



(11)

EP 3 719 183 A1

(12)

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

(43) Date of publication:

07.10.2020 Bulletin 2020/41

(51) Int Cl.:

D01F 8/14 ^(2006.01)

D02G 3/22 ^(2006.01)

(21) Application number: **18884607.5**

(86) International application number:

PCT/JP2018/041591

(22) Date of filing: **09.11.2018**

(87) International publication number:

WO 2019/107111 (06.06.2019 Gazette 2019/23)

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

KH MA MD TN

(72) Inventors:

- **ONO, Yusuke**
Mishima-shi
Shizuoka 411-8652 (JP)
- **SUZUKI, Ryota**
Mishima-shi
Shizuoka 411-8652 (JP)
- **FUJIMORI, Minoru**
Nomi-shi
Ishikawa 923-1294 (JP)

(30) Priority: **28.11.2017 JP 2017227923**

(71) Applicant: **Toray Industries, Inc.**
Tokyo 103-8666 (JP)

(74) Representative: **Kador & Partner PartG mbB**
Corneliusstraße 15
80469 München (DE)

(54) **HIGH-STRENGTH FINE-DENIER POLYESTER MULTIFILAMENT**

(57) In this polyester multifilament, a core-component high-viscosity polyester and sheath-component low-viscosity polyester have been composited into a core-in-sheath, wherein the difference in intrinsic viscosity between the core component and the sheath component is 0.20 to 1.00, the total fineness is 4 to 30 dtex, the single-yarn fineness is 1.0 to 5.0 dtex; the breaking strength is 5.0 to 9.0 cN/dtex, the fracture elongation is

12 to 45%, the degree of interlacement is 2.0 to 15.0/m, and the number of filaments thereof is 3 to 15. This fine-denier polyester multifilament has high strength and excellent wear resistance and convergence, and makes it possible to obtain a high-density thin woven fabric suitable for use with athletic and outdoor clothing by combining excellent durability, weaving properties, and fabric grade.

EP 3 719 183 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a high-strength fine-denier multifilament that is excellent in weaving properties and wear resistance and that can be used in particular in a high-density thin woven fabric suitable for use with athletic and outdoor clothing.

BACKGROUND ART

[0002] Until now, many high-density woven fabrics made of synthetic fiber multifilaments such as those of polyesters and nylons have been proposed mainly for uses such as athletic clothing and airbags. Along with the sophistication of uses, there has been a demand for lighter woven fabrics, that is, thinner woven fabrics, and accordingly higher-strength woven fabrics. In particular, in athletic and outdoor clothing, there is an increasing demand for improved durability against active movements, and woven fabrics have been desired to have improved wear resistance.

[0003] In Patent Document 1, a single-component polyester multifilament woven fabric is proposed. The single-component polyester multifilament woven fabric has high strength because it contains polyethylene terephthalate having an intrinsic viscosity of 0.70 to 1.20, and has improved weaving properties because it contains 0.3 to 0.8 wt% of titanium oxide containing 60% or more of particles having a primary particle diameter of 0.1 to 0.6 μm based on the total number of titanium oxide particles.

[0004] In addition, for thinning a woven fabric, it is required to reduce the total fineness of the yarn, and the number of constituent filaments of the yarn is inevitably reduced. Therefore, the filaments are interlaced with difficulty, and the polyester multifilament has poor convergence. The poor convergence deteriorates the process passability in the production process, and makes handling during warping and weaving difficult. In addition, because of insufficient convergence, filament breakage (separation into single yarns) may occur, the working of the warp during the weaving may be deteriorated, and the warp breakage may easily occur. The warp breakage not only merely stops the loom but also requires a large amount of labor to reconnect and restore the warp, and may inconveniently reduce the productivity greatly. Also in respect of the woven fabric quality, filament breakage may cause streak-like defects. In Patent Document 2, in order to provide a polyamide multifilament excellent in convergence, it is proposed to reduce the single-yarn fineness to 0.8 dtex or less to facilitate interlacing in spite of a small total fineness of 6 to 18 dtex, thereby making the degree of interlacement 25 or more.

[0005] In Patent Document 3, a polyester monofilament for screen gauze is proposed. The polyester monofilament is a core-in-sheath composite yarn, a polyester used in the core component has a limiting viscosity of 0.70 or more so that the monofilament may have high strength, and a polyester used in the sheath component has a limiting viscosity lower by 0.15 to 0.30 than that of the polyester used in the core component to suppress the scum (improve the wear resistance).

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0006]

Patent Document 1: Japanese Patent Laid-open Publication No. 2009-074213 (paragraph numbers [0008] to [0009])

Patent Document 2: Japanese Patent Laid-open Publication No. 2009-013511 (paragraph numbers [0008] to [0009])

Patent Document 3: Japanese Patent Laid-open Publication No. 2003-213528 (paragraph numbers [0013] to [0014])

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0007] The single-component polyester disclosed in Patent Document 1, however, has a problem in wear resistance, and hardly meets the demand for durability in sophisticated uses.

[0008] In Patent Document 2, the weaving properties are indeed greatly improved by increasing the degree of interlacement to improve the convergence. The small single-yarn fineness, however, may cause problems such as breakage of warp and weft during the weaving as well as generation of fluff.

[0009] As for Patent Document 3, it is difficult to make the monofilament into a high-density woven fabric, and the monofilament is unsuitable for use in clothing because a cloth made of the monofilament has high rigidity due to the high single-yarn fineness. Moreover, in the case where the core-in-sheath composite yarn technique is applied to a fine-

denier multifilament, a core-in-sheath composite yarn having a small single-yarn fineness may inconveniently cause sheath breakage or may be excessively thinned in the sheath part so that sufficient wear resistance may not be ensured. On the contrary, in a core-in-sheath composite yarn having a large single-yarn fineness, due to the small number of filaments, the filaments are interlaced with difficulty, the core-in-sheath composite yarn has poor convergence, and the weaving properties and woven fabric quality are deteriorated.

[0010] In other words, it is difficult with conventional techniques to obtain a polyester multifilament for thin woven fabrics that combine the durability, weaving properties, and woven fabric quality required in sophisticated uses. Therefore, development of a high-strength fine-denier polyester multifilament having excellent wear resistance and convergence has been expected.

[0011] An object of the present invention is to solve the above-mentioned problems of the conventional techniques, and to provide a high-strength fine-denier polyester multifilament having excellent wear resistance and convergence for the purpose of providing a high-density thin woven fabric that combines excellent durability, weaving properties, and woven fabric quality and that is suitable for use with athletic and outdoor clothing.

SOLUTIONS TO THE PROBLEMS

[0012] The object of the present invention can be achieved using the following polyester multifilament.

[0013] The polyester multifilament is a polyester multifilament characterized in that it contains: a high-viscosity polyester as a core component; and a low-viscosity polyester as a sheath component, the core component and the sheath component forming a core-in-sheath composite, and that the polyester multifilament has a difference in intrinsic viscosity between the core component and the sheath component of 0.20 to 1.00, a total fineness of 4 to 30 dtex, a single-yarn fineness of 1.0 to 5.0 dtex, a breaking strength of 5.0 to 9.0 cN/dtex, a fracture elongation of 12 to 45%, a degree of interlacement of 2.0 to 15.0/m, and a number of filaments of 3 to 15.

[0014] Further, the polyester multifilament is characterized in that the high-viscosity polyester as the core component has an intrinsic viscosity of 0.70 to 1.50, and the sheath component has a high viscosity of 0.40 to 0.70.

EFFECTS OF THE INVENTION

[0015] The high-strength polyester multifilament of the present invention has excellent wear resistance and convergence, and is capable of providing a high-density thin woven fabric that combines excellent durability, weaving properties, and woven fabric quality and that is suitable for use with athletic and outdoor clothing.

EMBODIMENT OF THE INVENTION

[0016] The polyester multifilament of the present invention will be described.

[0017] The polyester multifilament of the present invention is made of a core-in-sheath composite fiber in which, in a cross section of a single yarn, a core component and a sheath component are arranged such that the core component is covered with the sheath component and the core component is not exposed to the surface of the polyester multifilament. In general, in order to increase the strength of a polyester fiber, it is known that drawing at a high draw ratio is required in the production process of an original yarn for high orientation and high crystallization. In weaving a high-density thin woven fabric, since a yarn having a small total fineness is woven at high density, the warp is subjected to intense abrasion with a reed under a heavy load so that fluff due to single yarn breakage may be generated. Further, thin woven fabrics used in sophisticated uses are required to have durability against friction, and it is an important issue to improve the wear resistance of the original yarn.

[0018] In the polyester multifilament of the present invention, from the viewpoint of obtaining excellent wear resistance, the polyester used in the sheath component is required to have an intrinsic viscosity lower than that of the core component polyester, and the difference in intrinsic viscosity is preferably 0.20 to 1.00. A difference in intrinsic viscosity of 0.20 or more can suppress the degree of orientation and degree of crystallinity of the sheath component polyester, that is, the polyester at the fiber surface of the polyester multifilament, and can provide satisfactory wear resistance. In addition, since the sheath component bears the shear stress at the inner wall surface of the discharge hole of the melt spinning spinneret, the core component receives weak shear force, has a low degree of molecular chain orientation, and is spun in a uniform state. Therefore, the finally obtained polyester multifilament has improved strength. Meanwhile, in order for the polyester multifilament to have high strength, the sheath component is also required to be moderately oriented. Therefore, if the difference in intrinsic viscosity is larger than 1.00, a satisfactory original yarn strength is not obtained. A more preferable difference in intrinsic viscosity of the polyester is 0.30 to 0.70.

[0019] The high-viscosity polyester as the core component used in the polyester multifilament of the present invention preferably has an intrinsic viscosity in the range of 0.70 to 1.50. An intrinsic viscosity of 0.70 or more enables production of a polyester multifilament combining sufficient strength and elongation. A more preferable intrinsic viscosity is 0.80 or

more. The upper limit of the intrinsic viscosity is preferably 1.50 or less from the viewpoint of ease of molding such as melt extrusion. In consideration of the production cost, the reduction in molecular weight due to molecular chain scission caused by heat or shear force in the production process, and the melt flow stability, the upper limit of the intrinsic viscosity is more preferably 1.20 or less.

[0020] Meanwhile, an intrinsic viscosity of the low-viscosity polyester as the sheath component of 0.40 or more provides stable yarn-making properties. A more preferable intrinsic viscosity is 0.50 or more. Further, in order to obtain satisfactory wear resistance, the intrinsic viscosity is preferably 0.70 or less.

[0021] The polyester used in the polyester multifilament of the present invention may be a polyester containing polyethylene terephthalate (hereinafter referred to as PET) as a main component.

[0022] PET used in the present invention may be a polyester containing terephthalic acid as a main acid component and ethylene glycol as a main glycol component, and containing 90 mol% or more of ethylene terephthalate repeating units. PET may, however, contain other copolymer components capable of forming an ester bond in a proportion of less than 10 mol%. Examples of such copolymer components include, as an acid component, bifunctional aromatic carboxylic acids such as isophthalic acid, phthalic acid, dibromoterephthalic acid, naphthalene dicarboxylic acid, and o-ethoxybenzoic acid, bifunctional aliphatic carboxylic acids such as sebacic acid, oxalic acid, adipic acid, and dimer acid, and dicarboxylic acids such as cyclohexanedicarboxylic acid, and as a glycol component, ethylene glycol, diethylene glycol, propanediol, butanediol, neopentyl glycol, bisphenol A, cyclohexane dimethanol, and polyoxyalkylene glycols such as polyethylene glycol and polypropylene glycol, but the copolymer components are not limited thereto.

[0023] In addition, PET may contain, as additives, titanium dioxide as a matting agent, silica or alumina fine particles as a lubricant, a hindered phenol derivative as an antioxidant, and further, a flame retardant, an antistatic agent, an ultraviolet absorber, a coloring pigment, and the like as required.

[0024] PET in the core component is mainly responsible for the strength of the polyester multifilament. Therefore, the amount of an inorganic particle additive usually added to a polyester fiber, which is typified by titanium oxide, is preferably 0.5 wt% or less. Meanwhile, PET in the sheath component is mainly responsible for the wear resistance of the polyester multifilament. Therefore, it is preferable to add inorganic particles typified by titanium oxide in an amount of about 0.1 wt% to 0.5 wt% to the sheath component.

[0025] Next, the cross-sectional shape of the polyester multifilament of the present invention will be described.

[0026] As described above, the polyester multifilament of the present invention is a core-in-sheath composite polyester multifilament in which, in a cross section of a single yarn, the core component and the sheath component are arranged such that the core component is covered with the sheath component and the core component is not exposed to the surface of the polyester multifilament. Here, in the "core-in-sheath" composite polyester multifilament, it is only required that the core component be completely covered with the sheath component, and it is not necessarily required that the core component and the sheath component be concentrically arranged. The polyester multifilament may have any of number of cross-sectional shapes, such as round, flat, triangular, square, and pentagonal cross-sectional shapes. In view of ease of achieving stable yarn-making properties and high-order processability as well as densification of a woven fabric, a round cross-sectional shape is preferable.

[0027] In the present invention, since both the core component and the sheath component contain a polyester, a phenomenon of delamination at a composite interface, which frequently occurs in polyester/nylon composite yarns, is unlikely to occur. However, in view of achieving both an effect of improving the wear resistance exerted by the sheath component and increase of the strength by the core component, the composite ratio of core component : sheath component is preferably in the range of 60 : 40 to 95 : 5, and is more preferably in the range of 70 : 30 to 90 : 10.

[0028] Here, the "composite ratio" defined in the present invention refers to, in a cross-sectional photograph of a single yarn of the polyester multifilament, a cross-sectional area ratio between two types of polyesters constituting the single yarn.

[0029] The polyester multifilament of the present invention is required to have a total fineness of 4 to 30 dtex. A total fineness of 4 dtex or more enables stable yarn making and weaving, whereas a total fineness of 30 dtex or less may provide a desired high-density thin woven fabric. A preferable range of the total fineness is 8 to 25 dtex.

[0030] The polyester multifilament of the present invention is required to have a single-yarn fineness of 1.0 to 5.0 dtex. If the single-yarn fineness is less than 1.0 dtex, it is difficult to form a desired core-in-sheath cross section, and sheath breakage tends to occur or the sheath component tends to have a small thickness so that the polyester multifilament may have insufficient wear resistance. Moreover, the process passability such as yarn-making properties and weaving properties also tends to deteriorate. A single-yarn fineness of 5.0 dtex or less may facilitate interlacing and improve convergence, and may provide an effect of improving process passability and weaving properties. Moreover, the obtained woven fabric has a satisfactory texture without being too hard while maintaining denseness. A preferable range of the single-yarn fineness is 1.5 to 3.0 dtex. In order to achieve a single-yarn fineness in the above-mentioned range, in the method for producing a polyester multifilament, the discharge amount and the spinneret are required to be appropriately changed.

[0031] Further, the polyester multifilament of the present invention is required to have a number of filaments of 3 to

15. A number of filaments of 3 or more may facilitate interlacing. Moreover, since an increased number of filaments can distribute the contact with a reed or a guide during the weaving among single yarns, the load of friction applied to a single yarn can be reduced, and the wear resistance of the original yarn and the durability of the woven fabric are greatly improved. The upper limit of the number of filaments depends on the total fineness and single-yarn fineness, but is 15 or less.

[0032] The polyester multifilament of the present invention is required to have improved convergence in order to achieve excellent weaving properties and woven fabric quality. If the convergence is insufficient, filament breakage (separation into single yarns) may occur, the working of the warp during the weaving may be deteriorated, and the warp breakage may easily occur. Also in respect of the woven fabric quality, filament breakage may cause streak-like woven fabric defects.

[0033] The polyester multifilament of the present invention is required to have a degree of interlacement of 2.0 to 15.0/m, the degree of interlacement representing the number of interlacements per meter. If the degree of interlacement is less than 2.0/m, weaving properties tend to deteriorate, that is, warp breakage may occur. The obtained woven fabric tends to have streak-like woven fabric defects due to filament breakage, and tends to be poor in the woven fabric quality. A degree of interlacement of 2.0/m or more may provide excellent weaving properties and woven fabric quality. Meanwhile, if the degree of interlacement is too high, the polyester multifilament has too many constraint points, and the above-mentioned effect of distributing the contact with a reed or a guide during the weaving among single yarns to reduce the load of friction applied to a single yarn may be reduced, and therefore the wear resistance of the original yarn and the durability of the woven fabric tend to deteriorate. Therefore, the degree of interlacement is required to be 15.0/m or less. Further, when the degree of interlacement is further increased, the load in the interlacing step increases, yarn breakage frequently occurs, and the productivity may be reduced. A more preferable range of the degree of interlacement is 4.0 to 10.0/m.

[0034] The polyester multifilament of the present invention having a breaking strength of 5.0 cN/dtex or more may have sufficient mechanical properties even when being made into a thin woven fabric. The breaking strength is more preferably 6.0 cN/dtex or more. In addition, the orientation and degree of crystallinity are required to be suppressed from the viewpoint of wear resistance. Therefore, the breaking strength is 9.0 cN/dtex or less, more preferably 8.0 cN/dtex or less.

[0035] Further, the polyester multifilament of the present invention having a fracture elongation of 12% or more can suppress yarn breakage and generation of fluff during the weaving, and is excellent in handleability. The polyester multifilament of the present invention having a fracture elongation of 45% or less may have a desired breaking strength. A more preferable range of the fracture elongation is 17 to 35%.

[0036] Further, as for the strength at 5% elongation (5% Mo) and the strength at 10% elongation (10% Mo) of the polyester multifilament of the present invention, from the viewpoint of dimensional stability of the woven fabric, the 5% Mo is preferably 3.5 cN/dtex or more, more preferably 3.8 cN/dtex or more. The 10% Mo is preferably 4.0 cN/dtex or more, more preferably 4.5 cN/dtex or more. In addition, for suppressing the orientation and degree of crystallinity from the viewpoint of wear resistance, the 5% Mo is preferably 6.0 cN/dtex or less, more preferably 5.0 cN/dtex or less. The 10% Mo is preferably 8.0 cN/dtex or less, more preferably 7.0 cN/dtex or less.

[0037] Next, a preferable method for producing the polyester multifilament of the present invention will be described.

[0038] A feature of the method for producing a polyester multifilament of the present invention is that the position at which the filaments are interlaced is after the drawing. When the filaments are subjected to interlacing at the stage of an undrawn yarn, it is difficult to interlace the filaments in the ranges of the total fineness, single-yarn fineness, and number of filaments of the multifilament of the present invention. Therefore, interlacing the filaments at the stage after the drawing, at which the single-yarn fineness is reduced, can achieve a desired degree of interlacement.

[0039] In addition, in the method for interlacing the filaments in the polyester multifilament of the present invention, a known interlacing nozzle can be used. The compressed air pressure in the interlacement is preferably 0.10 to 0.40 MPa. If the compressed air pressure is less than 0.10 MPa, it is difficult to sufficiently interlace the filaments, whereas if the compressed air pressure exceeds 0.40 MPa, yarn breakage frequently occurs, and the productivity may be reduced. The compressed air pressure is more preferably 0.15 to 0.30 MPa.

[0040] The method for spinning the polyester multifilament of the present invention is not particularly limited, and the polyester multifilament can be spun according to a known technique. For example, high-viscosity PET as a core component and low-viscosity PET as a sheath component are each melt-extruded and sent to a predetermined composite pack using a composite spinning machine, both the polymers are filtered in the pack and then bonded together in a core-in-sheath form and subjected to composite spinning with a spinneret, and a yarn discharged from the spinneret is taken up to produce an undrawn yarn. The undrawn yarn may be subjected to a two-step method in which the undrawn yarn is wound up once and then drawn in a drawing machine, or a one-step method in which the undrawn yarn is continuously drawn without being wound up once. The two-step method is more preferable because, in the interlacing described later, the filaments are hardly interlaced if the yarn speed is high.

[0041] The method for drawing the polyester multifilament of the present invention is not particularly limited, and the

polyester multifilament can be drawn according to a known technique. For example, the drawing method can be suitably selected from a method of performing one-stage hot drawing between a first hot roll and a second hot roll, a method of performing one-stage hot drawing with a first hot roll, an unheated roll, and a hot plate between the rolls, a method of performing the first stage hot drawing between a first hot roll and a second hot roll and performing the second stage hot drawing between the second hot roll and a third hot roll, and the like. In particular, in order to achieve high strength, it is required to draw an undrawn yarn at a high draw ratio. When an undrawn yarn is drawn in one-stage drawing, however, high drawing tension is applied, so that problems such as increased yarn unevenness and frequent yarn breakage may occur. Therefore, it is preferable to draw an undrawn yarn in two or more stages.

[0042] Further, as for the drawing temperature of the polyester multifilament of the present invention, in the case of one-stage drawing, it is preferable that the first hot roll usually have a temperature of (glass transition temperature of the high-viscosity PET as the core component) + 10 to 30°C, and the second hot roll or the hot plate have a temperature in the range of 130 to 230°C. A temperature of the second hot roll or the hot plate of 130°C or more controls the orientation, promotes the crystallization of the fiber, and increases the strength. Meanwhile, a temperature of the second hot roll or the hot plate of 230°C or less prevents fusion at the hot roll or the hot plate, and provides satisfactory yarn-making properties. In the case of multi-stage drawing, it is preferable that the first hot roll have a temperature of (glass transition temperature of the high-viscosity PET as the core component) + 10 to 30°C, the second and subsequent hot rolls have gradually increased temperatures, and the last hot roll have a temperature in the range of 100 to 230°C.

[0043] Further, the polyester multifilament of the present invention is preferably drawn at a draw ratio of 3.0 to 7.0 in total. The draw ratio is more preferably 3.5 to 6.0, still more preferably 3.8 to 5.0.

EXAMPLES

[0044] Hereinafter, the polyester multifilament of the present invention will be specifically described with reference to examples. The measured values in the examples were measured by the following methods.

(1) Intrinsic viscosity (IV)

[0045] The relative viscosity η_r defined by η/η_0 was determined according to the following mathematical formula at a temperature of 25°C using an Ostwald viscometer by dissolving 0.8 g of a sample polymer in 10 mL of o-chlorophenol (hereinafter abbreviated as "OCP") having a purity of 98% or more at a temperature of 25°C to prepare a polymer solution. The intrinsic viscosity (IV) was calculated from η_r according to the following mathematical formula.

$$\eta_r = \eta/\eta_0 = (t \times d) / (t_0 \times d_0)$$

$$\text{Intrinsic viscosity (IV)} = 0.0242\eta_r + 0.2634$$

[0046] In the formula, η is the viscosity of the polymer solution, η_0 is the viscosity of OCP, t is the dropping time of the solution (sec), d is the density of the solution (g/cm³), t_0 is the dropping time of OCP (sec), and d_0 is the density of OCP (g/cm³).

(2) Total fineness (dtex)

[0047] A yarn was wound up into a 500-m skein, and a value obtained by multiplying the mass (g) of the skein by 20 was defined as the fineness.

(3) Breaking strength (cN/dtex), fracture elongation (%), and strength (modulus) at 5% elongation (cN/dtex) and strength (modulus) at 10% elongation (cN/dtex)

[0048] The breaking strength, fracture elongation, and strength at 5% elongation and strength at 10% elongation were measured according to JIS L1013 (1999) using TENSILON UCT-100 manufactured by ORIENTEC CORPORATION.

(4) Degree of interlacement (number/m)

[0049] A yarn was floated on water, and the number of convergence points per meter was counted as the degree of interlacement. The number was counted 10 times, and the average of the counted numbers was calculated.

(5) Wear resistance of original yarn

[0050] A yarn was subjected to a yarn tension of 0.9 g/dtex, a flat part of a reed (material: SK material, 7 mm in width $\times$ 50 mm in length $\times$ 50 μ m in thickness) was pressed against the yarn at a contact angle of 20°, and the yarn was subjected to a reciprocating motion at a stroke length of 30 mm and a speed of 670 times/min for 10 minutes. The treated yarn was magnified and observed with a microscope. The wear resistance of the original yarn was evaluated as "A" when no fluff or fibrillation (surface fraying) was observed, and was evaluated as "C" when fluff or fibrillation was observed.

(6) Evaluation of weaving properties and weaving quality

[0051] A fabric was woven so that the fabric may have a basis weight in the range of 30 to 35 g/m² by adjusting the basis weight using a water jet loom according to the total fineness of the filaments used. The weaving properties were evaluated as "S" when the number of loom stoppages per 100 m due to yarn breakage or the like was less than 3 times, "A" when the number of loom stoppages was 3 times or more and less than 10 times, and "C" when the number of loom stoppages was 10 times or more. The weaving quality was evaluated by counting the total number of defects such as fluff and filament breakage. The weaving quality was evaluated as "S" when the total number of defects was less than 3 per 100 m, "A" when the total number of defects was 3 or more and less than 10, and "C" when the total number of defects was 10 or more.

(7) Wear resistance of fabric

[0052] The wear resistance of the fabric was measured according to JIS L1096 (2010), method E (Martindale method). The test was performed under the conditions of a polyester standard friction cloth and a pressing load of 9 kPa. The judgment was made according to the number of friction cycles before the generation of fluff. The wear resistance of the fabric was evaluated as "A" when the number of friction cycles was 5,000 times or more, "B" when the number of friction cycles was 3,000 times or more and less than 5,000 times, and "C" when the number of friction cycles was less than 3,000 times.

[0053] As for the production methods in examples and comparative examples, polyester filaments were obtained under the production conditions shown in Tables 1 to 3 according to a known technique.

[Example 1]

[0054] PET having an intrinsic viscosity of 0.80 as a core component and PET having an intrinsic viscosity of 0.50 as a sheath component were melted at a temperature of 295°C using an extruder type extrusion machine. Then, the polymers were metered with a pump at a polymer temperature of 290°C so that the composite ratio might be core component : sheath component = 80 : 20, and allowed to flow into a known composite spinneret having five holes arranged in a core-in-sheath structure. A yarn discharged from the spinneret was wound up once at a spinning speed of 1,200 m/min, and then drawn with a known drawing device between a first hot roll heated to 90°C and a second hot roll heated to 130°C at a draw ratio of 4.2 and heat-set. The obtained drawn yarn was interlaced with an interlacing nozzle disposed between a final roll and a winder at an interlacing pressure of 0.23 MPa, and then wound up at 800 m/min. No particular problem was found in yarn-making properties, and a polyester multifilament having a total fineness of 12.0 dtex, a single-yarn fineness of 2.4 dtex, a breaking strength of 6.5 cN/dtex, a fracture elongation of 17.7%, and a degree of interlacement of 5.8/m was obtained. The polyester multifilament had satisfactory wear resistance of the original yarn. Other physical properties of the original yarn were as shown in Table 1.

[0055] Using the polyester multifilament, a fabric was woven with a water jet loom so that the fabric might have a basis weight of 30 g/m². No yarn breakage occurred during 100 m of weaving, and the polyester multifilament had very satisfactory weaving properties. The obtained fabric was free from defects such as fluff, and had a very satisfactory weaving quality. In addition, the wear resistance of the fabric was satisfactory, and no fluff was generated even after a number of friction cycles of 6,000 times.

[Examples 2 and 3]

[0056] A polyester multifilament was obtained in the same manner as in Example 1 except that the draw ratio was changed to 3.9 and 3.6, respectively. The original yarn of the obtained polyester multifilament had physical properties as shown in Table 1. In each of Examples 2 and 3, no yarn breakage occurred during 100 m of weaving, and the polyester multifilament had very satisfactory weaving properties. The obtained fabric was free from defects such as fluff, and had a very satisfactory weaving quality. In addition, the wear resistance of the fabric was satisfactory, and no fluff was generated even after a number of friction cycles of 6,000 times.

[Examples 4 and 5] and [Comparative Examples 1 and 2]

[0057] A polyester multifilament was obtained in the same manner as in Example 1 except that the interlacing pressure was changed in the range of 0.08 to 0.42 MPa. The original yarn of the obtained polyester multifilament had physical properties as shown in Table 1. In Example 4, the degree of interlacement was 9.9/m, and satisfactory results were obtained as in Example 1 as for the wear resistance of the original yarn, weaving properties, weaving quality, and wear resistance of the fabric. In Example 5, the degree of interlacement was 4.2/m, and the polyester multifilament had slightly lower convergence than that of Example 1. Therefore, 3 times of yarn breakage occurred during 100 m of weaving, but the polyester multifilament had satisfactory weaving properties. Although no fluff was observed in the obtained fabric, defects of filament breakage were observed, and the fabric was slightly inferior to that of Example 1. In Comparative Example 1, the interlacing pressure was high, the yarn swayed largely at an interlacing position, and yarn breakage occurred. The degree of interlacement was as high as 15.3/m. The wear resistance of the original yarn was lower than that in Example 1, and the polyester multifilament easily generated fluff. During the weaving, 6 times of yarn breakage occurred. The weaving quality was lower than that in Example 1 and fluff was observed. As for the wear resistance of the fabric, fluff was generated even after a number of friction cycles of 3,500 times. In Comparative Example 2, the interlacing pressure was low. The degree of interlacement was 1.7/m, and the filaments were insufficiently interlaced. During the weaving, warp breakage frequently occurred, and loom stoppages occurred every few meters. As for the weaving quality, filament breakage frequently occurred, and many streak-like defects were observed.

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2
		High-viscosity component (core component)	Intrinsic viscosity	0.80	0.80	0.80	0.80	0.80
	Low-viscosity component (sheath component)	Intrinsic viscosity	0.50	0.50	0.50	0.50	0.50	0.50
	Difference in intrinsic viscosity	Core component - sheath component	0.30	0.30	0.30	0.30	0.30	0.30
	Composite ratio	Core component : sheath component	80 : 20	80 : 20	80 : 20	80 : 20	80 : 20	80 : 20
	Production method	Two-step method	Two-step method	Two-step method	Two-step method	Two-step method	Two-step method	Two-step method
	Spinning speed [m/min]	1200	1200	1200	1200	1200	1200	1200
	Draw ratio [times]	4.2	3.9	3.6	4.2	4.2	4.2	4.2
	Interlacing position	After drawing	After drawing	After drawing	After drawing	After drawing	After drawing	After drawing
	Single-yarn fineness at interlacing position [dtex]	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Compressed air pressure in interlacement [MPa]	0.23	0.23	0.23	0.30	0.15	0.42	0.08
	Total fineness [dtex]	12.0	12.0	12.0	12.0	12.0	12.0	12.0
	Single-yarn fineness [dtex]	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Number of filaments	5	5	5	5	5	5	5
	Breaking strength [cN/dtex]	6.5	6.0	5.5	64	6.4	6.4	6.5
	Fracture elongation [%]	17.7	24.6	31.7	17.2	17.2	17.2	17.3
	Strength at 5% elongation [cN/dtex]	5.0	4.3	3.6	5.0	5.0	5.0	5.0

(continued)

	Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2
Strength at 10% elongation [cN/dtex]	5.9	5.4	4.2	5.9	5.9	5.9	5.9
Degree of interlacement [number/m]	5.8	5.9	5.8	9.9	9.2	15.3	1.7
Wear resistance of original yarn	A	A	A	A	A	C	A
Weaving properties	S	S	S	S	A	A	C
Weaving quality	S	S	S	S	A	A	C
Wear resistance of fabric	A	A	A	A	A	B	A

[Comparative Example 3]

[0058] A polyester multifilament was obtained in the same manner as in Example 1 except that the interlacing position was changed to before winding of the spun yarn. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 2. The degree of interlacement was 0.8/m, and the filaments were insufficiently interlaced. During the weaving, warp breakage frequently occurred, and loom stoppages occurred every few meters. As for the weaving quality, filament breakage frequently occurred, and many streak-like defects were observed.

[Examples 6 to 8] and [Comparative Examples 4 and 5]

[0059] A polyester multifilament was obtained in the same manner as in Example 2 except that the discharge amount and the number of holes of the spinneret were adjusted to change the total fineness, single-yarn fineness, and number of filaments. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 2. In Examples 6 to 8, the physical properties of the original yarn, weaving properties, weaving quality, and wear resistance of the fabric were comparable to those in Example 2. In Comparative Example 4, since the single-yarn fineness was as large as 5.6 dtex, the degree of interlacement was 1.2/m, and the filaments were insufficiently interlaced. During the weaving, warp breakage frequently occurred, and loom stoppages occurred every few meters. As for the weaving quality, filament breakage frequently occurred, and many streak-like defects were observed. Moreover, the obtained fabric had a rough texture. In Comparative Example 5, single yarn breakage frequently occurred during spinning, and single yarn wrapping frequently occurred during drawing. The obtained polyester multifilament had a single-yarn fineness as small as 0.8 dtex, and thus the degree of interlacement was as high as 18.8/m. The polyester multifilament after the wear test of the original yarn had a large amount of fluff, and had poor wear resistance. In addition, when the obtained polyester multifilament was subjected to weaving, warp breakage frequently occurred and no fabric was woven.

[Comparative Example 6]

[0060] A polyester monofilament was obtained in the same manner as in Example 1 except that the number of holes of the spinneret was changed to one to change the discharge amount, and that no interlacing nozzle was used. The physical properties of the original yarn of the obtained polyester monofilament were as shown in Table 2. The obtained polyester monofilament frequently caused both warp breakage and weft breakage in a water jet loom, and no fabric was woven.

[Table 2]

High-viscosity component (core component)	Intrinsic viscosity	Comparative Example 3				Example 6				Example 7				Example 8				Comparative Example 4				Comparative Example 5				Comparative Example 6			
		0.80				0.80				0.80				0.80				0.80				0.80				0.80			
Low-viscosity component (sheath component)	Intrinsic viscosity	0.50				0.50				0.50				0.50				0.50				0.50				0.50			
Difference in intrinsic viscosity	Core component - sheath component	0.30				0.30				0.30				0.30				0.30				0.30				0.30			
	Core component : sheath component	80:20				80:20				80:20				80:20				80:20				80:20				80:20			
Production method		Two-step method				Two-step method				Two-step method				Two-step method				Two-step method				Two-step method				Two-step method			
Spinning speed [m/min]		1200				1200				1200				1200				1200				1200				1200			
Draw ratio [times]		4.2				3.9				3.9				3.9				3.9				3.9				4.2			
Interlacing position		Spun yarn				After drawing				After drawing				After drawing				After drawing				After drawing				-			
Single-yarn fineness at interlacing position [dtex]		10.1				2.2				1.9				1.6				5.6				0.8				-			
Compressed air pressure in interlacement [MPa]		0.23				0.23				0.23				0.23				0.23				0.23				-			
Total fineness [dtex]		12.0				21.7				28.1				8.2				28.2				12.0				9.8			
Single-yarn fineness [dtex]		2.4				2.2				1.9				1.6				5.6				0.8				9.8			
Number of filaments		5				10				15				5				5				15				1			
Breaking strength [cN/dtex]		6.2				6.1				6.0				6.4				5.8				6.1				6.3			
Fracture elongation [%]		16.7				23.2				23.5				21.3				26.4				19.8				21.2			
Strength at 5% elongation [cN/dtex]		4.9				4.2				4.2				4.4				4.0				4.6				3.9			

(continued)

	Comparative Example 3	Example 6	Example 7	Example 8	Comparative Example 4	Comparative Example 5	Comparative Example 6
Strength at 10% elongation [cN/dtex]	5.8	54	5.3	5.5	5.0	5.8	5.5
Degree of interlacement [number/m]	0.8	6.3	6.4	6.9	1.2	18.8	-
Wear resistance of original yarn	A	A	A	A	A	C	A
Weaving properties	C	S	S	S	C	C	C
Weaving quality	C	S	S	S	C	-	-
Wear resistance of fabric	A	A	A	A	B	-	-

[Example 9]

[0061] Spinning was performed in the same manner as in Example 1 except that PET having an intrinsic viscosity of 1.00 was used as a core component and that the spinning speed was adjusted to 600 m/min. The yarn was wound up once, and then drawn in the same manner as in Example 1 except that the yarn was subjected to two-stage drawing with a known drawing device between first and second hot rolls heated to 90°C and between the second hot roll and a third hot roll heated to 200°C at a draw ratio of 4.5 and heat-set, whereby a polyester multifilament was obtained. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 3. During the weaving, no yarn breakage occurred over 100 m, and the polyester multifilament had very satisfactory weaving properties. The obtained fabric was free from defects such as fluff, and had a very satisfactory weaving quality. In addition, the wear resistance of the fabric was satisfactory, and no fluff was generated even after a number of friction cycles of 6,000 times.

[Example 10]

[0062] A polyester multifilament was obtained in the same manner as in Example 9 except that PET having an intrinsic viscosity of 1.25 was used as a core component and that the spinning speed and the draw ratio were adjusted to 500 m/min and 5.8, respectively. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 3. As for the wear resistance of the original yarn, no fluff or fibrillation was observed, but 8 times of warp breakage occurred during 100 m of weaving. The quality of the obtained fabric was lower than in Example 1 and fluff was observed. The wear resistance of the fabric was lower than in Example 1, and fluff was generated after a number of friction cycles of 4,500 times.

[Comparative Example 7]

[0063] PET having an intrinsic viscosity of 0.80 was used as a single component, and melted at a temperature of 295°C using an extruder type extrusion machine. Then, the polymer was allowed to flow into a known single-component spinneret having five holes at a polymer temperature of 290°C. A yarn discharged from the spinneret was wound up once at a spinning speed of 800 m/min, and then drawn with a known drawing device between a first hot roll heated to 90°C and a second hot roll heated to 130°C at a draw ratio of 4.3 and heat-set. The obtained drawn yarn was interlaced with an interlacing nozzle disposed between a final roll and a winder at an interlacing pressure of 0.23 MPa, and then wound up at 800 m/min. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 3. The wear resistance of the original yarn was lower than that in Example 1, and the polyester multifilament easily generated fluff. No yarn breakage occurred during 100 m of weaving, and the polyester multifilament had very satisfactory weaving properties. However, fluff was observed in the obtained fabric, and the fabric was inferior to that of Example 1. In addition, the wear resistance of the fabric was greatly lower than in Example 1, and generation of fluff was observed after a number of friction cycles of 500 times.

[Example 11]

[0064] PET having an intrinsic viscosity of 0.80 as a core component and PET having an intrinsic viscosity of 0.50 as a sheath component were used, and subjected to spinning and drawing in a known direct spinning-drawing device. The polymers were melted at a temperature of 295°C using an extruder type extrusion machine. Then, the polymers were metered with a pump at a polymer temperature of 290°C so that the composite ratio might be core component : sheath component = 80 : 20, and allowed to flow into a known composite spinneret having five holes arranged in a core-in-sheath structure. A yarn discharged from the spinneret was taken up at a spinning speed of 1,300 m/min, and then drawn at a draw ratio of 3.8 without being wound up once and heat-set. The obtained drawn yarn was interlaced with an interlacing nozzle disposed between a final roll and a winder at an interlacing pressure of 0.23 MPa, and then wound up at 5,000 m/min. The yarn-making properties were inferior to those in the two-step method as in Example 1, and yarn breakage was observed at the interlaced portion. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 3. The single-yarn fineness at the interlacing position after the drawing was 2.4 dtex, which was comparable to that of Example 1. However, the speed of the yarn passing through the interlacing nozzle was as high as 5,000 m/min, so that the degree of interlacement was as small as 2.8/m. Since the degree of interlacement was inferior to that of Example 1, the polyester multifilament had poor convergence, and 7 times of yarn breakage occurred during 100 m of weaving. Although no fluff was observed in the obtained fabric, defects of filament breakage were observed, and the fabric was slightly inferior to that of Example 1.

[Comparative Example 8]

[0065] A polyester multifilament was obtained in the same manner as in Example 11 except that the interlacing position was changed to before taking up of the spun yarn. The physical properties of the original yarn of the obtained polyester multifilament were as shown in Table 3. The degree of interlacement was 0.7/m, and the filaments were insufficiently interlaced. During the weaving, warp breakage frequently occurred, and loom stoppages occurred every few meters. As for the weaving quality, filament breakage frequently occurred, and many streak-like defects were observed.

[Table 3]

		Example 9	Example 10	Comparative Example 7	Example 11	Comparative Example 8
	High-viscosity component (core component)	1.00	1.25	0.80	0.80	0.80
	Intrinsic viscosity					
	Low-viscosity component (sheath component)	0.50	0.50	-	0.50	0.50
	Intrinsic viscosity					
	Difference in intrinsic viscosity	0.50	0.75	-	0.30	0.30
	Core component - sheath component					
	Composite ratio	80 : 20	80 : 20	100 : 0	80 : 20	80 : 20
	Core component : sheath component					
	Production method	Two-step method	Two-step method	Two-step method	One-step method	One-step method
	Spinning speed [m/min]	600	500	800	1300	1300
	Draw ratio [times]	4.5	5.8	4.3	3.8	3.8
	Interlacing position	After drawing	After drawing	After drawing	After drawing	Spun yarn
	Single-yarn fineness at interlacing position [dtex]	2.4	2.4	2.4	2.4	9.1
	Compressed air pressure in interlacement [MPa]	0.23	0.23	0.23	0.23	0.23
	Total fineness [dtex]	12.0	12.0	12.0	12.0	12.0
	Single-yarn fineness [dtex]	2.4	2.4	2.4	2.4	2.4
	Number of filaments	5	5	5	5	5
	Breaking strength [cN/dtex]	7.4	8.5	5.6	6.1	6.0
	Fracture elongation [%]	18.6	13.6	33.2	20.6	19.8
	Strength at 5% elongation [cN/dtex]	4.8	5.7	3.2	3.9	3.9
	Strength at 10% elongation [cN/dtex]	6.6	8.0	4.0	5.5	5.5
	Degree of interlacement [number/m]	5.3	5.1	5.5	2.8	0.7
	Wear resistance of original yarn	A	A	C	A	A
	Weaving properties	S	A	S	A	C
	Weaving quality	S	A	A	A	C
	Wear resistance of fabric	A	B	C	A	A

Claims

1. A polyester multifilament comprising:

a high-viscosity polyester as a core component; and
a low-viscosity polyester as a sheath component,
the core component and the sheath component forming a core-in-sheath composite,
the polyester multifilament having a difference in intrinsic viscosity between the core component and the sheath
component of 0.20 to 1.00, a total fineness of 4 to 30 dtex, a single-yarn fineness of 1.0 to 5.0 dtex, a breaking
strength of 5.0 to 9.0 cN/dtex, a fracture elongation of 12 to 45%, a degree of interlacement of 2.0 to 15.0/m,
and a number of filaments of 3 to 15.

2. The polyester multifilament according to claim 1, wherein the high-viscosity polyester as the core component has
an intrinsic viscosity of 0.70 to 1.50, and the sheath component has a high viscosity of 0.40 to 0.70.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/041591

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. D01F8/14(2006.01) i, D02G3/22(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)

Int.Cl. D01F8/00-8/18, D02G1/00-3/48, D02J1/00-13/00

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2009-7730 A (TORAY INDUSTRIES, INC.) 15 January 2009, claims 1-3, paragraphs [0018]-[0028], [0107], [0111] (Family: none)	1-2



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 January 2019 (16.01.2019)

Date of mailing of the international search report

29 January 2019 (29.01.2019)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/041591

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 02/063080 A1 (ASAHI KASEI CORPORATION) 15 August 2002, example 18 & EP 1365049 A1, example 18 & US 6555220 B1 & US 2003/0232194 A1 & DE 60211125 T & KR 10-0532552 B1 & MX PA03005962 A & TW 571008 B & AT 325209 T & ES 2258614 T & CN 1489649 A & JP 2006-342488 A & JP 2009-46800 A & JP 4353698 B2	1-2
A	JP 2555185 B2 (TEIJIN LTD.) 20 November 1996, claim 1, page 2, left column, lines 14-23, page 2, right column, line 44 to page 3, left column, line 5, examples 1, 2, 4 & JP 2-289113 A	1-2

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2018/041591

<Regarding the subject of the examination>

The examination was carried out by assuming, from the description of paragraph [0020] of the present application, that the text of "the high viscosity of a sheath component is 0.40-0.70" in claim 2 of the present application is a typographical error of "the intrinsic viscosity of low viscosity polyester of a sheath component is 0.04-0.70".

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- JP 2009074213 A [0006]
- JP 2009013511 A [0006]
- JP 2003213528 A [0006]