtained when processing the conjugate fiber of the present invention into a nonwoven fabric can be calculated based on a specific volume and can be easily at least 20 cm³/g, or preferably at least 30 cm³/g.

[0061] When the conjugate fiber of the present invention is processed into a nonwoven fabric, another nonwoven fabric, a fibrous web, thermoplastic film, sheet or the like may be stacked on this nonwoven fabric, depending on the purpose. For example, a breathable film, a porous film, a porous nonwoven fabric may be laminated to the nonwoven fabric, an elastic nonwoven fabric composed of elastomer or other ethylene - α -olefin copolymer may be stacked on the nonwoven fabric.

[0062] In the present invention, "formed article" means a finished product that is obtained using the conjugate fiber of the present invention without processing the conjugate fiber into a nonwoven fabric, and a finished product that is obtained by processing the conjugate fiber into a nonwoven fabric. When obtaining the formed article without processing the conjugate fiber into a nonwoven fabric, a fibrous web of a desired mass per unit area that is obtained by the carding method or the like can be formed into a sliver, which is then placed in a specific mold and subjected to heat processing, whereby the "formed article" can be obtained. When obtaining the formed article by processing the conjugate fiber into a nonwoven fabric, the conjugate fiber of the present invention is formed into fibrous webs of a desired mass per unit area by means of the carding method or air-laid method or the like, which are then processed into a nonwoven fabric by means of the hot-air adhesion method or the like. Thus obtained nonwoven fabrics are stacked, cut or combined to have a desired mass per unit area and thickness, and the resulting fabric can be integrated into the "formed article" by means of the hot-air adhesion method or hot-water adhesion method. In addition, after the conjugate fiber of the present invention is processed into a nonwoven fabric, the obtained nonwoven fabric can be stacked, cut or combined to have a desired mass per unit area and thickness, which is then placed in a specific mold and subjected to heat processing, whereby the "formed article" can be obtained.

[0063] Additional processing can be easily performed on the "formed article" obtained using the conjugate fiber of the present invention, for example, by cutting a part of the formed article or heat-processing the formed article.

[0064] The conjugate fiber of the present invention can be suitably used for use applications as a powder puff, medicine sheet, a sheet for cooling fever, a food plastic tray, a cushion material, a buffer material, an aromatic substance core of home fragrance, a liquid retaining material such as a humidifier, a nursery sheet, a wiper, and the like.

[Examples]

[0065] Next, the present invention is described specifically by using examples and comparative examples, but the present invention is not limited to the following examples. Note that the terms and measuring methods used in the present specification, particularly the examples and comparative examples, and the following tables 1 to 3 are defined as follows.

(1) Melt Index

[0066] MI: Measurement was performed under conditions with a temperature of 190°C and a load of 21.2 N based on ASTM D-1238.

[0067] Note that the numeric values shown in the tables are the results of measuring a resin. (Unit: g/min)

(2) Density

[0068] Measurement was performed based on JIS K7112.

[0069] Note that the numeric values shown in the tables are the results of measuring the resin. (Unit: g/cm³)

(3) Molecular Weight Distribution (Mw/Mn)

[0070] The ratio between weight-average molecular weight and number average molecular weight, which is obtained by means of a gel permeation chromatography. Measurement was performed using "GPC-150C" produced by Waters. (Column: One TSKgel GMH₆-HT produced by Tosoh Corporation, 7.5 cm I.D. × 60 cm)

[0071] Note that the numeric values shown in the tables are the results of measuring a raw material resin.

(4) Melting Point

[0072] The temperature at which the resin melts, measured by means of a differential scanning calorimeter (DSC). (Unit: °C)

[0073] Measurement was performed using DSC "Q-10" produced by TA Instruments. The resin was cut to have a weight of 4.20 to 4.80 mg, which is then put into a sample pan and a cover is placed thereon. Measurement was performed thereon at a rate of temperature increase 10 °C/min in an N₂ purge between 30°C to 200°C, to obtain a melt chart. The chart was analyzed to obtain a melting peak temperature.

(5) Melt Mass Flow Rate (MFR)

[0074] Measurement was performed under conditions with a temperature of 230°C and a load of 21.2 N based on JIS K7210.

[0075] Note that the numeric values shown in the tables are the results of measuring the raw material resin. (Unit: g/min)

(6) Fineness, Fiber Diameter

[0076] The thickness of a fiber, calculated from the weight per length. (Unit: dtex)

[0077] When each fiber is longer than 60 mm, a bundle of fibers is cut into 60 mm, and the weight of 150 cut fibers was measured using "AEL-40SM," an electronic balance produced by Shimadzu Corporation. The obtained numeric value was multiplied by 1111 to obtain fineness of the resulting fibers. When the length of the fibers was not sufficient, the fibers were observed through a scanning electron microscope. One hundred fibers were selected from the obtained image, and the diameter of each fiber was measured. The fineness was calculated from the average value of the diameters and the specific gravity of the fibers.

(7) Proportion of the first component to the length of the outer periphery of the fiber cross section, observation of cross-sectional shape

[0078] Results obtained were: the proportion (%) of the first component to the length of the outer periphery of the fiber in the fiber cross section perpendicular to the fiber axis; the ratio of the length of a fiber cd to the length of a fiber ce (cd/ce) when supposing that two intersections of the outer periphery of the fiber and the borderline between the first component and the second component are taken as point a and point b, the borderline forming a curve bulging toward the first component, and that a point where the segment ab is halved is taken as point c, and a point where the borderline between the first component and the second component intersects with a straight line that extends in a direction perpendicular to a line ab through point c is taken as point d, and a point where said straight line that extends in a direction perpendicular to a line ab through point c intersects with the outer periphery of the fiber on the second component side as point e; the ratio of the length g of the borderline to the entire outer peripheral length h (g/h) of a circle or an ellipse formed by the second component, when the borderline between the first component and the second component that forms a curve bulging toward the first component is considered to take up a part of the outer periphery of the circle or ellipse formed by the outer periphery of the second component; and a relationship between the length f of the diameter or long axis of the circle or ellipse and the length of the segment ab when both ends of the diameter or long axis of the circle or ellipse formed by the second component exists within the fiber cross section perpendicular to the fiber axis of the conjugate fiber. The conjugate fiber was cut so as to be perpendicular to the length direction, and thus obtained fibers were observed through an optical microscope or a scanning electron microscope, whereby the above results were obtained.

[0079] Observation was performed using an optical microscope produced by NIKON Corporation or a scanning electron microscope, "JSM-T220," produced by Jeol Datum. The length of each part where each component is exposed to the fiber surface was measured from the obtained image and calculated from the following equation. Note that the first component of the second component can be distinguished in the fiber cross section by heat processing the fiber after cutting it so as to be perpendicular to the length direction. For example, the cut fiber is left stand in an oven dryer heated at 100 °C, and the first component is then softened, molten, and observed through the optical microscope or scanning electron microscope to check which part of the fiber cross section corresponds to the first component.

$$\text{Length of peripheral surface of first component (\%)} = (L_1/L) \times 100$$

L₁: Length of peripheral surface of first component

L: Entire length of peripheral surface of fiber cross section

(8) Heat shrinkage percentage

[0080] A change (reduction rate) in length per unit of the fibrous web obtained after performing the heat treatment, calculated from the ratio between change amount and unit length. (Unit: %)

[0081] The fibrous web of 200 g/m² that was inserted into a miniature card machine was cut along a pattern of 250 mm × 250 mm in a flow direction (MD) of the fiber and a direction perpendicular to this flow direction (CD). The obtained fiber was left stand for ten minutes, and then the cut fibrous webs were placed on a piece of craft paper (350 mm × 700 mm) to measure the length thereof in MD. Subsequently, the craft paper was folded into two to slightly cover the top of the fibrous webs, which is then put into a 100-degree convection oven (circulating hot air oven) produced by SANYO Electric Co., Ltd., to heat process it for five minutes. The processed product was taken out from the dryer and cooled at room temperature for five minutes, and the length thereof in MD was measured. The heat shrinkage percentage was calculated based on the following equation.

$$\text{Heat shrinkage percentage (\%)} = \{(L_0 - L)/L_0\} \times 100$$

L₀: Length of MD before heat processing

L: Length of MD after heat processing

(9) Mass per unit area

[0082] The weight per unit area of the nonwoven fabric and fibrous web, calculated from the weight of the nonwoven fabric or fibrous web cut into a certain area. (Unit: g/m²)

[0083] The weight of the nonwoven fabric that was cut into 250 mm × 250 mm was measured by "HF-200," an electronic scale balance produced by A&D Company. The obtained numeric value was multiplied by 16 to calculate the mass per unit area.

(10) Bulkiness (specific volume)

[0084] The weight per unit volume of the nonwoven fabric, calculated according to mass per unit area measurement and thickness measurement (Unit: cm³/g)

[0085] The thickness of the nonwoven fabric was measured using "Digi-Thickness Tester" produced by Toyo Seiki Seisaku-Sho, Ltd., under conditions with an anvil load of 2g/cm² and a speed of 2 mm/sec, and calculated from the obtained numeric value (mm) and mass per unit area (g/m²).

(11) Feeling

[0086] The uniformity of the appearance, softness by hand touch, stiffness, bulging and the like of the nonwoven fabric were determined comprehensively.

[0087] These were determined based on a sensory evaluation performed by trialists on a scale of "good," "fair," and "bad."

[0088] Hereinafter, Examples 1 to 6 and Comparative Examples 1 to 6 are described and the results thereof are shown in Tables 1 to 3.

[Example 1]

[0089] The first component was an ethylene -α-olefin copolymer polymerized using a metallocene catalyst, wherein α-olefin was octene-1 and contained in the copolymer in an amount of 10 mol%. The density was 0.880, the melting point 72°C, the melt index (MI) 18 g/10 min, and the molecular weight distribution (Mw/Mn) 1.9. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 8 g/10 min and a melting point of 160°C.

[0090] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 200°C and 260°C on the second component side. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. Good spinnability was obtained. Thus obtained spun conjugate

filament having a fineness of 6.5 dtex was drawn 1.7 times by using a 55°C heating device provided with a heating roll, and crimped by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 4.4 dtex (fiber diameter of 25.2 μm).

[0091] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 1. The obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 1 along with schematic diagrams. Peeling of the components was not observed in the fiber cross section in the direction perpendicular to the fiber axis. Moreover, $cd/ce = 7.5$, $f > ab$, and $g/h = 0.80$.

[0092] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form a fibrous web. The fiber passability was good during the card processing. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 1. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form a fibrous web. This fibrous web was processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. The property of thus obtained through-air nonwoven fabric was measured and evaluated using the measuring methods of (9) to (11) described above. The results are shown in the section corresponding to nonwoven fabric property on Table 1.

[0093] Because the heat shrinkage percentage of the fibrous web in which the obtained conjugate fiber (staple fiber) is used was as low as 15%, a bulky nonwoven fabric with excellent uniformity and excellent feeling was obtained even when the hot-air adhesion method was used.

[Example 2]

[0094] The first component was an ethylene - α -olefin copolymer polymerized using a metallocene catalyst, wherein α -olefin was octene-1 and contained in the copolymer in an amount of 9 mol%. The density was 0.885, the melting point 78°C, the melt index (MI) 30 g/10 min, and the molecular weight distribution (Mw/Mn) 2.0. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 16 g/10 min and a melting point of 160°C.

[0095] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 200°C and 260°C on the second component side. At the time of reeling, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. Good spinnability was obtained. Thus obtained spun conjugate filament having a fineness of 10.2 dtex was stretched 1.7 times by using a 60°C heating device provided with a heating roll, and crimped by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 7.0 dtex (fiber diameter of 31.7 μm).

[0096] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 1. The obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 1 along with schematic diagrams. Peeling of the components was not observed in the fiber cross section in the direction perpendicular to the fiber axis. Moreover, $cd/ce = 6.0$, $f > ab$, and $g/h = 0.75$.

[0097] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form a fibrous web. The fiber passability was good during the card processing. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 1. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form a fibrous web. This fibrous web was processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. The property of thus obtained through-air nonwoven fabric was measured and evaluated using the measuring methods of (9) to (11) described above. The results are shown in the section corresponding to nonwoven fabric property on Table 1.

[0098] Because the heat shrinkage percentage of the fibrous web in which the obtained conjugate fiber (staple fiber) is used was as low as 17%, a bulky nonwoven fabric with excellent uniformity and excellent feeling was obtained even when the hot-air adhesion method was used.

[Example 3]

[0099] The first component was an ethylene- α -olefin copolymer polymerized using a metallocene catalyst, wherein α -olefin was octene-1 and contained in the copolymer in an amount of 5 mol%. The density was 0.902, the melting point 98°C, the melt index (MI) 30 g/10 min, and the molecular weight distribution (Mw/Mn) 2.1. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 16 g/10 min and a melting point of 160°C.

[0100] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 45/55 under conditions with an extrusion temperature (preset temperature) on the first component of 200°C and 260°C on the second component side. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. Good spinnability was obtained. Thus obtained spun conjugate filament having a fineness of 10.0 dtex was drawn 2.6 times by using a 70°C heating device provided with a heating roll, and crimped by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 4.4 dtex (fiber diameter of 25.0 μ m).

[0101] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 1. The obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 1 along with schematic diagrams. Peeling of the components was not observed in the fiber cross section in the direction perpendicular to the fiber axis. Moreover, $cd/ce = 3.0$, $f > ab$, and $g/h = 0.70$.

[0102] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to collect a fibrous web. The fiber passability was good during the card processing. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 1. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form a fibrous web. This fibrous web was processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. The property of thus obtained through-air nonwoven fabric was measured and evaluated using the measuring methods of (9) to (11) described above. The results are shown in the section corresponding to nonwoven fabric property on Table 1.

[0103] Because the heat shrinkage percentage of the fibrous web in which the obtained conjugate fiber (staple fiber) is used was as low as 28%, a bulky nonwoven fabric with excellent uniformity and excellent feeling was obtained even when the hot-air adhesion method was used.

[Example 4]

[0104] Spinning and stretching were performed on the filament under the same conditions and using the same components as with Example 3, and crimps are provided on the filament using the crimping device. The filament is then cut into 5 mm to obtain a conjugate fiber (chop for air-laid) having a fineness of 4.4 dtex (fiber diameter of 25.0 μ m).

[0105] 200g of the obtained conjugate fiber (chop for air-laid) was inserted into an air-laid machine having a pair of forming heads, and consequently a fibrous web was obtained by an air-laid method. Good fiber dischargeability was obtained from the air-laid machine. This fibrous web was subjected to hot-air adhesion processing by using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.38 m/sec, and a processing time of 14 seconds. The property of thus obtained through-air nonwoven fabric was measured and evaluated using the measuring methods of (9) to (11) described above. The results are shown in the section corresponding to nonwoven fabric property on Table 1.

[0106] As a result of processing the obtained conjugate fiber into the fibrous web using the air-laid method and then subjecting it to the hot-air adhesion method, a bulky nonwoven fabric that hardly shrinks and has excellent uniformity and excellent feeling was obtained.

[Comparative Example 1]

[0107] The first component was an ethylene- α -olefin copolymer, wherein α -olefin was octene-1 and contained in the copolymer in an amount of 2 mol%. The density was 0.913, the melting point 107°C, the melt index (MI) 30 g/10 min, and the molecular weight distribution (Mw/Mn) 3.0. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 16 g/10 min and a melting point of 160°C.

[0108] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset

temperature) on the first component of 200°C and 260°C on the second component side, thereby producing a conjugate fiber that has a fiber cross-sectional structure in which the borderline between the first component and the second component forms a curve bulging toward the first component. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. Good spinnability was obtained. Thus obtained spun conjugate filament having a fineness of 11.5 dtex was drawn 3.3 times by using a 70°C heating device provided with a heating roll, and crimped by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 3.8 dtex (fiber diameter of 23.2 μm).

[0109] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 2. The obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 2 along with schematic diagrams. In the direction perpendicular to the fiber axis, $cd/ce = 3.5$, $f > ab$, and $g/h = 0.55$.

[0110] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form fibrous webs. The fiber passability was good during the card processing. The heat shrinkage percentage of these fibrous webs was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 2. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form a fibrous web. These fibrous webs were processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. However, due to the high melting point of the ethylene octene-1 which is the first component, the fiber entangled point is not melted at the processing temperature of 98°C, hence the conjugate fiber was not processed into a nonwoven fabric. Although Comparative Example 1 is significantly different from Example 3 in that the melting point is 107°C in this example, but the same method as that of Example 3 was used to produce a nonwoven fabric. However, the processing temperature enable to be adopted for the obtained conjugate fiber was not low enough to adopt the hot-water adhesion method, and thus the conjugate fiber could not be processed into a nonwoven fabric or a formed article. Therefore, evaluation of the shrinkage percentage of the fibrous webs at 100°C according to the low-temperature processing ended up meaningless.

[Comparative Example 2]

[0111] The first component was an ethylene- α -olefin copolymer, wherein α -olefin was propylene and butene that are contained in the copolymer in an amount of 3 mol% and 3 mol%. The density was 0.897, the melting point 81°C, the melt index (MI) 4 g/10 min, and the molecular weight distribution (Mw/Mn) 2.0. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 8 g/10 min and a melting point of 160°C.

[0112] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 220°C and 260°C on the second component side. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. However, when the pulled-up spun conjugate filament was checked, agglutination was observed. Thus obtained spun conjugate filament having a fineness of 9.8 dtex was drawn 1.7 times by using a 60°C heating device provided with a heating roll to provide the filament with crimps by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 6.8 dtex (fiber diameter of 31.1 μm).

[0113] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 2. The obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 2 along with schematic diagrams. Because the melt index (MI) of the first component is low, the borderline between the first component and the second component in the fiber cross section in the direction perpendicular to the fiber axis formed a curve bulging toward the second component. Therefore, cd/ce , f , and g/h could not be measured. Also, peeling was observed between the components.

[0114] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form a fibrous web. The fiber passability was not good during the card processing because unevenness occurred in the fiber dischargeability. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 2. 50g of the obtained

conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form fibrous webs. These fibrous webs were processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. However, large shrinkage was observed and the strength of the nonwoven fabric was low, and thus a nonwoven fabric with excellent uniformity and excellent feeling was not obtained. The heat shrinkage percentage of each fibrous web in which the obtained conjugate fiber was used was as high as 55%.

[Comparative Example 3]

[0115] The first component was an ethylene- α -olefin copolymer, wherein α -olefin was propylene that is contained in the copolymer in an amount of 15 mol%. The density was 0.863, the melting point 50°C, the melt index (MI) 21 g/10 min, and the molecular weight distribution (Mw/Mn) 2.0. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 16 g/10 min and a melting point of 160°C.

[0116] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 220°C and 260°C on the second component side. However, at the time of reeling, agglutination has occurred on the spun conjugate filament, thus it was impossible to stretch it. Regarding this comparative example, the schematic diagrams of the fiber cross section shown in Table 2 were obtained from the agglutinated conjugate spun filament by collecting and observing the fibrous webs somehow. Because the melt index (MI) of the first component is significantly low in relation to the melt mass flow rate (MFR) of the second component, the borderline between the first component and the second component in the fiber cross section perpendicular to the fiber axis formed a straight line. That is, the both conjugate components formed half-moon-shaped conjugate cross sections. In the fiber cross section perpendicular to the fiber axis, $cd/ce = 0$, and peeling was not observed between the conjugate fibers.

[0117] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 2.

[Comparative Example 4]

[0118] A mixture of two resins was used as the first component. One of the resins was an ethylene- α -olefin copolymer, wherein α -olefin was propylene that is contained in the copolymer in an amount of 12 mol%. The density was 0.870, the melting point 75°C, the melt index (MI) 1 g/10 min, and the molecular weight distribution (Mw/Mn) 1.9. The other resin was a propylene- α -olefin copolymer, wherein α -olefin was ethylene and butene-1 that are contained in the copolymer in an amount of 1 mol% each. The melting point was 128°C and the melt mass flow rate (MFR) was 16 g/10 min. These two resins were mixed at a weight ratio of 20/80. Note that Table 2 shows the property of an ethylene propene copolymer, which is a resin having a lower melting point. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 8 g/10 min and a melting point of 160°C.

[0119] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 200°C and 260°C on the second component side, to produce a conjugate fiber that has the fiber cross-sectional structure in which the borderline between the first component and the second component forms a curve bulging toward the first component. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. Good spinnability was obtained. Thus obtained spun conjugate filament having a fineness of 9.7 dtex was drawn 2.6 times by using a 60°C heating device provided with a heating roll to provide the filament with crimps by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 4.4 dtex (fiber diameter of 25.1 μ m).

[0120] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 2. The property of the obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 2 along with schematic diagrams. Moreover, in the fiber cross section in the direction perpendicular to the fiber axis, $cd/ce = 0.2$ and $g/h < 0.5$.

[0121] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form a fibrous web. The fiber passability was good during the card processing. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section

corresponding to yarn quality on Table 2. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form a fibrous web. This fibrous web was processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. However, large shrinkage was observed, and thus a nonwoven fabric with excellent uniformity and excellent feeling could not be obtained. The heat shrinkage percentage of the fibrous web in which the obtained conjugate fiber is used was as high as 65%.

[Comparative Example 5]

[0122] A mixture of two resins was used as the first component. One of the resins was a low-density polyethylene. The density thereof was 0.918, the melting point 105°C, the melt index (MI) 24 g/10 min, and the molecular weight distribution 7.0. The other resin was an ethylene-vinyl acetate copolymer. The density thereof was 0.939, the melting point 92°C, the melt index (MI) 20 g/10 min, and the molecular weight distribution (Mw/Mn) 5.0. These two resins were mixed at a weight ratio of 75/25. Note that Table 3 shows the property of the ethylene-vinyl acetate copolymer, which is a resin having a lower melting point. The second component is a crystalline polypropylene having a melt mass flow rate (MFR) of 8 g/10 min and a melting point of 160°C.

[0123] Melt spinning was performed on these two components by means of a side-by-side conjugate spinneret at a volume ratio of first component/second component = 50/50 under conditions with an extrusion temperature (preset temperature) on the first component of 200°C and 260°C on the second component side, to produce a conjugate fiber that has the fiber cross-sectional structure in which the borderline between the first component and the second component forms a curve bulging toward the first component. At the time of pulling up, an antistatic agent that has ethylene oxide additives of sorbitan fatty acid ester and lauryl phosphate potassium salt as the main components is attached to these components. A number of broken yarns were observed during spinning. Thus obtained spun conjugate filament having a fineness of 9.7 dtex was drawn 2.6 times by using a 60°C heating device provided with a heating roll to provide the filament with crimps by means of a crimping device. Thereafter, the filament was cut into 38 mm to obtain a conjugate fiber (staple fiber) having a fineness of 3.3 dtex (fiber diameter of 21.5 μm).

[0124] The density, melting point, melt index (MI), and molecular weight distribution (Mw/Mn) of the first component were measured using the measuring methods of (1) to (4) described above. The melting point and melt mass flow rate (MFR) of the second component were measured using the measuring methods of (4) and (5) described above. The results are shown in the section corresponding to components on Table 3. The property of the obtained conjugate fiber (staple fiber) was measured using the measuring methods of (6) and (7) described above. The results are shown in the section corresponding to yarn quality on Table 3 along with schematic diagrams. Moreover, in the fiber cross section in the direction perpendicular to the fiber axis, $cd/ce = 9.5$, $f > ab$, and $g/h = 0.86$.

[0125] 100g of the obtained conjugate fiber (staple fiber) was inserted into a 500mm-wide miniature card machine to form a fibrous web. The fiber passability was not good during the card processing because unevenness occurred when discharging the fiber. The heat shrinkage percentage of this fibrous web was measured using the measuring method of (8) described above. The results are shown in the section corresponding to yarn quality on Table 3. 50g of the obtained conjugate fiber (staple fiber) were inserted into a 500mm-wide miniature card machine to form fibrous webs. These fibrous webs were processed using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.8 m/sec, and a processing time of 12 seconds. However, large shrinkage was observed and the strength of the nonwoven fabric was low, and thus a nonwoven fabric with excellent uniformity and excellent feeling was not obtained.

[0126] The heat shrinkage percentage of each fibrous web in which the obtained conjugate fiber was used was as high as 60%.

[Comparative Example 6]

[0127] Spinning and drawing were performed on the filament under the same conditions and using the same components as with Comparative Example 5, and crimps are provided on the filament using the crimping device. The filament is then cut into 5 mm to obtain a conjugate fiber (chop for air-laid) having a fineness of 3.3 dtex (fiber diameter of 21.5 μm).

[0128] 200g of the obtained conjugate fiber (chop for air-laid) was inserted into an air-laid machine having a pair of forming heads, and consequently a fibrous web was obtained by an air-laid method. Poor fiber dischargeability was obtained from the air-laid machine. This fibrous web was subjected to hot-air adhesion processing by using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.38 m/sec, and a processing time of 14 seconds. However, although hot-air adhesion was possible at 98°C, shrinkage has occurred, and thus a nonwoven fabric with excellent uniformity and excellent feeling could not be obtained. The results are shown in Table 3.

[Example 5]

[0129] The conjugate fiber (staple fiber) obtained in Example 3 was processed into a fibrous web by means of the carding method, and this fibrous web was formed into a rod-like sliver. The fibrous web formed into a sliver was placed into a cylindrical mold (10 mm × 10 mm × 60 mm) made from a 20-mesh metallic wire having a wire diameter of 0.29 mm, which is then subjected to hot-air adhesion processing by means of a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, hot air velocity of 1.2 m/sec, and a processing time of 12 seconds, to obtain a cubical fiber formed article. The obtained fiber formed article has excellent cushioning characteristics.

[Example 6]

[0130] The conjugate fiber (chop for air-laid) obtained in Example 4 was processed into a fibrous web having a mass per unit area of 50 g/m² by means of the air-laid method, and this fibrous web was subjected to hot-air adhesion processing by using a through-air processing device of hot-air circulation type under conditions with a preset temperature of 98°C, a hot air velocity of 0.38 m/sec, and a processing time of 14 seconds. The obtained through-air nonwoven fabric was placed into a glass tube having an inner diameter of 8 mm, which is then immersed into boiled water and boiled for two minutes. The through-air nonwoven fabric was then cooled after the boiling, to obtain a cylindrical fiber formed article. The obtained fiber formed article is moderately soft and has less fluctuation in fiber density. Therefore, this fiber formed article is suitable for retaining fluid and the like.

[Table 1]

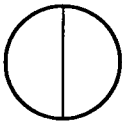
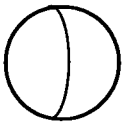
			Example 1	Example 2	Example 3	Example 4
Components	1 st Component	Resins Used	Ethylene · octene-1 copolymer	Ethylene · octene-1 copolymer	Ethylene · octene-1 copolymer	Ethylene · octene-1 copolymer
		Density (g/cm ³)	0.880	0.885	0.902	0.902
		Melting Point (°C)	72	78	98	98
		Melt Index (g/10min)	18	30	30	30
		Molecular weight Distribution	1.9	2.0	2.1	2.1
	2 nd Component	Resins Used	Polypropylene	Polypropylene	Polypropylene	Polypropylene
		Melt Mass Flow Rate (g/10min)	8	16	16	16
		Melting Point (°C)	160	160	160	160
	Spinning Condition	Extruder Preset Temperature (°C) (First Component/ Second Component)	200/260	200/260	200/260	200/260
		Spinning Fineness (dtex)	6.5	10.2	10.0	10.0
Drawing Condition	Drawing Condition	Heating Device (Heating Roll) Preset Temperature (°C)	55	60	70	70
		Draw Ratio	1.7	1.7	2.6	2.6

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5 10 15 20 25 30 35 40 45 50 55	Yarn Quality	Fineness (dtex)	4.4	7.0	4.4	4.4
		Cut Length (mm)	38	38	38	5
		Fiber Cross Section				
		Length of Peripheral Surface (First Component) (%)	85	80	75	75
		Shrinkage Percentage of Fibrous Web (%)	15	17	28	
	Nonwoven Fabric Property	Processing into Nonwoven Fabric (processing temperature is set at 98°C)	Possible	Possible	Possible	Possible
		Mass per unit area (g/m ²)	50	50	50	50
		Specific Volume (cm ³ /g)	30	34	38	30
		Feeling	Good	Good	Good	Good

[Table 2]

			Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Components	1 st Component	Resins Used Figures in parenth- esis indicate mixing ratios [wt%]	Ethylene · octene-1 copolymer	Ethylene · propylene · butene-1 copolymer	Ethylene · propylene copolymer	Ethylene · propene copolymer (20) + propylene · ethylene · butene-1 copolymer (80)
		Density (g/cm ³)	0.913	0.897	0.863	0.870
		Melting Point (°C)	107	81	50	75
		Melt Index (g/10min)	30	4	21	1
		Molecul- ar weight Distrib- ution	3.0	2.0	2.0	1.9
	2 nd Component	Resins Used	Polypropylene	Polypropylene	Polypropylene	Polypropylene
		Melt Mass Flow Rate (g/10min)	16	16	16	8
		Melting Point (°C)	160	160	160	160
	Spinning Condition	Extruder Preset Temperature (°C) (First Component/ Second Component)	200/260	220/260	220/260	200/260
		Spinning Fineness (dtex)	11.5	9.8	Unobtainable	9.7

5	Drawing Condition	Heating Device (Heating Roll) Preset Temperature (°C)	70	60	-	70
		Draw Ratio	3.3	1.7	-	2.6
10	Yarn Quality	Fineness (dtex)	3.8	6.8	-	4.2
		Cut Length (mm)	38	38	-	38
15		Fiber Cross Section				
20		Length of Peripheral Surface (First Component) (%)	70	40	50	55
25		Shrinkage Percentage of Fibrous Web (%)	1	55	-	65
30	Nonwoven Fabric Property	Processing into Nonwoven Fabric (processing temperature is set at 98°C)	Unable to adhere, and unobtainable	Shrinkage was large	-	Shrinkage was large
35		Mass per unit area (g/m ²)	-	-	-	-
40		Specific Volume (cm ³ /g)	-	-	-	-
		Feeling	-	Poor	-	Poor

[Table 3]

Components	1 st Component	Resins Used Figures in parenthesis indicate mixing ratios [wt%]	Comparative Example 5	Comparative Example 6
		Density (g/cm ³)	0.940	0.940
		Melting Point (°C)	92	92
		Melt Index (g/10min)	20	20
		Molecular weight Distribution	5.0	5.0
	2 nd Component	Resins Used	Polypropylene	Polypropylene
		Melt Mass Flow Rate (g/10min)	8	8
		Melting Point (°C)	160	160
Spinning Condition	Extruder Preset Temperature (°C) (First Component/ Second Component)		200/260	200/260
	Spinning Fineness (dtex)		7.2	7.2
Drawing Condition	Heating Device (Heating Roll) Preset Temperature (°C)		70	70
	Draw Ratio		2.6	2.6
Yarn Quality	Fineness (dtex)		3.5	3.5
	Cut Length (mm)		38	5
	Fiber Cross Section			
	Length of Peripheral Surface (First Component) (%)		90	90
	Shrinkage Percentage of Fibrous Web (%)		60	-
Nonwoven Fabric Property	Processing into Nonwoven Fabric (processing temperature is set at 98°C)		Shrinkage was large	Shrinkage was large
	Mass per unit area (g/m ²)		-	-
	Specific Volume (cm ³ /g)		-	-
	Feeling		Poor	Poor

Industrial Applicability

[0131] The conjugate fiber of the present invention, in which the first component containing an ethylene- α -olefin copolymer of a specific property and the second component containing a crystalline polypropylene form the side-by-

side cross section, has low-temperature processability and low heat shrinkage percentage. Therefore, this conjugate fiber is useful in producing bulky nonwoven fabric and formed articles having excellent uniformity and excellent feeling at a heat processing temperature of 100°C or lower.

Claims

1. A conjugate fiber in which a first component that contains 100 % by weight of an ethylene- α -olefin copolymer having an α -olefin content of 20 mol% or less and having a melting point of 70 to 100°C and a second component that contains at least 75% by weight of a crystalline polypropylene form a side-by side cross section, wherein, in a fiber cross section perpendicular to a fiber axis, the first component accounts for 55 to 90% of an outer periphery of the fiber, a borderline between the first component and the second component forms a curve bulging toward the first component, an area ratio between the first component and the second component (first component/second component) is in a range of 70/30 to 30/70, and wherein the ratio of the melt index (MI) of the first component to the melt mass flow rate (MFR) of the second component is 1.5 to 3; whereas the melting point, MI, and MFR are measured according to methods specified in the description.
2. The conjugate fiber according to claim 1, wherein the ethylene- α -olefin copolymer has a molecular weight distribution (Mw/Mn) of 1.5 to 2.5, a density of 0.87 to 0.91 g/cm³, and a melt index (MI) of 10 to 35 g/10 min as measured under conditions with a temperature of 190°C and a load of 21.2 N based on ASTM D- 1238.
3. The conjugate fiber according to claim 1 or 2, wherein a heat shrinkage percentage measured according to method specified in the description, obtained when subjected to heat processing at 100°C for five minutes is 50% or lower.
4. A nonwoven fabric, which is obtained by processing the conjugate fiber described in any one of claims 1 to 3 into a nonwoven fabric.
5. The nonwoven fabric according to claim 4, wherein the conjugate fiber is processed into a nonwoven fabric by a hot- air adhesion method or a hot-water adhesion method.
6. A formed article, which is obtained by using the conjugate fiber described in any one of claims 1 to 3.
7. A formed article, which is obtained by using the nonwoven fabric described in claim 4 or 5.

Patentansprüche

1. Konjugatfaser, in der ein erster Bestandteil, der 100 Gew.-% eines Ethylen- α -Olefin-Copolymers mit einem α -Olefingehalt von 20 Mol-% oder weniger und mit einem Schmelzpunkt von 70 bis 100 °C enthält, und ein zweiter Bestandteil, der mindestens 75 Gew.-% eines kristallinen Polypropylens enthält, einen Querschnitt bilden, in dem sie nebeneinander sind, wobei in einem Faserquerschnitt senkrecht zu einer Faserachse der erste Bestandteil 55 bis 90 % eines äußeren Randbereichs der Faser ausmacht, eine Grenzlinie zwischen dem ersten Bestandteil und dem zweiten Bestandteil eine Krümmung bildet, die sich zu dem ersten Bestandteil hin wölbt, ein Flächenverhältnis zwischen dem ersten Bestandteil und dem zweiten Bestandteil (erster Bestandteil/zweiter Bestandteil) in einem Bereich von 70/30 bis 30/70 ist, und wobei das Verhältnis des Schmelzindex (MI) des ersten Bestandteils zu der Schmelze-Massefließrate (MFR) des zweiten Bestandteils 1,5 bis 3 ist; wobei der Schmelzpunkt, MI und MFR gemäß den in der Beschreibung angegebenen Verfahren gemessen werden.
2. Konjugatfaser gemäß Anspruch 1, wobei das Ethylen- α -Olefin- Copolymer eine Molmassenverteilung (Mw/Mn) von 1,5 bis 2,5, eine Dichte von 0,87 bis 0,91 g/cm³ und einen Schmelzindex (MI) von 10 bis 35 g/10 min, wie unter Bedingungen, die auf ASTM D-1238 basieren, mit einer Temperatur von 190 °C und einer Belastung von 21,2 N gemessen, hat.
3. Konjugatfaser gemäß Anspruch 1 oder 2, wobei ein Hitzeschrumpfungsanteil, der gemäß des in der Beschreibung angegebenen Verfahrens gemessen wird, der erhalten wird, wenn die Konjugatfaser einer Hitzeverarbeitung bei 100 °C für fünf Minuten ausgesetzt wird, 50 % oder weniger ist.
4. Vliesstoff, der durch Verarbeiten der Konjugatfaser, die in einem der Ansprüche 1 bis 3 beschrieben ist, zu einem

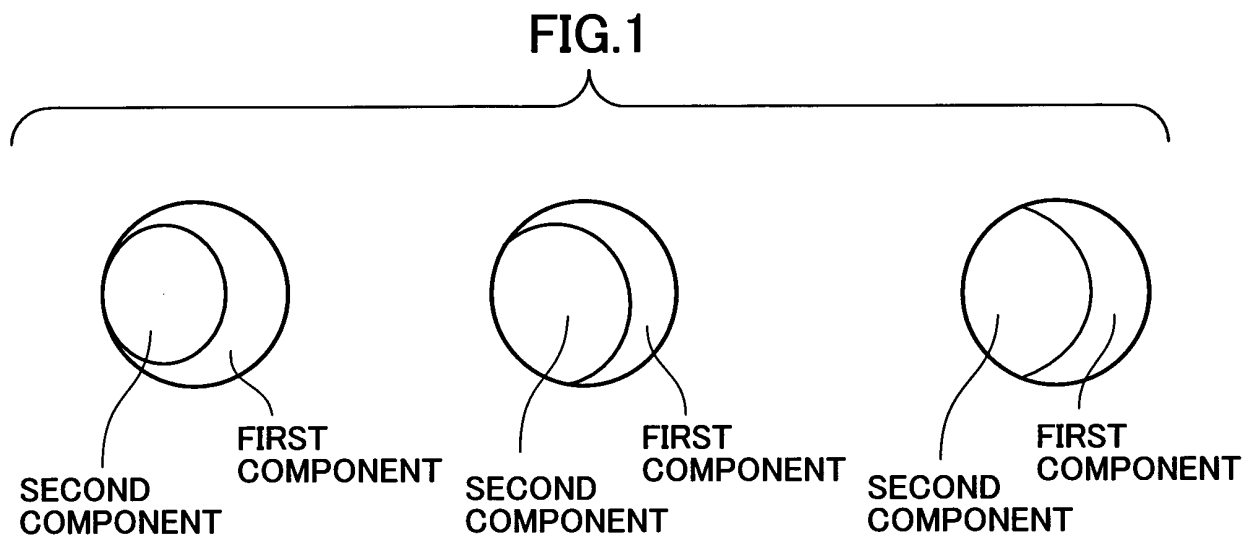
Vliesstoff erhalten wird.

- 5 5. Vliesstoff gemäß Anspruch 4, wobei die Konjugatfaser durch ein Heißluft-Adhäsionsverfahren oder ein Heißwasser-Adhäsionsverfahren zu einem Vliesstoff verarbeitet ist.
6. Geformter Gegenstand, der durch Verwenden der Konjugatfaser, die in einem der Ansprüche 1 bis 3 beschrieben ist, erhalten wird.
- 10 7. Geformter Gegenstand, der durch Verwenden des Vliesstoffes, der in Anspruch 4 oder 5 beschrieben ist, erhalten wird.

Revendications

- 15 1. Une fibre conjuguée dans laquelle un premier composant qui contient 100% en poids d'un copolymère éthylène- α -oléfine ayant une teneur en α -oléfine égale ou inférieure à 20 mol% et présentant un point de fusion allant de 70 à 100°C et un second composant qui contient au moins 75% en poids de polypropylène cristallin forment une coupe transversale côte-à-côte, fibre conjuguée dans laquelle,
 - 20 - dans une section transversale de la fibre perpendiculaire à un axe de fibre, le premier composant représente 55 à 90% de la périphérie extérieure de la fibre,
 - une bordure entre le premier composant et le second composant forme une courbe bombée dans la direction du premier composant,
 - 25 - un rapport de surface entre le premier composant et le second composant (premier composant/second composant) se situe dans une plage de 70/30 à 30/70 et où le rapport indice de fusion (MI) du premier composant par rapport à la vitesse d'écoulement de la masse fondue (MFR) du second composant est de 1.5 à 3,

le point de fusion, MI et MFR étant mesurés selon les méthodes définies dans la description.
- 30 2. La fibre conjuguée selon la revendication 1, dans laquelle le copolymère éthylène- α -oléfine présente une distribution de poids moléculaire (M_w/M_n) de 1.5 à 2.5, une densité de 0.87 à 0.91 g/cm³, et un indice de fusion (MI) de 10 à 35 g/10 min, mesuré dans des conditions de température de 190° C et une charge de 21.2 N selon ASTM D-1238.
- 35 3. La fibre conjuguée selon la revendication 1 ou 2, dans laquelle le pourcentage de retrait thermique mesuré selon la méthode définie dans la description, obtenue quand la fibre a été soumise à un traitement thermique à 100°C pendant 5 minutes est de 50% ou moins.
- 40 4. Un tissu non tissé, qui est obtenu en traitant la fibre conjuguée selon l'une quelconque des revendications 1 à 3 en un non-tissé.
5. Le tissu non tissé selon la revendication 4, dans lequel la fibre conjuguée est transformée en un tissu non tissé par un procédé d'adhérence à l'air chaud ou par un procédé d'adhérence à l'eau chaude.
- 45 6. Un article façonné, qui est obtenu en utilisant la fibre conjuguée décrite dans l'une quelconque des revendications 1 à 3.
7. Un article façonné, qui est obtenu en utilisant le tissu non tissé décrit dans la revendication 4 ou 5.



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0036200 A [0005]
- JP 2006233381 A [0005]
- JP S4811417 B [0037]
- JP S5274011 B [0037]