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(54) POLYESTER BASED THERMALLY ADHESIVE COMPOSITE SHORT FIBER

(57) Polyester-based heat-bonding conjugate staple fibers capable of giving a high grade fiber structure which has good dimensional stability and is hardly deformed, even when used under a high temperature atmosphere, comprises an amorphous polyester having a glass transition point of 50 to 100°C and not having a crystal-melting point as a heat-bonding component and a polyalkylene terephthalate' having a melting point of not less than 220°C as a fiber-forming component, have characteristics comprising the number of crimps of 3 to 40 crimps / 25 mm, a crimp percent of 3 to 40% and a web area shrinkage percent of not more than 20%. Herein, the web area shrinkage percent (%) is represented by the expression: $(A_0\text{-}A_1) / A_0 \times 100$, wherein a card web nonwoven fabric comprising 100% of the heat-bonding conjugate staple fibers and having an area of A_0 and a basis weight of 30 g / m^2 is left in a hot air dryer maintained at 150°C for two minutes, and the area of the left nonwoven fabric is A_1.

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Description

Technical Field

[0001] The present invention relates to a polyester-based heat-bonding conjugate staple fibers suitable for bonding a fiber structure such as nonwoven fabric or wadding and to a method for producing the same, in more detail to heat-bonding conjugate staple fibers capable of giving a fiber structure which can thermally be bonded at relatively low temperature and has good dimensional stability and to a method for producing the same.

Background Art

[0002] Heretofore, as polyester-based heat-bonding conjugate staple fibers, conjugate fibers comprising a polyalkylene terephthalate such as polyethylene terephthalate as a core component and an amorphous polyester comprising isophthalic acid component, terephthalic acid component, or the like as an acid constituent and not having a crystal-melting point as a sheath component have widely been used, because of being capable of being bonded at relatively low temperature of 120 to 150°C to form a fiber structure without needing a thermal treatment at high temperature.

[0003] However, the polyester-based heat-bonding conjugate fibers can form the fiber structure at the relatively low temperature, but has a problem that the obtained fiber structure has insufficient dimensional stability and is therefore largely deformed, when used under a high temperature atmosphere.

[0004] The present inventors have tried drawing treatments and thermal treatments at high temperature to solve the problem and improve the dimensional stability of the heat-bonding fibers themselves, but it has be found that the fibers are cohered each other at higher temperature than the glass transition point of the amorphous polyester to make the production of yarns difficult.

[0005] From such the reason, it is the fact that heat-bonding conjugate fibers containing an amorphous polyester, especially an amorphous polyester having a glass transition point of 50 to 100°C, as a heat-bonding component and having excellent dimensional stability have still not been proposed.

Disclosure of the Invention

[0006] The object of the present invention is to provide polyester-based heat-bonding conjugate staple fibers capable of giving a high grade fiber structure, such as nonwoven fabric or wadding, which can thermally be bonded at relatively low temperature without needing a thermal treatment at high temperature, has good dimensional stability and is hardly deformed, even when used in a high temperature atmosphere, and to provide a method for producing the same.

[0007] The present inventors have found that it is effective for the achievement of the above-described object to use an amorphous polyester having a glass transition point of 50 to 100°C as a heat-bonding component and a polyalkylene terephthalate as a fiber-forming component and select heat-drawing conditions for the fibers, and has thus completed the present invention.

[0008] Namely, the polyester-based heat-bonding conjugate staple fibers of the present invention, enabling the achievement of the above-described object is heat-bonding conjugate staple fibers comprising an amorphous polyester having glass transition point of 50 to 100°C and not having a crystal-melting point as a heat-bonding component and a polyalkylene terephthalate having a melting point of not less than 220°C as a fiber-forming component, characterized by having the number of crimps of 3 to 40 crimps / 25 mm, a crimp percent of 3 to 40%, and a web area shrinkage percent of not more than 20% defined as described below.

< Web area shrinkage percentage >

[0009] A card web nonwoven fabric comprising 100% of the heat-bonding conjugate staple fibers and having an area of A_0 and a basis weight of 30 g / m^2 is left in a hot air dryer maintained at 150°C for two minutes, and then the area A_1 of the nonwoven fabric is measured. The web area shrinkage percentage is determined by the following expression.

$$\text{Web area shrinkage percentage (\%)} = (A_0\text{-}A_1) / A_0 \times 100$$

[0010] In addition, a method for producing polyester-based heat-bonding conjugate staple fibers as the other object of the present invention, are characterized by melting and conjugationally extruding an amorphous polyester having a glass transition point of 50 to 100°C and not having a crystal-melting point and a polyalkylene terephthalate having a melting point of not less than 220°C, cooling and solidifying the conjugationally extruded fibers, taking off the fibers at a rate of not more than 1,500 m / minute to form the undrawn conjugate fibers, imparting a polyether polyester block

copolymer to the undrawn conjugate fibers in an amount of not less than 0.03 percent by weight on the basis of the weight of the fibers, drawing the undrawn conjugate fibers in a draw ratio of 0.72 to 1.25 times the cold maximum draw ratio at a temperature of T_1 to (T_2 + 30°C), and further crimping the drawn fibers so as to give the number of crimps of 3 to 40 crimps / 25 mm and a crimp percent of 3 to 40%. Herein, T_1 is either higher temperature among the glass transition point of the amorphous polyester and the glass transition point of the polyalkylene terephthalate, and T_2 is the glass transition point of the amorphous polyester.

Best Mode for Carrying Out the Invention

[0011] The fiber-forming component of the polyester-based heat-bonding conjugate staple fibers of the present invention is a polyalkylene terephthalate having a melting point of not less than 220°C. When the melting point of the polyester as the fiber-forming component is less than 220°C, it is not only difficult to stably produce the conjugate fibers, but the stability of the conjugate fibers is also deteriorated on a heat-bonding treatment. The preferable concrete examples of the polyalkylene terephthalate are polyethylene terephthalate and polybutylene terephthalate, and may contain one or more copolymerization components and additives such as a delustering agent, a coloring matter, and a lubricant in small amounts within ranges not deteriorating the characteristics, respectively. Especially, the polyethylene terephthalate is more preferable because of being inexpensive and generally used.

[0012] On the other hand, the amorphous polyester used as the heat-bonding component is a polyester having a glass transition point of 50 to 100°C and not having a crystal-melting point. When the glass transition point of said polyester is less than 50°C, the polyester is not preferable, because the fibers are easily cohered each other, when drawn by the production method described later, and because the conjugate fibers having excellent dimensional stability comprising an area shrinkage percent of not more than 20% can not be obtained. When the glass transition point exceeds 100°C, the polyester is also not preferable, because the thermal bonding property is deteriorated at low temperature of 120 to 150°C.

[0013] The amorphous polyester includes random or block copolymers comprising acid components such as terephthalic acid, isophthalic acid, 2, 6-naphthalene dicarboxylic acid, 5-sodium sulfoisophthalic acid, adipic acid, sebacic acid, azelaic acid, dodecane dicarboxylic acid, and 1,4-cyclohexane dicarboxylic acid, and diols such as ethylene glycol, 1,3-propanediol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, diethylene glycol, 1,4-cyclohexanediol, and 1,4-cyclohexanedimethanol. Especially, an amorphous copolyester comprising terephthalic acid component, isophthalic acid component, ethylene glycol component and diethylene glycol component is preferable from the points of costs and handleability.

[0014] When the above-described copolyester comprising the terephthalic acid component, the isophthalic acid component, the ethylene glycol component and the diethylene glycol component is used as the heat-bonding component, it is necessary to set the copolymerization ratio so that the glass transition point of the copolyester is included within the above-described range. However, the molar ratio of the terephthalic acid component : the isophthalic acid component is suitably 50 : 50 to 80 20, and the molar ratio of the ethylene glycol component : the diethylene glycol component may arbitrarily be selected within a range of 0 : 100 to 100 : 0.

[0015] When the heat-bonding component occupies all parts or a part of the surfaces of the fibers (preferably not less than 40%, especially not less than 60%, of the surfaces of the fibers) in the polyester-based heat-bonding conjugate staple fibers of the present invention, the polyester-based heat-bonding conjugate staple fibers may be produced in any conjugate form selected from a sheath-core type form, an eccentric sheath-core type form, a side-by-side type form, a sea-island type form, a split type from, and the like. In particular, the sheath-core type form, the eccentric sheath-core type form, and the side-by-side type form are more preferable.

[0016] Next, it is necessary that the number of crimps and the crimp percent of the polyester-based heat-bonding conjugate staple fibers of the present invention are 3 to 40 crimps / 25 mm and 3 to 40%, respectively. When the staple fibers have the number of crimps of less than less than 3 crimps / 25 mm or a crimp percent of less than 3%, the fibers are not preferable, because the degree of entanglement between the staple fibers is insufficient to deteriorate the card passage of the staple fibers, whereby the high grade fiber structure is not obtained. On the other hand, when the staple fibers have the number of crimps of more than 40 crimps / 25 mm or a crimp percent of more than 40%, the fibers are also not preferable, because the degree of entanglement between the staple fibers is too large to sufficiently card the staple fibers, whereby a high grade fiber structure is not obtained. The number of crimps and the crimp percent are more preferably 5 to 30 crimps / 25 mm and 5 to 30%, respectively. The form of the crimps includes mechanical crimps and three-dimensional crimps, and may suitably be selected and set in response to the use or aim of the staple fibers.

[0017] The length and single fiber fineness of the polyester-based heat-bonding conjugate staple fibers do not need to be especially limited, and may suitably be set in response to the use and aim of the staple fibers.

[0018] In the heat-bonding conjugate staple fibers of the present invention, it is important that the web area shrinkage percent defined as described below is not more than 20%. Thereby, said conjugate staple fibers can be processed in the form of 100% or in the form of a blend with other fibers to obtain a fiber structure having excellent dimensional

stability even in high temperature atmosphere. When the shrinkage percent exceeds 20%, the fiber structure having excellent dimensional stability in a high temperature atmosphere can not be obtained. The web area shrinkage percent is more preferably not more than 10%.

< Web area shrinkage percentage >

[0019] A card web nonwoven fabric comprising 100% of the heat-bonding conjugate staple fibers and having an area of A_0 and a basis weight of 30 g / m^2 is left in a hot air dryer maintained at 150°C for two minutes, and then the area A_1 of the nonwoven fabric is measured. The web area shrinkage percentage is determined by the following expression.

$$\text{Web area shrinkage percentage (\%)} = (A_0\text{-}A_1) / A_0 \times 100$$

[0020] The above-mentioned polyester-based heat-bonding conjugate staple fibers of the present invention can efficiently be produced, for example, by the following method. Namely, the above-mentioned amorphous polyester and the polyalkylene terephthalate are conjugated, preferably conjugated in the form of a sheath-core type, an eccentric sheath-core type, or a side-by-side type, melted and extruded. The extruded fibers are taken off at a speed of less than 1,500 m / minute to obtain the undrawn conjugate fibers. Then, the obtained undrawn conjugate fibers are subjected to the addition of a polyether polyester block copolymer in an amount of not less than 0.03 percent by weight on the basis of the weight of said fibers, drawn in a draw ratio of 0.72 to 1.25 times the cold maximum draw ratio at a temperature of T_1 to (T_2 + 30°C), and further crimped into the crimped fibers having the number of crimps of 3 to 40 crimps / 25 mm and a crimp percent of 3 to 40%, and then cut in a desired length, thus enabling to produce the polyester-based heat-bonding conjugate staple fibers. Herein, T_1 is either higher temperature among the glass transition point of the amorphous polyester and the glass transition point of the polyalkylene terephthalate, and T_2 is the glass transition point of the amorphous polyester.

[0021] A take-off speed exceeding 1,500 m / minute is not preferable, because the web area shrinkage percent can not be reduced to not more than 20%, even when the obtained undrawn conjugate fibers are drawn in the above-described conditions.

[0022] The first point on the above-described production method is to add the polyether polyester block copolymer to the surfaces of the conjugate fibers at a stage before the taken undrawn conjugate fibers are drawn. Thereby, even when the undrawn conjugate fibers are drawn at a temperature not less than the glass transition point T_2 of the amorphous polyester (namely, corresponding to the softening point of the amorphous copolyester), the polyester-based heat-bonding conjugate staple fibers having a web area shrinkage percent of not more than 20% can be obtained without causing cohesion between the fibers in the drawing process, when the drawing temperature is not more than T_2 + 30°C. Further, the fiber structure having excellent mechanical characteristics can be obtained, because the heat-bonding property of the conjugate fibers is not deteriorated so much, even when said polyether polyester block copolymer is applied to the surfaces of the conjugate fibers.

[0023] Such the simultaneous achievements of the cohesion-preventing effect and the heat-bonding property-maintaining effect are impossible with an anionic surfactant or its polyoxyalkylene adduct, a cationic surfactant, a nonionic surfactant, a mineral oil, or the like, which has usually been used as an oiling agent for producing staple fibers, or even with a polysiloxane-based treating agent.

[0024] A preferably used polyether polyester block copolymer includes especially a copolymer comprising terephthalic acid component and isophthalic acid component and / or an alkali metal sulfoisophthalic acid component in a molar ratio of 40 : 60 to 100 : 0 as a dicarboxylic acid component and ethylene glycol as a glycol component and copolymerized with 20 to 95 percent by weight of a polyalkylene glycol having a number-average molecular weight of 600 to 10,000, and the copolymer is especially preferable from the point of the stability of an aqueous emulsion and the point of an cohesion generation-preventing effect in a drawing process. An acid component such as adipic acid, sebacic acid, azelaic acid, dodecane dicarboxylic acid, or 1, 4-cyclohexanedicarboxylic acid and / or a diol component such as 1, 3-propanediol, 1, 4-butanediol, 1, 5-pentanediol, 1, 6-hexanediol, diethylene glycol, 1, 4-cyclohexanediol, or 1, 4-cyclohexane dimethanol may be copolymerized in small amounts. Additionally, in order to adjust the molecular weight, one end of the polyalkylene glycol may be sealed with an ether bond such as a monomethyl ether, a monoethyl ether, or a monophenyl ether. The polyalkylene glycol includes polyethylene glycol, ethylene oxide - propylene oxide copolymer, polypropylene glycol, and polytetramethylene glycol. The polyethylene glycol is especially preferable.

[0025] The number-average molecular weight of the polyether polyester block copolymer is preferable to be in the range of 3,000 to 20,000, because of giving a higher cohesion-preventing effect.

[0026] The amount of the polyether polyester block copolymer adhered to the undrawn fibers is necessary to be not less than 0.03 percent by weight on the basis of said undrawn fibers. An amount of less than 0.03 percent by weight is not preferable, because a sufficient cohesion-preventing effect is not obtained in the drawing process described

later. On the other hand, the cohesion-preventing effect reaches the highest limit and does not increase, even when the adhesion amount is increased. Therefore, an amount of not more than 0.5 percent by weight, especially a range of 0.05 to 0.3 percent by weight, is suitable.

[0027] A method for applying the polyether polyester block copolymer to the surfaces of the undrawn conjugate fibers is especially not limited, and the polyether polyester block copolymer may be applied by an arbitrary conventional known method usually in the form of an aqueous emulsion solution. In order to stabilize said emulsion solution, not only an emulsifier but also additives such as an antistatic agent, a lubricant, a rust-preventing agent, an antifungal agent, and an antibacterial agent may be added.

[0028] Next, the second point on the above-described production method is a drawing temperature. Although it is undoubtedly necessary to set the drawing temperature to a temperature of not less than T_2 (glass transition point of the amorphous copolyester), it is simultaneously needed for the thermal setting of the polyalkylene terephthalate of fiber-forming component to set the drawing temperature to a temperature of not less than the glass transition point of the polyalkylene terephthalate. Even if the above-described polyether polyester block copolymer is preliminarily imparted to the surfaces of the undrawn conjugate fibers, the target heat-bonding conjugate staple fibers having the excellent dimensional stability by the present invention may not be obtained, when the drawing temperature is lower than either one of the glass transition points of the amorphous copolyester and the polyalkylene terephthalate. Further, it is also important not to set the drawing temperature to high temperature exceeding T_2 (glass transition point of the amorphous copolyester) + 30°C. When the drawing temperature exceeds T_2 + 30°C, the cohesion of the amorphous copolyester can sufficiently not be prevented , and the generation of fused fiber bundles and the deterioration in the stability of a crimper on the addition of crimps to the fibers by the use of a push type crimper are caused. Thereby, the drawing temperature exceeding T_2 + 30°C is not preferable.

[0029] When the drawing temperature is included in the above-described range, the above-described drawing may be one step drawing or more step drawing, but it is necessary that the total draw ratio is 0.72 to 1.25 times the cold draw ratio. When the draw ratio is less than 0.72 time the cold draw ratio, the draw ratio is not preferable, because the dimensional stability of the produced fiber structure is deteriorated. When the draw ratio is more than 1.25 times the cold draw ratio, the draw ratio is also not preferable, because the decrease in the heat-bonding property as well as the deterioration in the drawing property are caused. The cold draw ratio of the undrawn fibers is obtained by drawing the undrawn conjugate fibers collected within five minutes from the just spun time at a speed 5 cm / second in an initial chuck length of 10 cm in air having a relative humidity of 65% at 25°C, and then dividing the distance between the initial chuck length and the chuck length at a time when the chuck can not be elongated, by the initial chuck length (10 cm).

[0030] In the present invention, it is effective for the improvement of the dimensional stability and for the prevention of the cohesion that the above-described drawing is carried out in a draw ratio of 0.7 to 1.0 time the cold draw ratio of the undrawn conjugate fibers at a temperature of T_1 (either higher temperature among the glass transition point of the amorphous copolyester and the glass transition point of the polyalkylene terephthalate) to (T_1 + 10°C) and then in a draw ratio of 1.03 to 1.25 at a temperature of (T_1 + 10°C) to [T_2 (glass transition point of the amorphous copolyester) + 30°C].

[0031] Additionally, it is especially effective to use hot water as a drawing heating medium.

[0032] The drawn conjugate fibers are crimped in conditions giving the number of crimps of 3 to 40 crimps / 25 mm and a crimp percent of 3 to 40% by a known conventional method, and then cut in a desired length. Namely, when the crimping form is a mechanical crimp form, for example, a stuffing type crimper is used, and the conditions of the stuffing pressure and temperature may suitably be controlled. On the other hand, when the crimping form is a three-dimensional crimp form, the conjugate structures of the conjugate fibers and cooling conditions at the spinning time may suitably be selected.

[0033] The obtained polyester-based heat-bonding conjugate staple fibers of the present invention have good dimensional stability, and are suitable for fiber structures such as nonwoven fabrics or wadding. The heat-bonding conjugate staple fibers may singly be used for the fiber structures such as the nonwoven fabrics, or the heat-bonding conjugate staple fibers as main fibers may be blended with other fibers and then used for the fiber structures such as the nonwoven fabrics.

Examples

[0034] The present invention will be explained more concretely hereafter with examples. Therein, evaluation items in Examples obeyed the following methods.

(a) Glass transition point (Tg), melting point (Tm)

[0035] The glass transition point (Tg) and the melting point (Tm) were measured with a differential scanning calo-

rimeter DSC-7 type manufactured by Perkin-Elmer Inc. at a temperature-rising rate of 20°C / minute.

(b) Intrinsic viscosity ([η]).

[0036] The intrinsic viscosity was measured in ortho-chlorophenol as a solvent at a temperature of 35°C.

(c) Number of crimps, crimp percent

[0037] The number of crimps and the crimp percent were measured by a method described in JIS L 1015 7. 12.

(d) Fineness

[0038] The fineness was measured by a method described in JIS L 1015 7. 5. 1 A method.

(e) Fiber length

[0039] The fiber length was measured by a method described in JIS L 1015 7. 4. 1 C method.

(f) Oil pickup

[0040] A value obtained by measuring the weight of residues extracted from fibers with 30°C methanol in a bath ratio of 1: 20 for 10 minutes and then dividing the measured weight by a prescribed fiber weight.

(g) Web area shrinkage percent and deformation of fiber structure

[0041] The area shrinkage percent was determined by forming a card web comprising 100% of the heat-bonding conjugate staple fibers having a basis weight of 30 g / m^2 and an area A_0 (25 cm $\times$25cm = 625cm^2), leaving the formed card web in a hot air drier (hot air circulation constant-temperature drier : 41-S4, manufactured by Satake Kagaku Kikai Kogyo Kabushiki Kaisha) maintained at 150°C for two minutes, measuring the area A_1 of the thermally treated card web and then applying the area A_1 to the following expression. The card web having an area shrinkage percent of not more than 20% was accepted.

$$\text{Area shrinkage percent (\%)} = (625 - A_1) / 625 \times 100$$

(h) Cohesion

[0042] When the cohesion was generated on the drawing of the fibers to make the production impossible or when a cohered bonding was confirmed in the card web, the fibers were judged to be defective, and in other cases, the fibers were judged to be good.

[Example 1]

[0043] Polyethylene terephthalate having an intrinsic viscosity of 0.64, a Tg of 67°C and a Tm of 256°C was used as a fiber-forming component. An amorphous copolyester copolymerized from terephthalic acid component and isophthalic acid component in a molar ratio of 60 : 40 as an acid component and ethylene glycol and diethylene glycol in a molar ratio of 95 : 5 as a diol component, and having an intrinsic viscosity of 0.56 and a Tg of 64°C was used as a heat-bonding component. The pellets of the polymers were vacuum-dried, fed into a sheath-core type conjugate melt-spinning device and melt-spun from a spinneret having 450 spinning nozzles in a conjugate ratio comprising a volume ratio of 50 / 50 at a spinning temperature of 290°C in an extrusion rate of 650 g / minute. The spun fibers were cooled with 30°C cold air, subjected to the adhesion of a treating agent comprising the emulsion of a polyether polyester block copolymer copolymerized from terephthalic acid component and isophthalic acid component in a molar ratio of 80 / 20 as an acid component, ethylene glycol as a glycol component, and polyethylene glycol having a number-average molecular weight of 3,000 and having an average molecular weight of 10,000 in a pure content of 0.1 percent by weight on the basis of the fibers by the use of an oiling roller, and then taken off at a rate of 900 m / minute to obtain the undrawn sheath-core type conjugate fibers. The cold maximum draw ratip (hereinafter, referred to as CDR) of the undrawn fibers was 4.5.

[0044] The undrawn conjugate fibers were bundled to form the tow of 110,000 dtex (100,000 denier). The tow was

first drawn in a draw ratio of 3.5 (0.78 time CDR) in 72°C hot water, further drawn in a draw ratio of 1.15 (total draw ratio is 4.0; 0.89 time CDR) in 80°C hot water, oiled with a spinning oil comprising potassium laurylphosphate, naturally cooled to 35°C, crimped with a stuffing type crimper, and then cut in a fiber length of 51 mm to obtain the heat-bonding conjugate staple fibers having a single fiber fineness of 4.4dtex, the number of crimps of 10 crimps / 25 mm and a crimp percent of 15%.

[Examples 2 to 10, Comparative Examples 1 to 6]

[0045] Heat-bonding conjugate stable fibers having a single fiber fineness of 4.4 dtex, a fiber length of 51 mm, the number of crimps of 10 crimps / 25 mm, and a crimp percent of 15% were obtained in the same conditions as in Example 1 except that the heat-bonding component, the fiber-forming component, the treating agent, the drawing ratio, and the drawing temperature were changed.

[0046] The fiber constitutions, treating agent kinds, spinning and drawing conditions, and fiber evaluation results of the Examples and the Comparative Examples are shown in Tables 1, 2, 3, and 4, respectively.

Table 1

Conjugate Type			F1	F2	F3	F4	F5	F6
# I	Acid Component	TA	60	60	55	70	75	60
		IA	40	40	40	30	25	40
		SA	-	-	5	-	-	-
	Glycol Component	EG	95	100	100	62	44	95
		DEG	5	-	-	8	6	5
		HMG	-	-	-	30	50	-
	Tg °C		64	69	59	55	40	64
	Tm °C		-	-	-	-	-	-
	[η]		0.56	0.57	0.55	0.56	0.56	0.56
# II	Polymer		PET	PET	PET	PET	PET	PBT
	Tg °C		67	67	67	67	67	25
	Tm °C		256	256	256	256	256	228
	[η]		0.64	0.64	0.64	0.64	0.64	0.87

I : Heat-bonding component
II : Fiber-forming component
TA : Terephthalic acid IA : Isophthalic acid SA: Sebacic acid
EG : Ethylene glycol DEG : Diethylene glycol
HMG : Hexamethylene glycol
PET : Polyethylene terephthalate
PBT : Polybutylene terephthalate

Table 2

Treating agent		O1	O2	O3	O4	O5
Polyether polyester block copolymer component					-	-
Acid component	TA	80	90	72		
	IA	20	10	18		
	SIA	-	-	10		
Glycol component	EG	100	100	100		

Table 2 (continued)

Treating agent		O1	O2	O3	O4	O5
Polyalkylene glycol	Type	PEG3000	M-PEG3000	PEG4000		
	CD	70	80	70		
Number-average molecular weight		10000	9000	11000		
Other components		-	-	-	Phosphate 1	Phosphate 2

TA: Terephthalic acid IA: Isophthalic acid
SIA: 5-Sodium sulfophthalic acid
PEG 3000 : Polyethylene glycol having an average molecular weight of 3000
PEG 4000 : Polyethylene glycol having an average molecular weight of 4000
M-PEG 3000 : Polyethylene glycol monophenyl ether having an average molecular weight of 3000
CD : Copolymerization degree %

Phosphate 1 : Potassium lauryl phosphate
Phosphate 2 : Partial potassium lauryl phosphate having the average ethylene oxide addition number of five moles.

Table 3

	Spinning			Drawing				
	# 1	Treating agent	CDR	First step		Second step		Total drawing ratio
				#2	Ratio /CDR	#2	Ratio /CDR	Ratio(CDR)
Example 1	F1	O1	4.5	72	0.78	72	1.15	4.00(0.89)
Comparative example 1	F1	O1	4.5	65	0.78	60	1.15	4.00(0.89)
Comparative example 2	F1	O4	4.5	65	0.78	60	1.15	4.00(0.89)
Comparative example 3	F1	O4	4.5	72	0.78	72	1.15	4.00(0.89)
Comparative example 4	F1	O5	4.5	72	0.78	72	1.15	4.00(0.89)
Example 2	F1	O1	4.5	72	0.78	80	1.15	4.00(0.89)
Example 3	F1	O1	4.5	72	0.78	85	1.15	4.00(0.89)
Example 4	F1	O1	4.5	72	0.96	80	1.05	4.54(1.01)
Comparative example 5	F1	O1	4.5	72	0.60	72	1.15	3.10(0.69)
Example 5	F1	O2	4.5	72	0.78	72	1.15	4.00(0.89)
Example 6	F1	O3	4.5	72	0.78	72	1.15	4.00(0.89)
Example 7	F2	O1	4.5	72	0.78	72	1.15	4.00(0.89)
Example 8	F3	O1	4.5	72	0.78	72	1.15	4.00(0.89)
Example 9	F4	O1	4.5	72	0.78	72	1.15	4.00(0.89)
Comparative example 6	F5	O1	4.5	72	0.78	72	1.15	4.00(0.89)
Example 10	F6	O1	3.8	72	0.78	72	1.15	3.38(0.89)

1: Conjugate type
2: Temperature

Table 4

	Fiber		
	Appearance of Un-cohesion	Web area shrinkage percent (%)	Web grade after shrinkage
Example 1	Good	18.5	Good
Comparative example 1	Good	73.9	Defective
Comparative example 2	Good	55.3	Defective
Comparative example 3	Defective	Could not be drawn	-
Comparative example 4	Defective	Could not be drawn	-
Example 2	Good	8.1	Good
Example 3	Good	5.1	Good
Example 4	Good	6.8	Good
Comparative example 5	Defective	Could not be drawn	-
Example 5	Good	17.5	Good
Example 6	Good	18.1	Good
Example 7	Good	18.3	Good
Example 8	Good	16.3	Good
Example 9	Good	16.1	Good
Comparative example 6	Defective	Could not be drawn	-
Example 10	Good	14.8	Good

Utilization in Industry

[0047] The polyester-based heat-bonding conjugate staple fibers of the present invention can provide high-grade fiber structures which have good dimensional stability and hardly cause deformation, even when used under high temperature atmospheres, although the fiber structures can be formed at relative low temperature. In addition, by the production method of the present invention, the above-described heat-bonding conjugate staple fibers can extremely stably and easily be produced without causing cohesion.

Claims

1. Polyester-based heat-bonding conjugate staple fibers comprising an amorphous polyester having a glass transition point of 50 to 100°C and not having a crystal-melting point as a heat-bonding component and a polyalkylene terephthalate having a melting point of not less than 220°C as a fiber-forming component, **characterized by** having the number of crimps of 3 to 40 crimps / 25 mm, a crimp percent of 3 to 40%, and a web area shrinkage percent of not more than 20% defined as described below.
   < Web area shrinkage percentage >
   A card web nonwoven fabric comprising 100% of the heat-bonding conjugate staple fibers and having an area of A_0 and a basis weight of 30 g / m^2 is left in a hot air dryer maintained at 150°C for two minutes, and then the area A_1 of the nonwoven fabric is measured. The web area shrinkage percentage is determined by the following expression.

$$\text{Web area shrinkage percentage (\%)} = (A_0\text{-}A_1) / A_0 \times 100$$

2. The polyester-based heat-bonding conjugate staple fibers according to Claim 1, wherein a polyether polyester block copolymer is applied to the surfaces of the fibers in an amount of not less than 0.03 percent by weight on the basis of the weight of the fibers.

3. The polyester-based heat-bonding conjugate staple fibers according to Claim 1 or 2, wherein the heat-bonding component is an amorphous copolyester comprising isophthalic acid component, terephthalic acid component, ethylene glycol component, and diethylene glycol component.

4. The polyester-based heat-bonding conjugate staple fibers according to Claim 1 or 2, wherein the fiber-forming component is polyethylene terephthalate.

5. A method for producing polyester-based heat-bonding conjugate staple fibers, **characterized by** melting and conjugationally extruding an amorphous polyester having a glass transition point of 50 to 100°C and not having a crystal-melting point and a polyalkylene terephthalate having a melting point of not less than 220°C, cooling and solidifying the conjugationally extruded fibers, taking off the fibers at a rate of not more than 1,500 m/minute to form the undrawn conjugate fibers, applying a polyether polyester block copolymer to the undrawn conjugate fibers in an amount of not less than 0.03 percent by weight on the basis of the weight of the fibers, drawing the undrawn conjugate fibers in a draw ratio of 0.72 to 1.25 times the cold maximum draw ratio at a temperature of T_1 to (T_2 + 30°C), and further crimping the drawn fibers so as to give the number of crimps of 3 to 40 crimps / 25 mm and a crimp percent of 3 to 40%. Herein, T_1 is either higher temperature among the glass transition point of the amorphous polyester and the glass transition point of the polyalkylene terephthalate, and T_2 is the glass transition point of the amorphous polyester.

6. The method for producing the polyester-based heat-bonding conjugate staple fibers according to Claim 5, wherein the drawing is a two step drawing comprising drawing in a draw ratio of 0.70 to 1.00 time the cold maximum draw ratio at a temperature of T_1 to (T_1 + 10°C) and further in a draw ratio of 1.03 to 1.25 at a temperature of (T_1 + 10°C) to (T_2 + 30°C).

7. The method for producing the polyester-based heat-bonding conjugate staple fibers according to Claim 5 or 6, wherein a heating medium used for the drawing is hot water.

8. The method for producing the polyester-based heat-bonding conjugate staple fibers according to Claim 5 or 6, wherein the polyether polyester block copolymer is a block copolymer comprising terephthalic acid component and isophthalic acid component and / or an alkali metal salt sulfoisophthalic acid component in a molar ratio of 40 : 60 to 100 : 0 as the acid component and ethylene glycol as the glycol component and copolymerized with 20 to 95 percent by weight of a polyalkylene glycol having a number-average molecular weight of 600 to 10,000.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/02694

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] D01F8/14

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] D01F8/14, D06M15/53

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Kokai Jitsuyo Shinan Koho	1971-2002	Jitsuyo Shinan Toroku Koho	1996-2002

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 7-34327 A (Teijin Ltd.), 03 February, 1995 (03.02.95), Full text (Family: none)	1-8
A	JP 2000-226735 A (Nippon Ester Kabushiki Kaisha), 15 August, 2000 (15.08.00), Full text (Family: none)	1-8
A	JP 2000-178827 A (Toray Industries, Inc.), 27 June, 2000 (27.06.00), Par. Nos. [0036] to [0050], [0073], [0074] (Family: none)	1-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 June, 2002 (07.06.02)	18 June, 2002 (18.06.02)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP02/02694

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 7-3534 A (Toyobo Co., Ltd.), 06 January, 1995 (06.01.95), Full text (Family: none)	1-8
A	JP 2001-3256 A (Unitika Ltd.), 09 January, 2001 (09.01.01), Full text (Family: none)	1-8
P,A	JP 2001-288682 A (Teijin Ltd.), 19 October, 2001 (19.10.01), Full text (Family: none)	1-8

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