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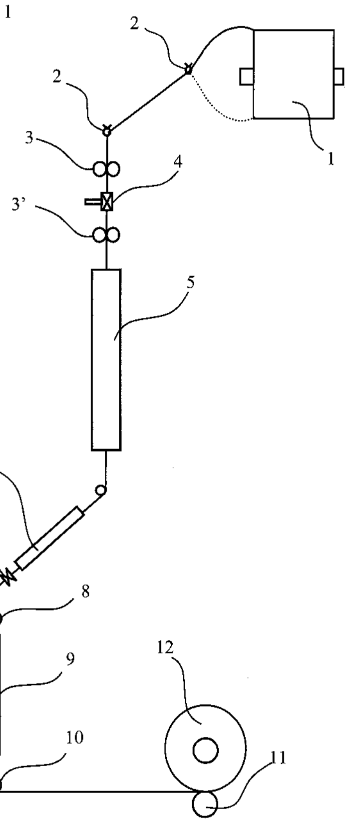
(54) ANTISTATIC POLYESTER FALSE TWIST YARN, PROCESS FOR PRODUCING THE SAME, AND ANTISTATIC SPECIAL COMPOSITE FALSE TWIST YARN INCLUDING THE ANTISTATIC POLYESTER FALSE TWIST YARN

(57) An unstretched filament composed of a PET-based aromatic polyester multifilament comprising a polyoxyalkylene-based polyether and an organic ionic compound is subjected to simultaneous stretching and false twisting under specified conditions to produce a polyester false twisted yarn, whereby rapid and stable false twisting can be accomplished without section deformation or fluff generation during false twisting, and the resulting yarn has a highly satisfactory hand quality and a fibrillation resistant fiber structure, while also exhibiting a highly durable antistatic property.

Interlacing of the unstretched filament with an unstretched polyester filament comprising a polymethyl methacrylate-based polymer and/or polystyrene-based polymer and stretching/false twisting thereof under specified conditions allows rapid and stable production of conjugated false twisted yarn exhibiting highly satisfactory bulkiness and a spun feel with the absence of fluff, as well as a highly durable antistatic property. The finished yarn is particularly useful for purposes that require static electricity to be inhibited, such as student wear, uniforms, dustproof clothing and the like.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a polyester false twisted yarn with an antistatic property, to a process for its production, and to antistatic special conjugated false twisted yarn comprising the antistatic polyester false twisted yarn. More specifically, the invention relates to polyester false twisted yarn with excellent durability and an antistatic property, to a process for rapid and stable production of the false twisted yarn, and to antistatic special conjugated false twisted yarn having a core-sheath structure that comprises the antistatic polyester false twisted yarn.

Background Art

[0002] Polyester, and especially polyethylene terephthalate or aromatic polyesters composed mainly thereof (hereinafter referred to as PET-based polyesters) have a wide range of excellent characteristics and are therefore widely used as molding materials for fibers, films, sheets and the like. However, because polyesters are hydrophobic, their use has been limited in fields that require antistatic properties.

[0003] It has been attempted in the past to impart hydrophilicity to PET-based polyesters in order to produce an antistatic property, and several ideas have been set forth. For example, methods are known for adding polyoxyalkylene-based polyether compounds to polyesters (see Japanese Examined Patent Publication SHO No. 39-5214), and for adding essentially non-compatible polyoxyalkylene-based polyether compounds and organic or inorganic ionic compounds to polyesters (see Japanese Examined Patent Publication SHO No. 44-31828, Japanese Examined Patent Publication SHO No. 60-11944, Japanese Unexamined Patent Publication SHO No. 53-80497, Japanese Unexamined Patent Publication SHO No. 53-149247, Japanese Unexamined Patent Publication SHO No. 60-39413, Japanese Unexamined Patent Publication HEI No. 3-139556). When fibers are produced from these polyester compositions, however, even though normal fully oriented yarn (FOY) has an antistatic property, the false twisted yarn tends to generate fluff due to twisting deformation, and PET-based polyester false twisted yarn with practical antistatic properties has not yet been achieved.

[0004] Another type of known yarn is conjugated false twisted yarn with a bilayer structure that exhibits high bulk and a satisfactory spun feel, the yarn being obtained by doubling and tangling two or more different polyester filament yarns of different ductility and then subjecting them to false twisting (for example, see Japanese Examined Patent Publication SHO No. 61-19733).

[0005] Despite increasing demands for hand quality, feel and outer appearance of woven or knitted fabrics in recent years, however, fabrics that have been knitted or woven using conventional false twisted yarn have almost universally failed to exhibit antistatic properties that can prevent stinging static electricity. In particular, antistatic PET-based polyester false twisted yarn fabrics do not yet exist that can be applied for preventing static electricity in student wear, uniforms and dustproof clothing, or for blouses or shirts that are in direct contact with the skin.

DISCLOSURE OF THE INVENTION

[0006] It is an object of the invention to provide a novel PET-based polyester false twisted yarn that can overcome the deficiencies of conventional products such as described above to yield polyester fabrics with excellent antistatic performance, to provide a process allowing stable production of such polyester false twisted yarn, and to provide a novel polyester conjugated false twisted yarn and process for stable production of the conjugated false twisted yarn, that can yield spun-like polyester fabrics with highly satisfactory bulk, a spun feel and excellent antistatic performance.

[0007] As a result of much diligent research aimed at achieving the object stated above, the present inventors have completed this invention upon discovering that a novel polyester false twisted yarn capable of yielding polyester fabrics with satisfactory durability and hand quality as well as excellent antistatic performance can be stably produced by using a specific false twisting tool for simultaneous stretching and false twisting of polyester unstretched filaments composed of a polyester composition containing a specific antistatic agent in a specified range, under conditions with a specified temperature and number of twists.

[0008] Moreover, the present inventors accomplished this invention upon further discovering that if the core yarn of polyester-based conjugated false twisted yarn is constructed with polyester yarn comprising a specific antistatic agent in a specific proportion and the sheath yarn is constructed with polyester yarn comprising a polymethyl methacrylate-based polymer or polystyrene-based polymer in a specific proportion, and the unstretched filament for the core yarn and the unstretched filament for the sheath yarn are doubled for simultaneous stretching and false twisting under specific conditions, the effect of uniformly enveloping the antistatic core yarn in the lengthwise direction of the sheath yarn allows tremendously stabilized and highly efficient production of polyester conjugated false twisted yarn that is capable of yielding a spun-like polyester fabric having a very satisfactory bulk and spun feel and excellent antistatic performance.

[0009] Specifically, the present invention provides:

· An antistatic polyester multifilament false twisted yarn composed of an aromatic polyester composition comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with aromatic polyesters, wherein at least 75 mol% of the repeating units are ethylene terephthalate units, the antistatic polyester false twisted yarn being characterized in that the electrostatic voltage half-life of the false twisted yarn is no greater than 60 seconds and the percentage crimp is 10-20%.

· A process for production of an antistatic polyester false twisted yarn, characterized by simultaneous stretching and false twisting of an unstretched filament with a birefringence of 0.02-0.05, obtained by melt spinning of an aromatic polyester composition comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with aromatic polyesters, wherein at least 75 mol% of the repeating units are ethylene terephthalate units, under conditions satisfying all of the following (a) to (d).

(a) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(b) The false twisting temperature is 170°C-300°C.
(c) The draw ratio during false twisting is 1.4-2.4.
(d) The number of false twists T (/m) is $15{,}000/Y^{1/2} \leq T \leq 35{,}000/Y^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

· An antistatic special conjugated false twisted yarn wherein the core yarn (A) is an antistatic polyester multifilament composed of an aromatic polyester composition having ethylene terephthalate units for at least 75 mol% of the repeating units and comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with polyesters, and the sheath yarn (B) is a polyester multifilament composed of an aromatic polyester composition comprising 0.5-3.0 wt% of a polymethyl methacrylate-based polymer and/or polystyrene-based polymer, the special conjugated false twisted yarn being characterized in that the electrostatic friction pressure of the finished yarn is no greater than 2000 V, the percentage crimp is 2-8% and the average filament length of the sheath yarn (B) is 10-20% longer than the average filament length of the core yarn (A).

· A process for production of an antistatic special conjugated false twisted yarn, **characterized in that** the texturing filament to be used for polyester multifilament stretching and false twisting is obtained by doubling an unstretched antistatic polyester multifilament (A') comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with polyesters and an unstretched polyester multifilament (B') comprising 0.5-3.0 wt% of a polymethyl methacrylate-based polymer and/or polystyrene-based polymer based on the weight of the polyester multifilament, and simultaneous stretching and false twisting are carried out under conditions satisfying all of the following (1)-(4).

(1) Air interlacing treatment is carried out immediately before false twisting to produce at least 30 tangles per meter.
(2) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(3) The false twisting temperature is 170°C-300°C.
(4) The number of false twists T (/m) is $15{,}000/Y^{1/2} \leq T \leq 35{,}000^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

<u>Brief Description of the Drawings</u>

[0010]

Fig. 1 is a schematic diagram of a simultaneous stretching/false twisting machine for production of false twisted yarn according to the invention, wherein 1 is polyester unstretched filament or spun combined filament yarn, 2 is a yarn guide, 3,3' are feed rollers, 4 is an interlace nozzle, 5 is a first stage heater, 6 is a cooling plate, 7 is a false twisting tool (three-axis friction disc unit), 8 is a first delivery roller, 9 is a second stage heater, 10 is a second delivery roller, 11 is a winding roller and 12 is a polyester false twisted yarn cheese.

Fig. 2 is a front view showing an embodiment of a false twisting disc unit used for the invention, wherein 13 is a false twisting disc, 14 is a guide disc, 15 is a rotation axis, 16 is a timing belt and 17 is a driving belt.

Best Mode for Carrying Out the Invention

[0011] The antistatic false twisted yarn of the invention is composed of a multifilament comprising a specific antistatic aromatic polyester composition, and it has a specific antistatic property and crimp. Embodiments of the invention will be explained in detail below, specifically for the aromatic polyester composition of the antistatic false twisted yarn, the properties of the false twisted yarn and the process for production of the false twisted yarn.

<Composition for formation of antistatic false twisted yarn>

[0012] An "aromatic polyester" according to the invention is a PET-based aromatic polyester wherein at least 75 mol% and preferably 85-100 mol% of the polymer repeating units are ethylene terephthalate, and it is a polymer primarily obtained by reaction between terephthalic acid or its ester-forming derivative and ethylene glycol or its ester-forming derivative.

[0013] The PET-based aromatic polyester may also be copolymerized with a small amount of a bifunctional aromatic carboxylic acid other than terephthalic acid, as the acid component. As such copolymerizing components there may be mentioned isophthalic acid, orthophthalic acid, 1,5-naphthalenedicarboxylic acid, 2,5-naphthalenedicarboxylic acid, 2,6-naphthalenedicarboxylic acid, 4,4'-biphenyldicarboxylic acid, 3,3'-biphenyldicarboxylic acid, 4,4'-biphenyl etherdicarboxylic acid, 4,4'-biphenylmethanedicarboxylic acid, 4,4'-biphenylsulfonedicarboxylic acid, 4,4'-biphenylisopropylidenedicarboxylic acid, 1,2-bis(phenoxy)ethane-4,4'-dicarboxylic acid, 2,5-anthracenedicarboxylic acid, 2,6-anthracenedicarboxylic acid, 4,4'-p-phenylenedicarboxylic acid, 2,5-pyridinedicarboxylic acid, β-hydroxyethoxybenzoic acid and p-oxybenzoic acid. These bifunctional aromatic carboxylic acids may also be used in combinations of two or more. The bifunctional aromatic carboxylic acids may also be used in combination with small amounts of one or more bifunctional aliphatic carboxylic acids such as adipic acid, azelaic acid, sebacic acid or dodecanedioic acid, bifunctional alicyclic carboxylic acids such as cyclohexanedicarboxylic acid, or 5-sodiumsulfoisophthalic acid.

[0014] The diol compound used for copolymerization may be ethylene glycol, another aliphatic diol such as propylene glycol, butylene glycol, hexylene glycol, neopentyl glycol, 2-methyl 1,3-propanediol, diethylene glycol or trimethylene glycol, an alicyclic diol such as 1,4-cyclohexanedimethanol, or a mixture of the above. Also, a small amount of these diol compounds may be copolymerized with a polyoxyalkylene glycol that is uncapped at one or both ends.

[0015] There may also be used a polycarboxylic acid such as trimellitic acid or pyromellitic acid and a polyol such as glycerin, trimethylolpropane or pentaerythritol, in ranges so that the polyester is substantially linear.

[0016] As specific examples of preferred PET-based aromatic polyesters there may be mentioned polyethylene terephthalate (PET) homopolymer and copolymer polyesters such as polyethylene isophthalate-terephthalate, polyethylene-butylene terephthalate and polyethylene terephthalate-decanedicarboxylate. Particularly preferred is polyethylene terephthalate homopolymer, for its balance between mechanical properties and reeling properties.

[0017] The PET-based aromatic polyester may be synthesized by any desired method. Polyethylene terephthalate, for example, can be easily produced by a first-stage reaction involving direct esterification between terephthalic acid and ethylene glycol, transesterification between ethylene glycol and a lower alkyl ester of terephthalic acid such as dimethyl terephthalate, or reaction between terephthalic acid and ethylene oxide, to produce a glycol ester of terephthalic acid and/or a low polymer thereof, followed by a second-stage reaction wherein the product is heated under reduced pressure for polycondensation reaction to the desired polymerization degree.

[0018] The PET-based aromatic polyester may if necessary also contain a stabilizer, delustering agent, coloring agent and other additives.

[0019] The antistatic aromatic polyester composition forming the false twisted yarn of the invention comprises two specific antistatic agents in a PET-based aromatic polyester, as mentioned above. The polyoxyalkylene-based polyether (a) added as the first antistatic agent according to the invention, so long as it is essentially insoluble in the PET-based aromatic polyester, may be a polyoxyalkylene glycol composed of a single oxyalkylene unit, or a copolymer polyoxyalkylene glycol composed of two or more oxyalkylene units, or a polyoxyethylene-based polyether represented by the following general formula (I).

$$Z[(CH_2CH_2O)_n(R^1O)_m\text{-}R^2]_k \qquad (I)$$

In formula (I), Z is an organic compound residue having 1-6 active hydrogens, R^1 is a C6 alkylene or substituted alkylene group, R^2 is hydrogen, a C1-40 monovalent hydrocarbon group, a C2-40 monovalent hydroxy-hydrocarbon or a C2-40 monovalent acyl group, k is an integer of 1-6, n is an integer satisfying the inequality $n \geq 70/k$, and m is an integer of 1 or greater.

[0020] As specific examples of such polyoxyalkylene-based polyethers there may be mentioned polyoxyethylene glycols with molecular weights of 4000 and greater, polyoxypropylene glycols and polyoxytetramethylene glycols with molecular weights of 1000 and greater, ethylene oxides and propylene oxide copolymers with molecular weights of 2000 and greater, trimethylolpropaneethylene oxide addition products with molecular weights of 4000 and greater, nonylphenolethylene oxide addition products with molecular weights of 3000 and greater, and compounds obtained by addition of C6 or greater substituted ethylene oxide to the terminal OH groups of the aforementioned molecules, among which there are preferred polyoxyethylene glycols of molecular weight 10,000-100,000 and compounds obtained by addition of C8-40 alkyl group-substituted ethylene oxides at both ends of polyoxyethylene glycol of molecular weight 5000-16,000.

[0021] The content of the polyoxyalkylene-based polyether compound (a) is in the range of preferably 0.2-30 parts by weight and even more preferably 2-6 parts by weight with respect to 100 parts by weight of the aromatic polyester. If the content is less than 0.2 part by weight it may not be possible to achieve a satisfactory antistatic property due to poor hydrophilicity. On the other hand, a content of greater than 30 parts by weight will produce no corresponding improvement in the antistatic property, and instead may impair the mechanical properties of the obtained composition and tend to cause bleed-out of the polyether compound, thus reducing the ability of the extruder to seize chips during melt spinning and resulting in poor spinning stability.

[0022] The aromatic polyester composition also contains an organic ionic compound (b) as a second antistatic agent, for further improvement in the antistatic property. As such organic ionic compounds there may be mentioned compounds that are substantially non-reactive with the PET-based aromatic polyester as the matrix and also substantially non-reactive with the polyoxyalkylene-based polyether compound (a), and preferred are sulfonic acid metal salts and sulfonic acid quaternary phosphonium salts represented by the following general formulas (II) and (III). These may be used alone or in combinations of two or more.

$$RSO_3M \quad (II)$$

[0023] In formula (II), R represents a C3-30 alkyl or C6-40 aryl group, and M represents an alkali metal or alkaline earth metal. When R in formula (II) is an alkyl group, the alkyl group may be straight-chain or it may have branching side chains. M is an alkali metal such as Na, K or Li or an alkaline earth metal such as Mg or Ca, among which Li, Na and K are preferred. The sulfonic acid metal salt may be one used alone or a combination of two or more.

[0024] As preferred examples of sulfonic acid metal salts there may be mentioned mixtures of sodium alkylsulfonates with an average of 14 carbon atoms, such as sodium stearylsulfonate, sodium octylsulfonate and sodium dodecylsulfonate, mixtures of sodium dodecylbenzenesulfonates, sodium dodecylbenzenesulfonate (hard, soft), lithium dodecylbenzenesulfonate (hard, soft), magnesium dodecylbenzenesulfonate (hard, soft), and the like.

$$RSO_3\,P\,R^1\,R^2\,R^3\,R^4 \qquad (III)$$

[0025] In formula (III), R^1, R^2, R^3 and R^4 each independently represent a C3-30 alkyl or C6-40 aryl group. R^1, R^2, R^3 And R^4 are each preferably a C5-15 lower alkyl, phenyl or benzyl group. The total number of carbon atoms of R^1, R^2, R^3 and R^4 is preferably no greater than 60.

[0026] As preferred examples of sulfonic acid quaternary phosphonium salts there may be mentioned tetrabutylphosphonium alkylsulfonates wherein the alkyl group has an average of 14 carbon atoms, tetraphenylphosphonium alkylsulfonates wherein the alkyl group has an average of 14 carbon atoms, butyltriphenylphosphonium alkylsulfonates wherein the alkyl group has an average of 14 carbon atoms, tetrabutylphosphonium dodecylbenzenesulfonates (hard, soft), tetraphenylphosphonium dodecylbenzenesulfonates (hard, soft) and benzyltriphenylphosphonium dodecylbenzenesulfonate (hard, soft). The sulfonic acid quaternary metal salt may be one which is used alone or it may be a combination of two or more.

[0027] The organic ionic compound (b) may also be one or a combination of two or more, but the total content is preferably in the range of 0.05-10 parts by weight and more preferably 0.5-4 parts by weight with respect to 100 parts by weight of the aromatic polyester. At less than 0.05 part by weight the improvement in antistatic property will be minimal, while at greater than 10 parts by weight the mechanical properties of the fiber may be impaired and the ionic compound will tend to bleed out, thus reducing the ability of the extruder to seize chips during melt spinning and resulting in poor spinning stability.

[0028] The aromatic polyester composition may also contain, in addition to the antistatic agent described above, other known additives such as pigments, dyes, delustering agents, stain-proofing agents, fluorescent whitening agents, flame retardants, stabilizers, ultraviolet absorbers, lubricants and the like, in ranges that do not interfere with the object of the invention.

<Properties of false twisted yarn>

[0029] The false twisted yarn of the invention has crimping to a percentage crimp in the range of 10-20% and especially 12-18%. A percentage crimp in this range will yield a woven or knitted fabric with an excellent soft feel.

[0030] A percentage crimp of less than 10% is not preferred because it will increase the space between filaments in a woven or knitted fabric, promoting infiltration of dyes and tending to cause dyeing spots. On the other hand, a percentage crimp of greater than 20% is also not preferred because it will whiten the color tone of the grain on the surface of woven or knitted fabrics and create a more puffed-up feel in woven or knitted fabric textures.

[0031] The false twisted yarn of the invention has an electrostatic voltage half-life of no greater than 60 seconds and preferably 5-40 seconds. The electrostatic voltage half-life is the value obtained by measurement of the antistatic performance using the electrostatic propensity test method A of JIS-L1094 (half-life measurement), after tube-knitting, dyeing and humidification of the false twisted yarn. The time (seconds) until attenuation of the electrostatic voltage to 1/2 of the initial electrostatic voltage is measured, with a shorter time (seconds) evaluated as superior antistatic performance. An electrostatic voltage half-life of longer than 60 seconds will produce little or no antistatic effect, and the object of the invention will not be achieved.

[0032] For the false twisted yarn of the invention to facilitate adjustment of woven or knitted fabric density to a suitable range, the total size is appropriately in the range of 50-200 dtex (decitex) and preferably 50-150 dtex. The total size is preferably not less than 50 dtex because the textile fabric will tend to be weaker and it may become difficult to obtain a sufficiently compact textile. A total size of greater than 200 dtex is also not preferred because the basis weight of the woven or knitted fabric will tend to be too high for weaving or knitting. The size of the monofilament is preferably 1.0-5.0 dtex, and the number of filaments in the false twisted yarn is preferably 24-96.

<Process for production of false twisted yarn>

[0033] The antistatic polyester false twisted yarn of the invention as explained above can be stably produced with satisfactory efficiency by the following process, for example.

[0034] Specifically, in order to accomplish rapid and stable false twisting without deformation or fluff generation during false twisting in the production process of the invention, the texturing filament used is an unstretched multifilament with a birefringence of 0.02-0.05, melt spun from an aromatic polyester composition obtained by uniformly mixing both the aforementioned polyoxyalkylene glycol (a) and ionic antistatic agent (b) in a PET-based aromatic polyester, and the filament is subjected to simultaneous stretching and false twisting under conditions that satisfy all of the following (a) to (d).

(a) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(b) The false twisting temperature is 170°C-300°C.
(c) The draw ratio during false twisting is 1.4-2.4.
(d) The number of false twists T (/m) is $15{,}000/Y^{1/2} \leq T \leq 35{,}000/Y^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

[0035] In the melt spinning stage, the aromatic polyester composition is discharged as a melt from the spinning nozzle and cooled to solidity to form filaments, and each filament is doubled and coated with the necessary lubricants, and preferably taken up at a spinning speed of 2000-4500 m/min and especially 2500-3500 m/min.

[0036] The birefringence of the spun unstretched filament (multifilament) during this time must be in the range of 0.02-0.05. The birefringence is preferably not less than 0.02 because the tension during false twisting will be reduced, surging will tend to result, swaying of the yarn may result in unevenness of heat setting and consequent dyeing spots, and the yarn will be weakened due to an increased draw ratio during false twisting. On the other hand, a birefringence of greater than 0.05 is also not preferred because fluff will tend to be generated by the filament and can interfere with the process.

[0037] During the steps of spinning and/or stretching and false twisting in the process of the invention, the yarn is preferably subjected to interlacing treatment by a turbulent air stream. The air interlacing treatment may be carried out by a separate step from the stretching and false twisting, but preferably it is carried out just before the stretching and false twisting, using an interlace nozzle (4) installed in the stretching and false twisting apparatus as shown in Fig. 1. This can inhibit fluff generation and beneficially affect handling of the finished yarn. A separate interlace nozzle (not shown) may also be used for air interlacing with the yarn after false twisted heat setting, for complete combined filament interlacing and uniformity in the lengthwise direction of the yarn. This effect can produce a finished yarn that exhibits uniform antistatic performance in the lengthwise direction of the yarn and a high quality feel.

[0038] In the process of the invention, the unstretched filament subjected to interlacing treatment immediately before stretching and false twisting is preferably put through a stretching and false twisting machine equipped with a two-stage heater as shown in Fig. 1, for example, to produce a polyester false twisted yarn with crimping. In the example shown in Fig. 1, the polyester unstretched filament (1) described above is pulled out from a package, passed through a yarn guide (2) and subjected to air interlacing treatment using an interlace nozzle (4) situated between a pair of feed rollers (3,3'). The interlaced unstretched filament is twisted by a rotating three-axis friction disc type false twisting tool (7) while being stretched to the desired factor between the feed roller (3') and the first delivery roller (8). The false twisting tool (7) used is one wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.

[0039] The yarn is heat set in a twisted state by a first stage heater (5) and then cooled by a downstream end cooling plate (6) and passed through the false twisting tool (7) for untwisting. If necessary, the running yarn is again heat set by a second stage heater (9) situated between the first delivery roller (8) and second delivery roller (10), and again treated by air interlacing, after which it is wound up as a cheese package (12) using a wind-up roller (11) to produce the desired antistatic polyester false twisted yarn.

[0040] From the standpoint of accomplishing rapid stretching false twisting, the first stage heater (5) and second stage heater (9) are preferably non-contact types. In particular, while SW-OFF is usually not used in the second stage heater (9), it may be used if necessary for a given feel required for the finished yarn.

[0041] As explained above, it is an important aspect of the process of the invention that it employs a false twisting tool (7) which is a three-axis friction disc type as shown in Fig. 2, wherein the lowermost disc positioned at the untwisting section is ceramic and the diameter of the disc is 90-98% of the diameter of the disc immediately above it, and wherein the contact length between that disc and the running yarn is 2.5-0.5 mm. In other words, the false twisting tool (7) shown in Fig. 2 is a three-axis friction disc type having two false twisting discs (13) mounted on each of three rotation axes (15), where each rotation axis (15) rotates at a prescribed speed by a timing belt (16) driven by a driving belt (17), for rotation of each of the false twisting discs (13). Of the aforementioned false twisting discs (13) used in the process of the invention, at least the lowermost disc positioned at the untwisting section (the lower disc mounted on the rotation axis at the left of Fig. 2) is made of a ceramic material, and the diameter of that disc is 90-98% of the diameter of the disc immediately above it (the lower disc mounted on the rotation axis at the center of Fig. 2). The contact length between the ceramic disc and the running yarn is 2.5-0.5 mm.

[0042] The material of the lowermost disc in the false twisting tool (7) is preferably ceramic from the viewpoint of disc attrition. Also, the contact length between that disc and the running yarn is 2.5-0.5 mm because the present inventors have found that when twisting has been completed and the crimped yarn enters the final untwisting section, a minimal contact area between the disc and the yarn and reduced resistance are effective for achieving significant reduction in fluff. Similarly, it has been found that specifying the diameter of the lowermost disc to be 90-98% of the diameter of the disc immediately above it reduces resistance when the yarn is moved to the following step (heat setting) and creates an optimum zone for smooth movement of the yarn.

[0043] Since the filament used for the unstretched filament in the process of the invention includes the two different antistatic agents mentioned above, the natural tendency to readily produce fluff by stretching and false twisting can be notably reduced by employing the aforementioned conditions in the process of the invention to reduce such processing fluff. However, generation of processing fluff adversely affects the weaving properties, reeling properties and woven fabric product quality when the conditions are outside of the ranges mentioned above. As a result of further diligent research, the present inventors have determined that specifying a contact length of 2.5-0.5 mm between the running yarn and lowermost disc is particularly effective for reducing processing fluff in the stretching and false twisting of the process of the invention.

[0044] The false twisting temperature according to the invention must be 170-300°C. A temperature of below 170°C will lower the crimp performance and produce a harder hand quality, while a temperature of above 300°C will yield a finished yarn that is too flat and will increase processing fluff. When using an apparatus equipped with a non-contact heater as the false twisting machine, the heat treatment is preferably carried out with the temperature of the first-stage non-contact heater set to 170-300°C. The optimum heater temperature in this case is for a commercially available false twisting machine (216 spinning position HTS-15V by Teijin, Ltd.), assuming a non-contact length of 1.0-1.5 m and a yarn speed of from about 800 m/min, and appropriate adjustments in the temperature must of course be implemented when using a special heater or conducting the process at ultrafast speeds.

[0045] The heat treatment time for the yarn at the first stage heater may be appropriately set according to the type of heater, its length and its temperature, but an excessively short heat treatment time will tend to result in an insufficient percentage crimp for the finished yarn, and may lead to breakage of the stretched and false twisted yarn due to variable tension, as well as finished yarn fluff and dyeing spots in woven or knitted fabrics. On the other hand, an excessively long heat treatment time will tend to increase the percentage crimp. For a non-contact heater, the appropriate range is preferably in the range of 0.04-0.12 second and especially 0.06-0.10 second.

[0046] The draw ratio for stretching and false twisting is optimally 1.4-2.4, as surging and uneven heat setting due to swaying of yarn occur in zones with a draw ratio lower than this range, and the finished yarn becomes flatter and processing fluff is generated in zones with a draw ratio higher than this range.

[0047] For the process of the invention, the number of false twists T (/m) in the simultaneous stretching and false twisting is in the range of $(15{,}000\text{-}35{,}000)/Y^{1/2}$ and preferably $(20{,}000\text{-}30{,}000)/Y^{1/2}$, according to the size Y (dtex) of the false twisted yarn. If the number of false twists is less than $15{,}000/Y^{1/2}$ (/m) it will become difficult to produce fine, rigid crimps and the resulting fabric will tend to have a hard paper-like feel, while a number of false twists in excess of 35,000/$Y^{1/2}$ (/m) will tend to increase the yarn breakage and fluff generation.

[0048] It is desirable in the process of the invention to first produce interlacing between the filaments using an air stream on the polyester unstretched filament that is supplied to the stretching and false twisting apparatus. The air interlacing treatment may be carried out separately from the stretching and false twisting, but preferably the air interlacing treatment is carried out just prior to stretching and false twisting using an interlace nozzle installed in the stretching and false twisting apparatus, as shown in Fig. 1. The degree of interlacing is 30-80/m and more preferably 50-70/m as the degree of interlacing measured for the polyester false twisted yarn. A degree of interlacing of less than 30/m is not preferred because it will result in poor mixing between the filaments of the polyester unstretched filament yarn, and yarn breakage and monofilament breakage during twisting/untwisting will increase due to problems with reeling out (pulling out from the yarn package) during the stretching and false twisting process. If the degree of interlacing is greater than 80/m, entanglement will be excessively increased between the filaments of the polyester false twisted yarn, resulting in blocking of the yarn.

[0049] Twisting and untwisting in the process of the invention are preferably carried out using a false twisting disc with a diameter of 40-70 mm and more preferably 45-62 mm. The false twisting disc used is a false twisting unit assembly having two discs situated on each of three axes, as shown in Fig. 2, for example. If the diameter of the false twisting disc is less than 40 mm, friction damage caused by the false twisting disc on the polyester composition yarn will increase drastically, and more yarn breakage and fluff will occur. If the diameter of the false twisting disc is greater than 70 mm, the false twisting disc will have lower twisting force, thus resulting in more frequent failure to achieve fine, rigid crimping. The twisting tension will also increase and lead to more generation of fluff. In addition, it will become much more difficult to carry out the operation of guiding of the running yarn onto the false twisting disc (threading).

[0050] The transit angle of the yarn passing through the false twisting disc (the angle formed between the disc rotation axis and the yarn running in contact with the outer periphery of the disc) is preferably 30-48 degrees and especially 32-45 degrees. This will increase the feeding action and permit more stable twisting and untwisting, without reduction in twisting force by the disc. As mentioned above, the contact length between the lowermost disc and the running yarn is 2.5-0.5 mm, as this is effective for notably reducing processing fluff.

[0051] Fibers composed of the polyester composition lack fibrillation resistance, and it is generally assumed that fibers with low fibrillation resistance unavoidably produce fluff during processing; however, the process of the invention employs a technique whereby the yarn that is produced has a fiber structure with fibrillation resistance, and it therefore permits rapid and stable false twisting and production of high quality false twisted yarn without section deformation or fluff generation during false twisting.

[0052] The antistatic false twisted yarn of the invention obtained in the manner described above can be used for weaving or knitting without twisting and without sizing, in order to obtain satisfactory fabrics. The weaving and knitting properties are also satisfactory, for smooth, yarn breakage-free operation. The process of the invention as described above can efficiently and stably produce polyester false twisted yarn with excellent antistatic properties and durability.

<Conjugated false twisted yarn properties>

[0053] As mentioned above, the antistatic special conjugated false twisted yarn of the invention is conjugated false twisted yarn with a conjugated structure wherein the outer periphery of a core yarn composed of an antistatic polyester filament is essentially covered by a sheath yarn.

[0054] The sheath yarn composing the conjugated false twisted yarn of the invention comprises a polymethyl methacrylate-based polymer and/or polystyrene-based polymer combined with an aromatic polyester, as mentioned above. The aromatic polyester is composed of ethylene terephthalate constituting at least 75 mol% and especially at least 85 mol% of the total repeating units, and its intrinsic viscosity (measured at 35°C using orthochlorophenol as the solvent) is preferably no greater than 0.7 and especially 0.55-0.70. The aromatic polyester may have the same composition as the aromatic polyester of the core yarn, or it may have a different composition.

[0055] Such polyesters may also contain known additives such as pigments, dyes, delustering agents, stain-proofing agents, fluorescent whitening agents, flame retardants, stabilizers, ultraviolet absorbers, lubricants and the like.

[0056] The polymethyl methacrylate-based polymer or polystyrene-based polymer added to the aromatic polyester of the sheath yarn may be an amorphous polymer with an atactic structure or syndiotactic structure, or it may be a crystalline polymer with an isotactic structure. It may also include a copolymerizing component in a range that does not interfere with the object of the invention.

[0057] If the molecular weight of the polymer is too low the effect of the invention described hereunder will tend to be reduced, and therefore the weight-average molecular weight is preferably at least 2000 and more preferably 5000-200,000. As specific examples that are particularly preferred there may be mentioned polymethyl methacrylate-based copolymers or isotactic polystyrene-based copolymers with a weight-average molecular weight of 8000-200,000 and a melt index A (measured according to ASTM-D1238, at a temperature of 230°C and a load of 3.8 kgf) of 10-30 g/

10 min, and syndiotactic polystyrene-based copolymers with a weight-average molecular weight of 8000-200,000 and a melt index B (measured according to ASTM-D1238 at a temperature of 300°C and a load of 2.16 kgf) of 6-50 g/10 min. Such polymers are preferred because of their excellent thermostability and dispersion stability when molten and mixed with polyesters for melt spinning.

[0058] Mixture of the polymethyl methacrylate-based polymer and/or polystyrene-based polymer with the polyester is believed to form fine protrusions on the surfaces of the fibers, and this can result in lower friction resistance between fibers to facilitate sliding between them, whereby woven or knitted fabrics with a softer and smoother surface hand quality can be realized, while still maintaining a dyeing luster of about the same level as without addition. The content of the polymer for obtaining such an effect must be 0.5-3.0 wt%, and preferably 1.0-2.0 wt% as the total based on the weight of the polyester. A content of less than 0.5 wt% is not preferred because friction between the fibers will not be sufficiently reduced and the hand quality of the obtained fabric will be too hard.

[0059] On the other hand, a content of greater than 3.0 wt% is also not preferred because not only will the effect of polymer addition be saturated, but the stability during spinning and stretching of the fibers will be reduced, and more yarn breakage will occur. While a polymethyl methacrylate-based polymer and polystyrene-based polymer may be used together, their total content must be within the aforementioned range.

[0060] According to the invention, the composite yarn surface feel is sometimes improved by the composition of the sheath yarn, but more importantly, since blending of a polymethyl methacrylate-based polymer or polystyrene-based polymer with the sheath yarn produces greater ductility than an unblended yarn at the same spinning speed, conjugated false twisting thereof causes the blended yarn to more easily align with the composite yarn sheath, while the other antistatic yarn that is conjugated therewith is more easily aligned with the core.

[0061] The polyester composition forming the sheath may also contain various known additives such as pigments, dyes, delustering agents, stain-proofing agents, fluorescent whitening agents, flame retardants, stabilizers, ultraviolet absorbers, lubricants and the like, within ranges that do not interfere with the object of the invention.

[0062] In the conjugated false twisted yarn of the invention, the core yarn group A and sheath yarn group B must have different yarn lengths, with yarn group B preferably being 10-20% and more preferably 12-18% longer than yarn group A. Yarn group A is primarily aligned with the conjugated false twisted yarn core, while yarn group B primarily forms a core-sheath structure aligned with the sheath. With this range of difference in yarn lengths, the antistatic core yarn is enveloped by the sheath yarn in a stable manner in the lengthwise direction of the yarn, which helps maintain a high antistatic property and results in satisfactory washing durability. The finer size of the sheath yarn produces a softer hand quality for the finished yarn and woven or knitted fabrics formed from it. In addition, the handleability during woven or knitted fabric production is improved, and a higher quality product is obtained.

[0063] According to the invention, the percentage crimp of the conjugated false twisted yarn composed of yarn group A and yarn group B must be in the range of 2-8% and especially 3-7%.

[0064] A percentage crimp within this range will yield woven or knitted fabrics with an excellent soft feel. A percentage crimp of less than 2.0% will increase the space between yarns in a woven or knitted fabric, undesirably promoting infiltration of an excess of dye during dyeing and tending to create dyeing spots. On the other hand, a percentage crimp of greater than 8.0% is also not preferred because it will whiten the color tone of the grain on the surface of woven or knitted fabrics, and create a more puffed-up feel.

[0065] The percentage crimp separately measured for each yarn pulled out from yarn group A and yarn group B of the conjugated false twisted yarn may be the same or different, but preferably yarn group B has a greater percentage crimp because the yarn B will be more readily oriented with the sheath of the conjugated false twisted yarn, so that the surface hand quality will be soft and smooth when the yarn is used to form a woven or knitted fabric.

[0066] The conjugated false twisted yarn of the invention also has an electrostatic friction pressure of no greater than 2000 V and preferably 500 V-1500 V. The electrostatic friction pressure is the value obtained by measuring the antistatic performance using the electrostatic propensity test method B of JIS-L1094 (frictional electrostatic voltage measurement method), after tube-knitting, dyeing and humidification of the conjugated false twisted yarn, and it may be evaluated that an antistatic effect is exhibited if the frictional electrostatic voltage is no greater than about 2000 V (preferably no greater than 1500 V).

[0067] The conjugated false twisted yarn of the invention facilitates adjustment of the woven or knitted fabric density to a suitable range, and therefore the total size is appropriately in the range of 100-300 dtex (decitex) and preferably 130-270 dtex. The total size is preferably not less than 100 dtex because the pull strength will tend to be weaker and it may become difficult to obtain a sufficiently compact textile. A total size of greater than 300 dtex is also not preferred because the basis weight of the woven or knitted fabric will tend to be too high for weaving or knitting. The total size ratio of yarn group A and yarn group B is preferably in the range of 40/60-60/40 and especially 45/55-55/45 (former/latter) in order to achieve greater fineness.

[0068] The denier of yarn group A and yarn group B may be the same or different, but the average denier must be in the range of 1.0-5.0 dtex and preferably 1.2-4.0 dtex. If the average denier is less than 1.0 dtex, mixing between yarn group A and yarn group B will be excessive, making it difficult for the desired woven or knitted fabric surface to be exhibited. On the other hand, an average denier of greater than 5.0 dtex is not preferred because the hand quality of the resulting woven or knitted fabric will be rough and hard, and the surface will have an uncomfortable feel. When the denier of the core yarn and sheath yarn B are different, the yarn group of the conjugated false twisted yarn that is more easily aligned with the core preferably has the larger denier. If it is too large, however, the hand quality will tend to become rough and hard, and the upper limit is therefore 5.5 dtex.

<Process for production of conjugated false twisted yarn>

[0069] The polyester conjugated false twisted yarn for a woven or knitted fabric according to the invention as explained above may be produced by the following process, for example. Specifically, the polyester yarns used for stretching and false twisting of a polyester multifilament are a polyester unstretched filament (A') comprising the aforementioned polyoxyalkylene glycol (a) and ionic antistatic agent (b) and a polyester unstretched filament (B') comprising a blend of a polymethyl methacrylate-based polymer and/or polystyrene-based polymer, and these are doubled and subjected to simultaneous stretching and false twisting under conditions satisfying all of the following (1)-(4).

(1) Air interlacing treatment is carried out immediately before false twisting to produce at least 30 tangles per meter.
(2) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(3) The false twisting temperature is 170°C-300°C.
(4) The number of false twists T (/m) is $15,000/Y^{1/2} \leq T \leq 35,000/Y^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

[0070] Here, the low ductility unstretched filament (A') as the core yarn and the high ductility unstretched filament (B') as the sheath yarn have a difference in ductility, and the unstretched filament B' is preferably 70-150% and especially 90-130% larger, so that yarn group B in the obtained conjugated false twisted yarn will be primarily aligned with the sheath and the woven or knitted fabric will have a softer and pliable hand quality.
[0071] If the difference in ductility is greater than 150%, a puffed-up hand quality will be produced and tension variation will tend to result in the stretching and false twisting steps, thus increasing the frequency of yarn breakage and interfering with the processing stability.
[0072] If the low ductility unstretched filament (A') and the high ductility unstretched filament (B') are to be doubled and subjected to stretching and false twisting after being separately spun and wound up, the polymers may be simultaneously discharged as a melt from different spinning nozzles and each yarn group cooled before doubling and winding up for supply to the stretching and false twisting step; in the latter case the melt spinning is preferably carried out at a spinning speed of 2500-4000 m/min and especially 3000-3500 m/min so that the polyester containing the polymethyl methacrylate-based polymer and/or polystyrene-based polymer at 0.5-3.0 wt% can be obtained easily and efficiently with a ductility of 70-150% and especially 90-130% greater than the unstretched filament obtained by melt spinning of the polyester at the same speed.
[0073] In most cases, a yarn containing an antistatic agent is readily fibrillated and tends to produce fluff in the false twisting, but according to the invention the antistatic yarn is aligned with the core and the core is enveloped by the sheath yarn so that deformation during the process is reduced and generation of fluff during the process is generally inhibited. Therefore, almost no fluff is generated even during the stretching and false twisting steps.
[0074] According to the process of the invention, the unstretched filament obtained by doubling and spinning/combining of the low ductility unstretched filament (A') and the high ductility unstretched filament (B') in the manner described above must be subjected to air interlacing treatment.
[0075] The air interlacing treatment may be carried out by a separate step from the stretching and false twisting, but preferably it is carried out just before the stretching and false twisting, using an interlace nozzle (4) installed in the stretching and false twisting apparatus as shown in Fig. 1. This will inhibit nepping caused by the difference in ductility, and produce a beneficial effect on handling.
[0076] Durable antistatic performance and a high quality feel can also be obtained by air interlacing of yarn that has been heat set with false twisting using a separate interlace nozzle (not shown), for complete uniformity of combined filament interlacing, to achieve an effect of uniformly enveloping the core with the sheath in the lengthwise direction of the yarn.
[0077] If the degree of air interlacing by the interlace nozzle is too low, the low ductility yarn group A and high ductility yarn group B will tend to separate during the stretching/false twisting step, resulting in a non-uniform woven or knitted fabric surface, and usually resulting in a difference in ductility between the unstretched filaments A' and B' that exceeds 30%; the degree of interlacing measured for the obtained conjugated false twisted yarn is therefore preferably at least 30/m and especially at least 40/m. On the other hand, if the degree of interlacing by the interlace nozzle is too high the

monofilaments will become too strongly entangled, resulting in a rough and hard hand quality for woven or knitted fabrics, and therefore it is preferably no greater than 80/m.

[0078] The interlaced unstretched filament is passed through a stretching/false twisting machine equipped with a two-stage heater as shown in Fig. 1, for example, to create a polyester false twisted yarn with crimping. In the example shown in Fig. 1, the unstretched filament (1) obtained by simultaneous spinning and doubling of the two different polyester compositions is subjected to air interlacing treatment by an interlace nozzle (4) situated between a pair of feed rollers (3,3'). The unstretched filament that has been imparted with the prescribed interlacing is then twisted by friction with the disc of the false twisting tool (7) while being stretched between the feed roller (3') and the first delivery roller (8). After then being heat treated at the first stage heater (5) (while twisted) and cooled at the cooling plate (6) it is passed through the false twisting tool (7) for untwisting. The running yarn is subjected to another heat treatment if necessary at a second stage heater (9) situated between the first delivery roller (8) and the second delivery roller (10), and after air interlacing of the heat set false twisted yarn, it is wound up as a cheese package (12) by a wind-up roller (11) to obtain the desired antistatic polyester conjugated false twisted yarn.

[0079] The first stage heater (5) and second stage heater (9) are preferably non-contact types, considering that the stretching and false twisting steps are performed at high speed. The second stage heater (9) will usually be in the SW-OFF state (the heater is not used), but it may be used if necessary to achieve the feel desired for the finished yarn.

[0080] In the process of the invention, it is essential for the false twisting tool (7) to be a three-axis friction disc type as shown in Fig. 2, with a ceramic material for the lowermost disc positioned at the untwisting section, a contact length between the running yarn and the disc of 2.5-0.5 mm, and a disc diameter that is 90-98% of the diameter of the disc immediately above it.

[0081] That is, the false twisting tool (7) shown in Fig. 2 is a three-axis friction disc type having two false twisting discs (13) mounted on each of three rotation axes (15), wherein each rotation axis (15) is rotated at a fixed speed by a timing belt (16) driven by a driving belt (17), thereby rotating each false twisting disc (13). Of the false twisting discs (13) used in the process of the invention, at least the lower most disc positioned at the untwisting section (the lower disc mounted on the rotation axis at the left of Fig. 2) is made of a ceramic material, and the diameter of that disc is 90-98% of the diameter of the disc immediately above it (the lower disc mounted at the center rotation axis in Fig. 2). The contact length between the ceramic disc and the running yarn is 2.5-0.5 mm.

[0082] The material of the lowermost disc is preferably ceramic from the viewpoint of wear resistance. Experimentation by the present inventors has shown that in conjugated false twisting according to the invention, setting the contact length between the running yarn and disc to 2.5-0.5 mm can minimize the contact area and reduce resistance when twisting has been completed and the crimped yarn enters the final untwisting section, thereby resulting in notably less fluff, while setting the diameter of the disc to 90-98% of the diameter of the disc directly above it is effective for reducing the resistance value and allowing smoother movement when the yarn is moved to the next step (i.e., heat setting). The contact length between the moving yarn and the disc is most preferably 2.5-0.5 mm, since this has been confirmed to be effective for notably reducing processing fluff.

[0083] Combining these conditions in the process of the invention can also significantly reduce generation of processing fluff. However, generation of processing fluff adversely affects the weaving properties, reeling properties and woven fabric quality of marketed products when the conditions are outside of the ranges mentioned above.

[0084] The false twisting temperature according to the invention must be 170-300°C. A temperature of below 170°C will lower the crimp performance and produce a harder hand quality, while a temperature of above 300°C will yield a finished yarn that is too flat and will increase processing fluff. When using an apparatus equipped with a non-contact heater as the false twisting machine, the heat treatment is preferably carried out with the temperature of the first-stage non-contact heater at 170-300°C. The optimum heater temperature in this case is for a commercially available false twisting machine (216 spinning position HTS-15V by Teijin, Ltd.), assuming a non-contact length of 1.0-1.5 m and a yarn speed of from about 800 m/min, and appropriate adjustment of the temperature must of course be implemented when using a special heater or conducting the process at ultrafast speeds.

[0085] The first heater in the twisting zone is used to improve the stretching property and false twisting property (twistability) of the unstretched filament, and if its temperature is below 170°C for a non-contact heater, the twistability is reduced and it becomes impossible to create the desired crimping according to the invention, while woven or knitted fabrics produced using the yarn tend to have a paper-like feel. Yarn breakage and fluff generation during stretching and false twisting are also increased, while non-uniform crimping and uneven dyeing tend to result. On the other hand, a temperature of higher than 300°C tends to cause monofilament breakage during stretching and false twisting, and especially monofilament breakage of the unstretched filament (B') at the high ductility end, such that the obtained polyester conjugated false twisted yarn exhibits a greater amount of fluff. The first stage heater may be divided into a first section and second section depending on the type of stretching and false twisting machine, and according to the invention the first and second sections of the first stage heater may be set to the same temperature.

[0086] The heat treatment time for the yarn at the first stage heater may be appropriately set according to the type of heater, its length and its temperature, but an excessively short heat treatment time will tend to result in an insufficient percentage crimp for the finished yarn, and may lead to breakage of the stretched and false twisted yarn due to variable tension, as well as false twisted yarn fluff and dyeing spots in woven or knitted fabrics, while a long heat treatment time will tend to increase the percentage crimp. For heat treatment with a non-contact heater, the appropriate range is normally in the range of 0.04-0.12 seconds and especially 0.06-0.10 seconds.

[0087] The optimum zone for the draw ratio for texturing is 1.4-1.7, and a draw ratio outside of this range is not preferred because it may result in surging, fluff generation and non-uniform heat setting as a result of yarn swaying at the low draw ratio end, or increased flatness of the finished yarn and generation of processing fluff at the high draw ratio end.

[0088] The number of false twists is set to a range of [(15,000-35,000)/$Y^{1/2}$]/m and preferably [(20,000-30,000)/$Y^{1/2}$]/m, where the size of the conjugated false twisted yarn is represented as Y (dtex). A number of false twists of less than 15,000/$Y^{1/2}$/m will make it difficult to produce fine, rigid crimping and will produce a paper-like fabric with a hard feel. A number of false twists of greater than 35,000/$Y^{1/2}$/m will tend to increase yarn breakage and fluff.

[0089] According to the invention, the polyester unstretched filament composed of the doubled or spun combined filament, which is to be fed to the stretching and false twisting apparatus, must first be subjected to air interlacing. The air interlacing may be carried out separately from the stretching and false twisting, but preferably the air interlacing treatment is carried out just prior to stretching and false twisting using an interlace nozzle installed in the stretching and false twisting apparatus, as shown in Fig. 1. The degree of interlacing is 30-80/m and more preferably 50-70/m, as the degree of interlacing measured for the polyester false twisted yarn. A degree of interlacing of less than 30/m is not preferred because it will result in poor mixing between the filaments of the polyester unstretched filament yarn, and yarn breakage and monofilament breakage during twisting/untwisting will increase due to problems with reeling out during the stretching and false twisting process. If the degree of interlacing is greater than 80/m, entanglement will be excessively increased between the monofilaments of the polyester false twisted yarn, thus hardening the filaments.

[0090] The disc dimensions of the false twisting tool are not particularly restricted, but a disc with a diameter of 40-70 mm is preferred, and a disc with a diameter of 45-62 mm is more preferred. For example, two discs may be arranged on each of three axes to assemble a false twisting unit, as shown in Fig. 2. A disc diameter of less than 40 mm will tend to result in yarn breakage and fluff generation as friction damage to yarn group A' by the disc increases. On the other hand, a disc diameter of greater than 70 mm may hamper adequate crimping due to reduced twisting force by the disc.

[0091] The transit angle of the yarn passing through the disc (the angle formed between the disc rotation axis and the yarn running in contact with the outer periphery of the disc) is preferably 30-48 degrees and especially 32-45 degrees. This will increase the feeding action and permit more stable twisting and untwisting, without reduction in twisting force by the disc.

[0092] In most cases, yarn containing an antistatic agent is readily fibrillated and tends to produce fluff during false twisting, but according to the invention the antistatic yarn is aligned with the core and the core is enveloped by the sheath yarn, so that deformation during the process is reduced and generation of fluff during the process is generally inhibited, while selection of the false twisting conditions as specified above can yield a highly satisfactory conjugated false twisted yarn which also has very low fluff generation.

[0093] The conjugated false twisted yarn of the invention obtained in this manner can be made into a woven fabric using a water jet room or the like without twisting and without sizing, and the weaving can be accomplished smoothly with satisfactory weavability and low yarn breakage. Fabrics composed of the polyester conjugated false twisted yarn of the invention also have satisfactory antistatic properties, and exhibit very high depth and high quality in organoleptic evaluation, as well as a spun-like hand quality that is soft and satisfactorily bulky.

EXAMPLES

[0094] The present invention will now be explained in greater detail using examples and comparative examples. The measured values indicated in the examples were measured by the following methods. The term "parts" refers to "parts by weight" unless otherwise specified.

(1) Intrinsic viscosity

[0095] The aromatic polyester composition was dissolved in ortho-chlorophenol and measured at 35°C using an Ubbellohde viscosity tube.

(2) Spinning yarn breakage

[0096] Melt spinning was carried out for one week with a melt spinning apparatus, and the number of yarn breaks was recorded for evaluation of the number of spinning yarn breaks per spindle per day. However, artificial or mechanical yarn breaks were excluded from the yarn breakage count.

(3) Birefringence

[0097] An optical microscope and compensator were used according to an ordinary method to determine the retardation of polarized light obtained on the surface of the fibers.

(4) Transit angle

[0098] The yarn running on the false twisting disc was photographed, the transit angle θ of the yarn on each false twisting disc was measured on the photograph and the average of the measured values was recorded as the transit angle.

(5) Stretching/false twisting yarn breakage

[0099] A 216 spinning position HTS-15V by Teijin, Ltd. (2 heater false twisting machine with non-contact heater specifications) was used for continuous stretching and false twisting for one week, and the number of yarn breaks per stretching/false twisting machine per day was recorded as the stretching/false twisting yarn breakage. However, yarn breakage for artificial or mechanical reasons, such as yarn breakage before or after knots (knotted yarn breaks) or yarn breakage during automatic switching, was excluded from the yarn breakage count.

(6) Percentage crimp

[0100] A polyester false twisted yarn sample was subjected to tension of 0.044 cN/dtex and wound up on a reel frame to prepare an approximately 3300 dtex reel. Two weights of 0.0177 cN/dtex and 0.177 cN/dtex were applied to one end of the reel, and the length S0 (cm) after 1 minute was measured. It was then treated with boiling water at 100°C for 20 minutes with the 0.177 cN/dtex weight removed. After the boiling water treatment, the 0.0177 cN/dtex weight was removed and the reel was allowed to naturally dry for 24 hours, after which the 0.0177 cN/dtex and 0.177 cN/dtex weights were again applied and the length S1 (cm) after 1 minute was measured. The 0.177 cN/dtex weight was then removed, the length after 1 minute was measured and recorded as S2 (cm), and the percentage crimp was calculated by the following formula. The mean values for ten measurements were calculated for the examples and comparative examples.

$$\text{Percentage crimp (\%)} = [(S1-S2)/S0] \times 100$$

<(7) Strength and ductility of false twisted yarn and conjugated false twisted yarn>

[0101] The breaking strength and breaking elongation were measured according to JIS L-1013-75.

(8) Fluff count

[0102] A DT-104 fluff counter by Toray Co., Ltd. was used for continuous measurement of the polyester false twisted yarn sample for 20 minutes at a speed of 500 m/min to count the fluff number, and this was expressed as the number per 10,000 m length of sample.

(9) Hand quality

[0103] This was ranked on the following scale by a sensory test conducted by professionals.

(Soft feel)

[0104]

Level 1: Soft and pliable to touch
Level 2: Some lack of softness but noticeably resilient
Level 3: Rough or hard touch

(Spun feel)

[0105]

Level 1: Very bulky and fully spun feel
Level 2: Some lack of spun feel
Level 3: Flat yarn-like or hard touch

(10) Electrostatic propensity test: Method A (half-life measurement)

[0106] The false twisted yarn was tube-knit, dyed and humidified, and then a test piece was electrified in a corona discharge field, after which the time (sec) until attenuation of the electrostatic voltage to 1/2 was measured with a Static Honestmeter. A shorter time (sec) is evaluated as superior antistatic performance. (11) Electrostatic propensity test: Method B

(Frictional electrostatic voltage measuring method)

[0107] A test piece was rubbed with an rubbing cloth while rotating and the generated electrostatic voltage was measured. The specific procedure was according to JIS L 1094, "Electrostatic propensity test method B" (frictional electrostatic voltage measuring method). A frictional electrostatic voltage of below 2000 V (preferably below 1500 V) is evaluated as an antistatic effect.

(12) Degree of interlacing

[0108] A 0.2 cN/dtex load was applied to the end of an approximately 1.2 m polyester false twisted yarn and suspended vertically from an anchoring point at the top of a screen and a fishhook with a weight corresponding to a 0.1 cN/dtex load was inserted from the top anchoring point and removed after natural dropping of the hook ceased. The hook was then reinserted at a position 2 mm below the stopping point, and the procedure was repeated. This was repeated for a yarn length of 1 m, and the number of times the hook stopped during that time was recorded as the degree of interlacing (/m).

(13) Melt viscosity (MVPM, MVPS, MVPEs)

[0109] The melt viscosity of the polymethyl methacrylate-based copolymer, polystyrene-based copolymer and polyester (MVPM, MVPS and MVPEs) was measured using a Shimadzu Flow Tester by Shimadzu Corp. having an orifice with a discharge aperture of 0.5φmmx and a hole length of 1 mm, and with a cylinder temperature of 295°C under a load of 20 KG. The extrusion pressure was detected and the viscosity equation-extrapolated value was recorded. The measured melt viscosity of the matrix polyester (MVPEs) was 1400 poise. The proportion of the measured melt viscosity of the polymethyl methacrylate polymer or polystyrene polymer with respect to the aforementioned value was calculated.

(14) Melt index

[0110] The melt index of the polymethyl methacrylate-based copolymer and polystyrene-based copolymer was measured according to ASTM D-1238.

(15) Ductility

[0111] An unstretched filament sample was allowed to stand for a day and a night in a room kept at constant temperature and constant humidity (25°C atmospheric temperature, 60% humidity), and then a 100 mm length sample was set in a TENSILON tensile tester by Shimadzu Corp. and pulled at a speed of 200 mm/min, at which time the load-elongation curve was recorded. A load-elongation curve for two groups of constituent yarns was determined from the recorded chart, the ductility at the time of each break was read off, and the difference was recorded as the difference in ductility between the unstretched filament group A' and the unstretched filament group B'.

[0112] For measurement of the difference in ductility between yarn group (A) and yarn group (B), the ductility at the time of each break was measured for each yarn group from the load-elongation curve obtained using the TENSILON tensile tester. The absolute value of the difference between the ductility of yarn group (A) (Ea%) and the ductility of yarn group (B) which contained the amorphous polymers polystyrene or polymethyl methacrylate (Eb%) was determined, and the difference in ductility was calculated as (Eb)-(Ea). Yarn group A and yarn group B, which are the yarns to be combined, are interlaced for the purpose of the invention, and therefore measurement of their ductility is preferably carried out separately for separate samples of the yarn groups A and B; however, since the breaking elongation for yarn groups A and B can be determined from the load-elongation curve obtained by measurement of the interlaced combined filament yarn, the elongation was measured directly for the combined filament yarn. The measured values for the ductility of the sample yarn after combining were found to be 10-20% lower than the measured values for the separately sampled yarn, but the difference in ductility was equivalent.

(16) Difference in yarn lengths of yarn group A and yarn group B

[0113] A 0.176 cN/dtex (0.2 g/de) load was applied to one end of a 50 cm conjugated false twisted yarn and vertically suspended, and markings were formed precisely at 5 cm spacings. The load was removed, and the marking sections were precisely cut to produce ten samples. Ten sheath filaments and ten core filaments were taken from the sample, a load of 0.03 cN/dtex(1/30 g/de) was applied to each monofilament and vertically suspended, and the length of each was measured. This measurement was carried out for the ten samples, with the mean values for each being defined as Lb (sheath length) and La (core length), and the difference in yarn length was calculated by the following formula. Difference in yarn length = (Lb-La)/Lb $\times$ 100%

Examples 1-3, Comparative Examples 1-5

[0114] After charging 100 parts of dimethyl terephthalate, 60 parts of ethylene glycol, 0.06 part of calcium acetate monohydrate (0.066 mol% with respect to dimethyl terephthalate) and 0.013 part of cobalt acetate tetrahydrate (0.01 mol% with respect to dimethyl terephthalate) into a transesterification can, the temperature of the reaction product was raised from 140°C to 220°C over a period of 4 hours under a nitrogen gas atmosphere, and transesterification was carried out while removing from the system the methanol produced in the reaction can. Upon completion of transesterification, 0.058 part of trimethyl phosphate (0.080 mol% with respect to dimethyl terephthalate) was added as a stabilizer and 0.024 part of dimethylpolysiloxane was added as an antifoaming agent to the reaction mixture.

[0115] After 10 minutes, 0.041 part of antimony trioxide (0.027 mol% with respect to dimethyl terephthalate) was added to the reaction mixture, the temperature was raised to 240°C while distilling off the excess ethylene glycol, and then the reaction mixture was transferred to the polymerization can. Next, the pressure was reduced from 760 mmHg to 1 mmHg and the temperature was raised from 240°C to 280°C over a period of 1 hour and 40 minutes for polycondensation reaction, and to the obtained reaction product there were added, in a vacuum, the water-insoluble polyoxyethylene-based polyether {anti-static agent (a)} represented by the chemical formula shown below and sodium dodecylbenzenesulfonate {anti-static agent (b)} in the amounts (parts by weight) as listed in Table 1, after which polycondensation reaction was conducted for another 240 minutes, 0.4 part of IRGANOX 1010™ by Ciba-Geigy, K.K. was then added as an antioxidant in a vacuum, and polycondensation reaction was continued for 30 minutes. The polymer obtained by adding the antistatic agents during the polymerization reaction in this manner was prepared into chips by an ordinary method. The intrinsic viscosity of the anti-static agent-containing aromatic polyester composition was 0.657 and the softening point was 258°C.

[0116] The chips obtained in this manner were dried by an ordinary method. Next, the dry chips were supplied to a melt spinning apparatus, melted by ordinary methods, passed through a spin block and introduced into a spin pack. They were then discharged from a spinning nozzle with 36 disc-shaped discharge holes that had been embedded in the spin pack, cooled to solidification with cooling air from an ordinary crossflow-type spinning chimney, bundled as a single yarn while applying a spinning lubricant and drawn out at the speed shown in Table 1, to obtain a polyester unstretched filament with 140 dtex/36 filaments. The birefringence of each unstretched filament was as listed in Table 1.

[0117] Each polyester unstretched filament was introduced into a 216 spinning position stretching and false twisting machine, HTS-15V by Teijin, Ltd., passed through an interlace nozzle with 1.8 mm pore size air pressure blow holes at both the first stage and last stage of the stretching/false twisting step while being air interlaced to a degree of interlacing of 50/m for the finished yarn at a flow rate of 60 nL/min, as shown in Fig. 1, and the conditions were set to a draw ratio of 1.60, using a first stage heater (non-contact type) temperature of 250°C for stretching and false twisting with a three-axis friction disc type false twisting tool at a transit angle of 43 degrees and a number of false twists $\times$ $Y^{1/2}$ = approximately 26,000 [where Y = total size of the false twisted yarn (dtex)], after which a cheese was wound up at a speed of 800 m/min to obtain a polyester false twisted yarn with 84 dtex/36 filaments (average monofilament size = 2.1 dtex). The physical properties of the obtained polyester false twisted yarn are shown in Table 1.

[0118] The false twisting tool used was a three-axis friction disc type as shown in Fig. 2, the lowermost disc positioned at the untwisting section was made of ceramic, the contact length between the disc and the running yarn was 1.5 mm, the disc diameter was 57 mm (95% of the diameter of the disc immediately above it), and the discs other than the lowermost ceramic disc positioned at the untwisting section were polyurethane false twisting discs with diameters of 60 mm and thicknesses of 9 mm.

[0119] The obtained false twisted yarn was then used to produce a knitted fabric, and the antistatic property thereof was measured. The antistatic performance of the knitted fabric is shown in Table 1.

[0120] A false twisted yarn of the invention obtained in the manner described above was also used for weaving with a water jet room without twisting and without sizing to obtain a plain weave fabric with a basis weight of 135 g/m^2. The weaving properties were satisfactory and weaving was accomplished smoothly without yarn breakage. After weaving, the plain weave fabric was subjected to 20 minutes of relaxation in boiling water using a jet dyeing machine, followed by preset treatment, and finally alkali reduction treatment at boiling temperature in a 3.5 wt% aqueous solution of sodium hydroxide (20% reduction). Dyeing and final setting were also carried out to obtain a fabric composed of a polyester false twisted yarn.

[0121] By an organoleptic evaluation it was judged that the obtained fabric had a spun-like hand quality with very satisfactory depth and high quality, and sufficient softness and bulk (Examples 1-3).

[0122] For comparison, a polyester false twisted yarn produced under conditions outside of the scope of the invention was made into a fabric in the same manner and evaluated (Comparative Examples 1-5).

[0123] The experimental results for Examples 1-3 and Comparative Examples 1-5 are summarized in Table 1. The specific compositions for anti-static agents (a) and (b) in Table 1 were as follows.

Anti-static agent (a) : Water-insoluble polyoxyethylene-based polyether

Anti-static agent (b): Sodium dodecylbenzenesulfonate (The numerical values in Table 1 represent parts by weight with respect to 100 parts by weight of the aromatic polyester).

Table 1

	Example 1	Example 2	Example 3	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
Antistatic agent (a)	4	4	4	4	0	0	4	4
Antistatic agent (b)	2	2	2	0	2	0	2	2
Antistatic agent(s) used	both (a), (b)	both (a), (b)	both (a), (b)	only (a)	only (b)	none	both (a), (b)	both (a), (b)
Birefringence	0.035	0.02	0.05	0.03	0.03	0.03	0.015	0.055
Spinning speed (m/min)	3000	2000	4500	2800	2800	2800	1500	5000
Stretch factor	1.8	2.4	1.4	2.0	2.0	2.0	2.5	1.3
Percentage crimp (%)	15	11	19	15	13	17	10	18
Electrostatic propensity test Method A (sec) Method B (V)	15 1000	30 1100	15 800	75 2800	105 1850	150 3200	70 2100	78 2000
Hand quality, soft feel (rank)	1	1	1	3	3	3	3	3
Spinning yarn breakage (/day)	3	5	7	8	98	6	235	125
Stretching/ false twisting yarn breakage (/day)	3	6	9	19	89	6	432	112
Fluff (/10^4 m)	3	5	7	48	285	15	321	548
Textured yarn strength (cN/dtex)	3.8	3.4	3.8	3.5	2.3	3.8	3.0	2.3

(continued)

	Example 1	Example 2	Example 3	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3	Comp. Ex. 4	Comp. Ex. 5
Textured yarn ductility (%)	26	21	24	25	16	28	14	15

Examples 4-6, Comparative Examples 6-7

[0124] The polyester unstretched filament obtained in Example 2 was subjected to stretching and false twisting under the conditions shown in Table 2, to obtain polyester false twisted yarns with the physical properties shown in Table 2. The stretching and false twisting yarn breakage and fluff generation are also shown in Table 2. The polyester false twisted yarns were evaluated for quality by the method described above, giving the results shown in Table 2.

Table 2

	Example 4	Example 5	Example 6	Comp. Ex. 6	Comp. Ex. 7
Lowermost disc contact length (mm)	1.5	2.5	0.5	2.7	0.3
Spinning yarn breakage (/day)	3	3	6	3	51
Stretching/false twisting yarn breakage (/day)	4	5	7	51	93
Textured yarn fluff (/10^4m)	3	5	8	48	151
Weaving property: Interruptions (/day)	2	2	3	28	63
Percentage crimp (%)	14	15	16	17	15
False twisted yarn strength (cN/dtex)	3.3	3.4	3.0	2.8	2.4
False twisted yarn ductility (%)	22	23	21	18	12
Hand quality/soft feel (rank	1	1	1	3	3
Antistatic property Method A (sec)	15	28	23	58	51
Antistatic property Method B (V)	1100	1090	1250	1800	1900
Note				Operation disrupted	Operation disrupted

Examples 7-9, Comparative Examples 8-10

[0125] The polyester unstretched filament obtained in Example 2 was subjected to stretching and false twisting under the conditions shown in Table 3, changing the contact length of the lowermost disc of the false twisting step and the ratio of that disc diameter to the diameter of the disc immediately above it (standard) (St ratio%), to obtain polyester false twisted yarns having the physical properties shown in Table 3. The stretching and false twisting yarn breakage and fluff generation are shown in Table 3. The polyester false twisted yarns were evaluated for quality by the method described above, giving the results shown in Table 3.

Table 3

	Disc contact length mm	Disc diameter St ratio%	Textured yarn St/EL%	Percentage crimp %	Processing fluff /10^4 m
Comp. Ex. 8	2.7	88	2.4/13	14	86

(continued)

	Disc contact length mm	Disc diameter St ratio%	Textured yarn St/EL%	Percentage crimp %	Processing fluff /10^4 m
Comp. Ex. 9	6.0	100	2.3/11	14	351
Comp. Ex. 10	0.3	88	2.6/14	15	69
Example 7	1.0	95	3.4/24	16	3
Example 8	2.0	91	3.5/23	16	5
Example 9	0.5	98	3.3/21	16	5
[Note] The "St ratio" in Table 3 is the ratio (%) of the diameter of the lowermost disc to the diameter of the disc immediately above it (standard). The "St/EL%" for each finished yarn is for St as the breaking strength (cN/dtex) and EL as the breaking elongation (%).					

Examples 10-13, Comparative Examples 11-14

[0126] The polyester unstretched filament obtained in Example 2 was subjected to stretching and false twisting under the same conditions as in Example 2, except for using the conditions for number of false twists $\times$ $Y^{1/2}$ {where Y is the false twisted yarn size (dtex)} and the false twisting temperatures shown in Table 4, to obtain the polyester false twisted yarns shown in Table 4. The stretching and false twisting yarn breakage and fluff generation are shown in Table 4. The polyester false twisted yarns were evaluated for quality by the method described above, giving the results shown in Table 4.

Table 4

	Number of twists /m	False twisting temperature °C	Percentage crimp %	Knitted fabric hand quality, soft feel	Processing fluff /10^4 m	Antistatic property Method A (sec)
Example 10	26,000	180	13	1	3	25
Example 11	"	200	15	1	4	30
Example 12	"	250	16	1	6	18
Example 13	"	300	18	1	8	21
Comp. Ex. 11	"	310	20	3 (P)	148	60
Comp. Ex. 12	"	160	8	3	106	63
Comp. Ex. 13	36,000	200	15	3	173	60
Comp. Ex. 14	14,000	200	12	3	131	67
[Note] P: Hard hand quality (rough feel)						

Examples 14-16, Comparative Examples 15-17

[0127] A dry polymer containing the water-insoluble polyoxyethylene-based polyether {anti-static agent (a)} and sodium dodecylbenzenesulfonate {anti-static agent (b)} obtained by the process described in Example 1 was designated as dry polymer A1.

[0128] Separately, a polystyrene-based polymer (PS: melt index (measured at a temperature of 300°C and a load of 2.16 kgf) of 10 g/10 min according ASTM-D1238) or polymethyl methacrylate-based polymer (PMMA: melt index (measured at a temperature of 230°C and a load of 3.8 kgf) of 14.0 according to ASTM-D1238) was added to polyethylene terephthalate (PET) with an intrinsic viscosity of 0.64 and a softening point of 258°C, in the amount listed in Table 5 to prepare polyethylene terephthalate pellets, which were then dried by an ordinary method. (This was designated as dry polymer B1).

[0129] The dry polymer A1 and dry polymer B1 were melted by an ordinary method using a conjugated spinning apparatus equipped with a twin-screw extruder, passed through a spin block and introduced into a conjugated spinning pack. Polymer A1 was discharged from a spinning nozzle with 36 disc-shaped discharge holes that had been embedded in the spin pack, while polymer B1 was discharged from a spinning nozzle with 48 disc-shaped discharge holes. Next, the two discharged polymer streams were cooled to solidity with cooling air from an ordinary crossflow-type spinning chimney, bundled as a single yarn while applying a spinning lubricant, and taken up at a speed of 3200 m/min to obtain a polyester unstretched filament with 280 dtex/84 filaments (Examples 14-16).

[0130] For comparison, the same experiment was conducted with conditions outside of the scope of the invention (Comparative Examples 15-17). As clearly seen from Table 5, in Comparative Example 15 which had a polystyrene (PS) addition of less than 0.5 wt%, the difference in ductility between the two unstretched filament yarn groups was less than 70%, and the difference in yarn lengths of yarn group A and yarn group B in the obtained false twisted yarn was less than 10%.

[0131] The processing stability during melt spinning was as shown in Table 5, and frequent yarn breakage occurred during the spinning step in Comparative Example 2 where the polystyrene addition exceeded 3.0 wt%.

[0132] Each of the obtained polyester unstretched filaments was introduced into a 216 spinning position stretching and false twisting machine (HTS-15V by Teijin, Ltd.) and passed through an interlace nozzle with 1.8 mm pore size air pressure blow holes at both the first stage and last stage while being air interlaced to a degree of interlacing of 50/m for the finished yarn at a flow rate of 60 nL/min, as shown in Fig. 1, and the conditions were set to a draw ratio of 1.60 using a first stage heater (non-contact type) temperature of 250°C for simultaneous stretching and false twisting using as the false twisting disc a polyurethane disc with a diameter of 60 mm and a thickness of 9 mm, at a transit angle of 43 degrees and a number of false twists $\times$ $Y^{1/2}$ = near 26,000 [where Y = size of conjugated false twisted yarn (dtex)], after which a cheese was wound up at a speed of 800 m/min to obtain a polyester conjugated false twisted yarn with 180 dtex/84 filaments (average monofilament size = 2.1 dtex). The core of the polyester conjugated false twisted yarn was a low ductility yarn group A (90 dtex/36 filaments) composed of polymer A1, while the sheath was a high ductility yarn group B (90 dtex/48 filaments) composed of polymer B1.

[0133] The polyester conjugated false twisted yarns were woven by the method described hereunder and the quality thereof was evaluated. The results are shown in Table 5. As clearly seen from Table 5, the woven fabric of Comparative Example 15 with polystyrene addition of less than 0.5 wt% had a hard hand quality. In Comparative Example 2 which had polystyrene addition of greater than 3.0 wt%, the stretching/false twisting yarn breakage and fluff generation were considerable. The obtained conjugated false twisted yarn was also used to produce a knitted fabric, and the antistatic property thereof was measured. The results of antistatic performance evaluation are shown in Table 5.

[0134] The conjugated false twisted yarn was subjected to relaxation treatment for 20 minutes in boiling water using a jet dyeing machine, followed by preset treatment and then dyeing and final setting to obtain a fabric composed of the polyester conjugated false twisted yarn.

[0135] A plain weave fabric obtained in a water jet room without twisting and without sizing in the weaving step for the conjugated false twisted yarn of the invention had satisfactory weaving properties and allowed smooth weaving with no yarn breakage.

[0136] After weaving, the woven fabric was subjected to 20 minutes of relaxation in boiling water using a jet dyeing machine, followed by preset treatment, and finally alkali reduction treatment at boiling temperature in a 3.5 wt% aqueous solution of sodium hydroxide (20% reduction). This was followed by dyeing and final setting to obtain a fabric composed of the polyester conjugated false twisted yarn.

[0137] Based on organoleptic evaluation of fabrics obtained according to the invention (Examples 14-16), they were judged to have a spun-like hand quality with very satisfactory depth and high quality, and sufficient softness and bulk.

Table 5

	Example 14	Example 15	Example 16	Comp. Ex. 15	Comp. Ex. 16	Comp. Ex. 17
Additive to polymer B	PS*1	PS*1	PMMA*2	PS*1	PS*1	PS*1
PS*1/PMMA*2 Amount added (wt%)	0.5	1.5	3.0	0.3	3.5	1.5
Type of antistatic agent in polymer A*3	(a) and (b)	(a) and (b)	(a) and (b)	(a) and (b)	(a) and (b)	only (a)
Difference in ductility (A', B') (%)	70	110	150	50	180	105
Average yarn length difference (yarn group A, yarn group B) (%)	10	13	20	8	23	12

(continued)

	Example 14	Example 15	Example 16	Comp. Ex. 15	Comp. Ex. 16	Comp. Ex. 17
Percentage crimp (%)	7.1	5.5	3.1	4.7	4.9	5.1
Antistatic property test Method A (sec)	25	25	35	60	105	150
(Same) Method B (V)	1500	1100	1000	1900	1880	3200
Spun feel (rank)	1	1	1	3	3	1
Soft feel (rank)	1	1	1	3	3	2
Spinning yarn breakage (/day)	1	3	5	4	70	2
Stretching/false twisting yarn breakage (/day)	5	7	9	10	98	4
Textured yarn fluff (/ 10^4 m)	2	1	5	15	258	7
Textured yarn strength (cN/dtex)	2.3	2.4	1.9	2.5	1.2	2.4
Textured yarn ductility (%)	23	22	19	24	13	21
*1. PS: Polystyrene-based polymer *2. PMMA: Polymethyl methacrylate-based polymer *3. Antistatic agent: (a) Water-insoluble polyoxyethylene-based polyether (b) Sodium dodecylbenzenesulfonate						

Examples 17-19, Comparative Examples 18-19

[0138] The polyester unstretched filament obtained in Example 15 was subjected to stretching and false twisting under the false twisting conditions shown in Table 6, to obtain polyester conjugated false twisted yarns having the physical properties also shown in Table 6. The stretching/false twisting yarn breakage and fluff generation are also shown in Table 6. The polyester conjugated false twisted yarns were evaluated for quality by the method described above, giving the results shown in Table 6. Here, for purposes of the antistatic property it was found essential to prevent fluff by enveloping the core yarn (antistatic component) and thereby reducing deformation.

Table 6

	Example 17	Example 18	Example 19	Comp. Ex. 18	Comp. Ex. 19
Lowermost disc contact length (mm)	1.5	2.5	0.5	2.7	0.3
Spun yarn breaks (/day)	3	3	6	3	51
False twisting yarn breaks (/day)	4	5	7	51	93
Textured yarn fluff (/10^4 m)	3	5	8	48	151
Weaving property: Interruptions/day	2	2	3	28	63
Percentage crimp	4.0	5.1	6.3	7.6	5.1

(continued)

	Example 17	Example 18	Example 19	Comp. Ex. 18	Comp. Ex. 19
False twisted yarn strength (cN/dtex)	2.3	2.4	2.0	1.8	1.4
False twisted yarn ductility %	22	23	21	18	12
Hand quality Soft feel (rank)	1	1	1	3	3
Hand quality Spun feel (rank)	1	1	1	3	3
Antistatic property Method A (sec)	25	38	33	58	51
Antistatic property Method B (v)	1100	1090	1250	1800	1900
Note	No problems	No problems	No problems	Operation disrupted	Operation disrupted

Examples 20-22, Comparative Examples 20-22

[0139] In Example 14, the same experiment was conducted except for changing the yarn contact length with the lowermost disc and the ratio of the disc diameter to the diameter of the disc immediately above it (standard) (St ratio%). The results are shown in Table 7.

Table 7

	Disc contact length mm	Disc diameter St ratio%	False twisted yarn St/EL%	Percent -age crimp %	Processing fluff (/ 10^4 m)
Comp. Ex. 20	2.7	88	1.4/13	4	86
Comp. Ex. 21	6.0	100	1.3/11	4	351
Comp. Ex. 22	0.3	88	1.6/14	5	69
Example 20	1.0	95	2.4/24	6	3
Example 21	2.0	91	2.5/23	6	5
Example 22	0.5	98	2.3/21	6	5
[Note] The "St ratio" in Table 3 is the ratio (%) of the diameter of the lowermost disc to the diameter of the disc immediately above it (standard). The "St/EL%" is for St as the breaking strength (cN/dtex) and EL as the breaking elongation (%).					

Examples 23-26, Comparative Examples 23-26

[0140] The polyester unstretched filament obtained in Example 15 was subjected to stretching and false twisting under the same stretching and false twisting conditions as in Example 2, except for using the numbers of false twists and false twisting temperatures shown in Table 8, to obtain the polyester conjugated false twisted yarns in Table 8. The stretching and false twisting yarn breakage and fluff generation are shown in Table 8. The polyester conjugated false twisted yarns were evaluated for quality by the method described above, giving the results shown in Table 8. The "number of false twists" shown in Table 8 is the value of the number of twists $\times$ $(Y)^{1/2}$, and the total size (Y) of the conjugated false twisted yarn was 180 dtex for all yarns. It was confirmed in this experiment as well that enveloping the core yarn (antistatic component) and reducing deformation to prevent fluff are essential for the antistatic property.

Table 8

	Number of false twists (/m)	False twisting temperature (°C)	Percentage crimp (%)	Knitted fabric hand quality Soft feel (rank)	Knitted fabric hand quality Spun feel (rank)	Processing fluff (/10^4 m)	Antistatic property Method A (sec)	Antistatic property Method B (V)
Example 23	26,000	180	3	1 (G)	1 (G)	3	35	1500
Example 24	"	200	5	1 (G)	1 (G)	4	40	1450
Example 25	"	250	6	1 (G)	1 (G)	6	28	1500
Example 26	"	300	8	1 (G)	1 (G)	8	31	1350
Comp. Ex. 23	"	310	10	3(H)	3 (P)	148	60	1800
Comp. Ex. 24	"	160	1	3 (P)	3 (P)B	106	63	1900
Comp. Ex. 25	36,000	200	5	3 (P)	3 (P)	173	60	1800
Comp. Ex. 26	14,000	200	2	3 (P)	3 (P)B	131	67	1900
[Note] G: G good, H: Hard hand quality (rough feel), P: Poor, B: Insufficient bulk								

Industrial Applicability

[0141] The polyester false twisted yarn of the invention exhibits excellent antistatic properties because it contains an antistatic agent as described above. Specifically, according to the invention it is possible to accomplish rapid and stable false twisting without section deformation of filaments or fluff generation during false twisting, so that migration of the antistatic agent is reduced and an unexpected level of antistatic property is exhibited.

[0142] This effect is exhibited particularly with high-pressure dyeing, for improved powerful heat resistance and practicality. In addition, the satisfactory light fastness and durability exhibited are advantageous for student wear and uniforms. In other words, because the effect of the false twisted yarn of the invention is notably exhibited in high-pressure dyeing employed as post-processing, and the heat resistance is powerful and practical, an advantage of strong light fastness is provided when the yarn is used for student wear, uniforms and the like.

[0143] As a result, the polyester false twisted yarn can be used to produce spun-like polyester fabrics with excellent antistatic properties that are particularly suitable for purposes that require inhibiting static electricity, such as student wear, uniforms, dustproof clothing and the like, due to the highly satisfactory bulk and spun feel that are exhibited, as well as the excellent handleability in post-processing. Furthermore, the production process of the invention allows such antistatic false twisted yarn to be manufactured in a highly productive and stable manner.

[0144] The polyester conjugated false twisted yarn of the invention comprises the two different antistatic agents (a) and (b) mentioned above with the core yarn (A), and therefore exhibits superior antistatic properties. That is, the core-sheath structure including the core yarn (A) in the conjugated false twisted yarn is formed in a stable fashion in the lengthwise direction of the yarn, and therefore an unexpected level of antistatic property is exhibited by the finished yarn. This effect is most notably exhibited with woven fabrics that are not affected by twisting.

[0145] Furthermore, since the core yarn (A) (hereinafter referred to simply as "core yarn") that exhibits an antistatic property is enveloped by the sheath yarn (B) (hereinafter referred to simply as "sheath yarn"), the antistatic component is enveloped during false twisting and deformation is reduced, thereby preventing fluff generation during texturing so that satisfactory antistatic properties can be maintained, fluff generation during false twisting can be reduced, productivity can be improved and woven fabrics prepared from the yarn can exhibit excellent washing durability. As a result, the present invention can provide spun-like polyester fabrics with highly satisfactory bulk and spun feel and excellent antistatic properties, that are particularly suitable for purposes that require high inhibition of static electricity, such as student wear, uniforms, dustproof clothing and the like, as well as polyester conjugated false twisted yarn with excellent handleability in post-processing steps.

Claims

1. An antistatic polyester false twisted yarn which is an antistatic polyester multifilament false twisted yarn made from an aromatic polyester composition comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with aromatic polyesters, wherein at least 75 mol% of the repeating units are ethylene terephthalate units, the false twisted yarn being **characterized in that** the electrostatic voltage half-life is no longer than 60 seconds and the percentage crimp is 10-20%.

2. An antistatic polyester false twisted yarn according to claim 1, which comprises 0.2-30 parts by weight of the (a) polyoxyalkylene-based polyether and 0.05-10 parts by weight of the (b) organic ionic compound which is substantially non-reactive with aromatic polyesters, with respect to 100 parts by weight of the aromatic polyester.

3. An antistatic polyester false twisted yarn according to claim 1 or 2, wherein the total size is 50-200 dtex.

4. A process for production of an antistatic polyester false twisted yarn, **characterized by** simultaneous stretching and false twisting of an unstretched filament with a birefringence of 0.02-0.05, obtained by melt spinning of an aromatic polyester composition comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with aromatic polyesters, wherein at least 75 mol% of the repeating units are ethylene terephthalate units, under conditions satisfying all of the following (a) to (d).

(a) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(b) The false twisting temperature is 170°C-300°C.
(c) The draw ratio during false twisting is 1.4-2.4.
(d) The number of false twists T (/m) is $15{,}000/Y^{1/2} \le T \le 35{,}000/Y^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

5. A production process according to claim 4 for an antistatic polyester false twisted yarn which comprises 0.2-30 parts by weight of the (a) polyoxyalkylene-based polyether and 0.05-10 parts by weight of the (b) organic ionic compound which is substantially non-reactive with aromatic polyesters, with respect to 100 parts by weight of the aromatic polyester.

6. A process for production of an antistatic polyester false twisted yarn according to claim 4 or 5, **characterized by** carrying out interlacing treatment with air pressure applied to the unstretched filament that is to be simultaneously stretched and false twisted.

7. An antistatic special conjugated false twisted yarn wherein the core yarn (A) is an antistatic polyester multifilament composed of an aromatic polyester composition having ethylene terephthalate units for at least 75 mol% of the repeating units and comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with polyesters, and the sheath yarn (B) is a polyester multifilament composed of an aromatic polyester composition comprising 0.5-3.0 wt% of a polymethyl methacrylate-based polymer and/or polystyrene-based polymer, the special conjugated false twisted yarn being **characterized in that** the electrostatic friction pressure of the finished yarn is no greater than 2000 V, the percentage crimp is 2-8% and the average filament length of the sheath yarn (B) is 10-20% longer than the average filament length of the core yarn (A).

8. An antistatic special conjugated false twisted yarn according to claim 7, wherein the core yarn (A) is composed of an aromatic polyester composition comprising 0.2-30 parts by weight of the (a) polyoxyalkylene-based polyether and 0.05-10 parts by weight of the (b) organic ionic compound which is substantially non-reactive with aromatic polyesters, with respect to 100 parts by weight of the aromatic polyester.

9. A process for production of an antistatic special conjugated false twisted yarn, **characterized in that** the texturing filament to be used for polyester multifilament stretching and false twisting is obtained by doubling an unstretched antistatic polyester multifilament (A') comprising (a) a polyoxyalkylene-based polyether and (b) an organic ionic compound that is substantially non-reactive with polyesters and an unstretched polyester multifilament (B') comprising 0.5-3.0 wt% of a polymethyl methacrylate-based polymer and/or polystyrene-based polymer based on the weight of the polyester multifilament, and simultaneous stretching and false twisting are carried out under conditions satisfying all of the following (1)-(4).

(1) Air interlacing treatment is carried out immediately before false twisting to produce at least 30 tangles per meter.
(2) The false twisting tool used is a three-axis friction disc type wherein the material of the lowermost disc positioned at the untwisting section is ceramic, the contact length between that disc and the running yarn is 2.5-0.5 mm, and the diameter of the disc is 90-98% of the diameter of the disc immediately above it.
(3) The false twisting temperature is 170°C-300°C.
(4) The number of false twists T (/m) is $15,000/Y^{1/2} \leq T \leq 35,000/Y^{1/2}$, with respect to the size (Y dtex) of the false twisted yarn.

10. A process for production of an antistatic special conjugated false twisted yarn according to claim 9, wherein the unstretched antistatic polyester multifilament (A') is composed of an aromatic polyester composition comprising 0.2-30 parts by weight of the

(a) polyoxyalkylene-based polyether and 0.05-10 parts by weight of the (b) organic ionic compound which is substantially non-reactive with aromatic polyesters, with respect to 100 parts by weight of the aromatic polyester.

FIG. 1

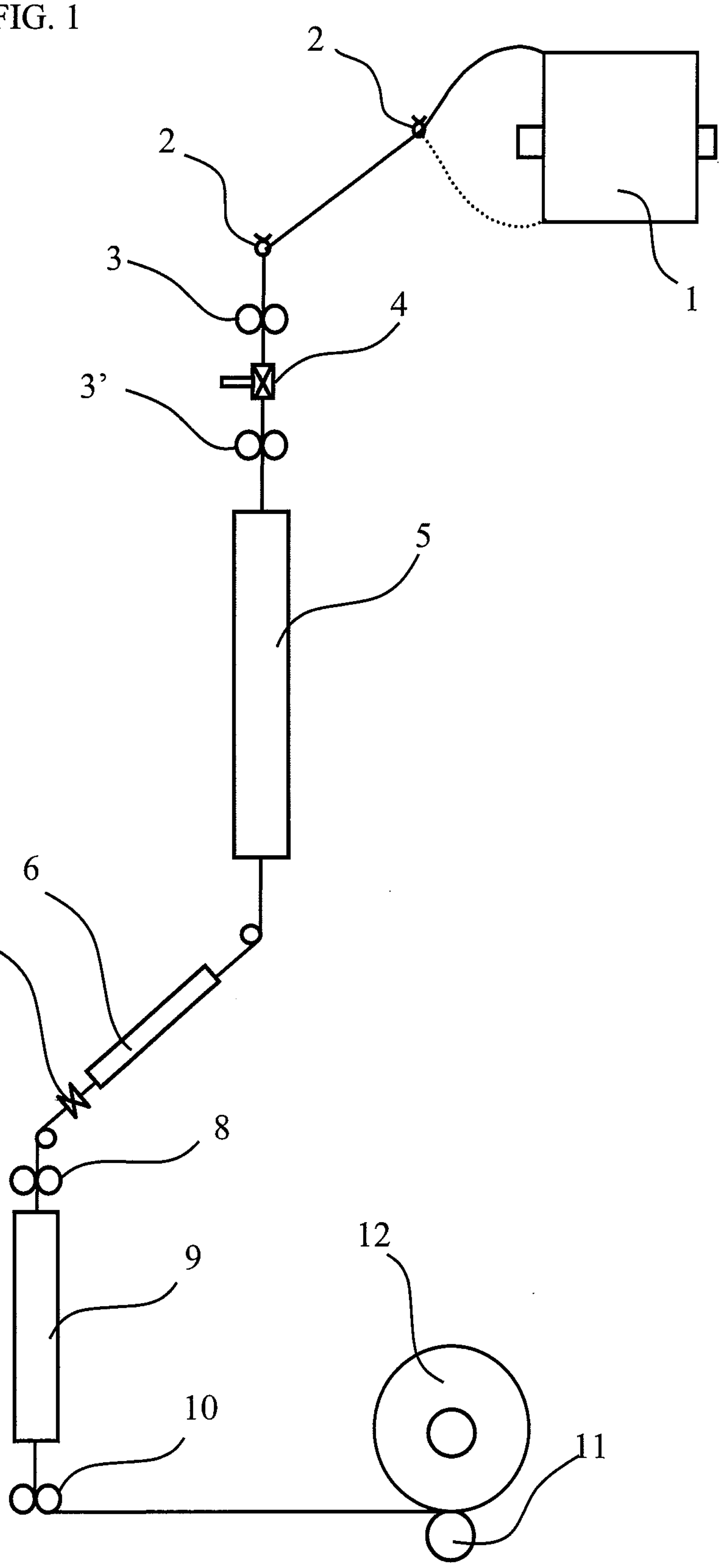
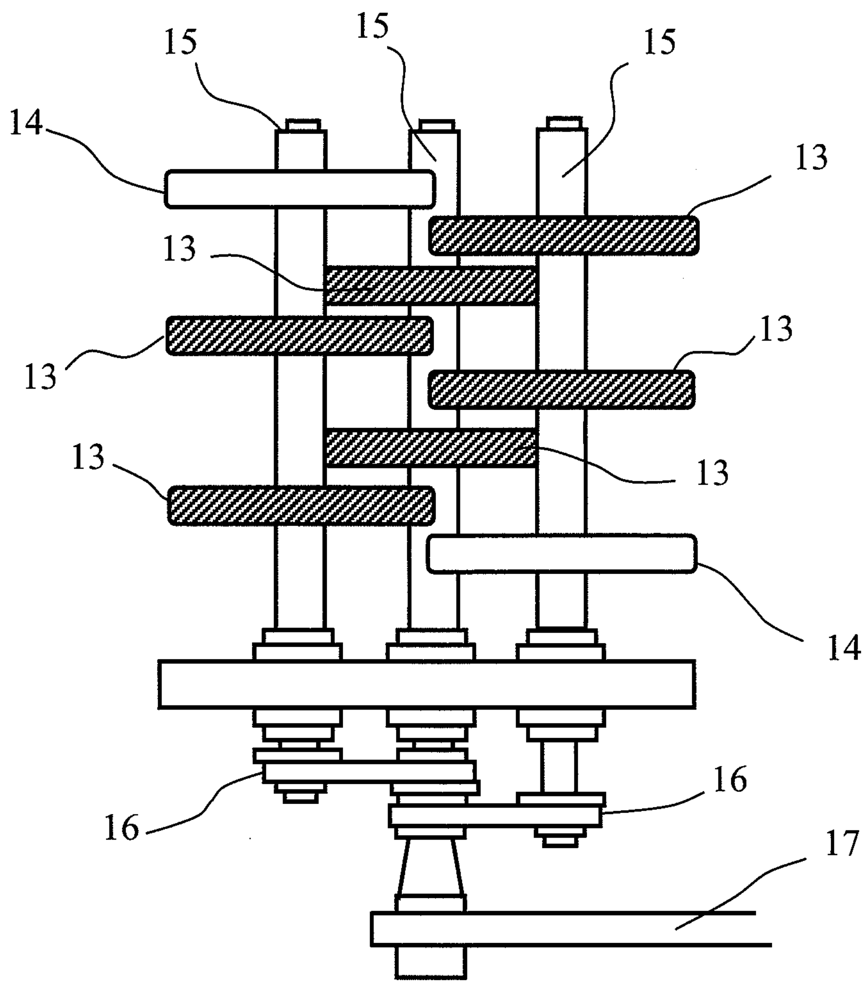


FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/064128

A. CLASSIFICATION OF SUBJECT MATTER
D02G1/02(2006.01)i, *D01F6/92*(2006.01)i, *D02G1/08*(2006.01)i, *D02G3/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
D02G1/00-3/48, D02J1/00-13/00, D01F6/00-6/96

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2007
Kokai Jitsuyo Shinan Koho	1971-2007	Toroku Jitsuyo Shinan Koho	1994-2007

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2002-180342 A (Nippon Ester Kabushiki Kaisha), 26 June, 2002 (26.06.02), Full text (Family: none)	1-10
A	JP 2005-054325 A (Teijin Fibers Ltd.), 03 March, 2005 (03.03.05), Full text (Family: none)	1-10
A	JP 9-279427 A (Teijin Ltd.), 28 October, 1997 (28.10.97), Full text (Family: none)	1-10

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

* Special categories of cited documents:
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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
16 October, 2007 (16.10.07)	23 October, 2007 (23.10.07)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/064128

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	JP 2007-239146 A (Teijin Fibers Ltd.), 20 September, 2007 (20.09.07), Full text (Family: none)	1-10

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- JP 61019733 A **[0004]**