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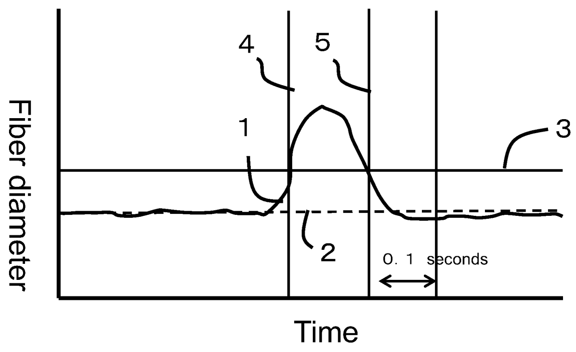
(54) **POLYESTER MONOFILAMENT**

(57) A polyester monofilament which exhibits a fiber size of 3.0-13.0 dtex, a strength of 5.0-9.0 cN/dtex, and a strength at 5% elongation of 2.7-6.0 cN/dtex, wherein the total length L of an abnormal section in which the fiber diameter equals 110% or more of the fiber diameter elsewhere along 1,000,000 m of the fiber in the lengthwise direction is no more than 2,000 mm. Provided is a polyester monofilament which exhibits high fiber diameter uniformity while also having high strength and a high modulus which are suitable for a very fine high mesh filter and a high mesh screen gauze for high-quality printing.

Figure 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a polyester monofilament suitable for a very fine high mesh filter and for a high mesh screen gauze used in high-quality printing that require a high fiber diameter uniformity. More specifically, the present invention relates to a high-modulus screen gauze having extremely high printing accuracy, and a monofilament suitable for obtaining a high mesh filter capable of achieving both filtration performance and permeation performance.

BACKGROUND ART

[0002] A gauze woven fabric obtained by weaving monofilaments, which is called a screen gauze, is applied in applications of molded filters that are used in automobiles, mobile phones, and the like, including mesh cloths for screen printing of printed circuit boards, in the field of electronics.

[0003] As for specific applications of the gauze woven fabric obtained by weaving monofilaments, examples of filter applications include a lint filter for preventing reattachment of dust in washing water, a filter for removing dust and dirt in a room mounted in an air conditioner, a molded filter for removing dust, dirt, and rubbish mounted in a vacuum cleaner in applications of filters, a blood transfusion kit for removing air bubbles and the like and a filter for an artificial dialysis circuit in the medical field, a fuel flow path such as a fuel pump and a fuel injection device, ABS, a brake, a transmission, a power steering, and the like in a field of automobiles. Furthermore, examples of applications of screen printing include T-shirts, banners, signboards, vending machine plates, vehicle panels, outdoor and indoor signs, ballpoint pens, various cards, name plates, scratches, Braille, CDs and DVDs, printed boards, plasma displays, liquid crystal displays, and the like.

[0004] In the applications of filters used in automobiles, mobile phones, and the like, it is required to achieve both downsizing of filters and dust prevention as well as permeability, and high mesh filters are in progress. Therefore, raw yarns having a small fineness are required as raw yarns for filters.

[0005] In screen printing applications of electronic circuits for home appliances, mobile phones, personal computers, and the like, in order to realize high printing accuracy, a screen gauze with less stretch and excellent dimensional stability has been required when stretching the gauze. In other words, high-strength and high-modulus raw yarns are required as raw yarns for the screen gauze.

[0006] In these applications, in addition to the above characteristics, the high fiber diameter uniformity of the raw yarns is commonly required, but it is known that a monofilament is pre-caused by a polymer gelled product, and a fiber diameter abnormal portion occurs, and various measures have been taken against the problem.

[0007] Patent Document 1 proposes a stationary kneader as a method for reducing occurrence of a fiber diameter abnormal portion. Although an effect of suppressing viscosity unevenness caused by thermal history of the polymer can certainly be expected from the stationary kneader, when a polymer having a high viscosity is used or when discharge amount of the polymer is small, the polymer is rather retained in the kneader and gelled while passing through a complicated flow path in the kneader. Accordingly, a monofilament having high strength raw yarns with a small fineness and having an excellent fiber diameter uniformity cannot be obtained. In addition, in Patent Document 1, determination of the number of fiber diameter abnormal portions employs a method in which the yarns are made to travel between slits adjusted to a specific width, and the number of times of breakage at the slits is regarded as the number of fiber diameter abnormal portions. However, in this method, there is a high possibility that the yarns are broken at the slits in a case of the fiber diameter abnormal portion having a sufficiently large diameter compared to a slit width, but in a case of the relatively small fiber diameter abnormal portion, the yarns are often deformed and slid through when passing through the slit. Therefore, the method for determining a fiber diameter abnormal portion in Patent Document 1 has a problem of poor accuracy.

[0008] Patent Document 2 proposes suppressing thermal deterioration of a polymer by reducing bending of a polymer liquid feeding pipe, setting a time from introduction of a pack to discharge to 1 minute or less, and reducing an amount of heat received by the polymer as much as possible. It is true that an effect of suppressing the thermal deterioration of the polymer can be expected by shortening residence time of the polymer, but when spinning small fineness raw yarns of the polymer, it is extremely difficult to set the time from introduction to discharge of a pack within 1 minute, and it is not possible to sufficiently provide a filtration tank for filtering foreign matters and a thermally deteriorated polymer, so that it is not possible to obtain a monofilament excellent in the fiber diameter uniformity.

[0009] Patent Document 3 proposes that generation of a thermally deteriorated product of a polymer is suppressed by defining a compound of the polymer together with a temperature and a heating time in a polymerization process of the polymer. Adopting the method of Patent Document 3 certainly has the effect of suppressing the thermally deteriorated product of the polymer in the polymerization process, but the thermally deteriorated product of the polymer is generated not only in the polymerization process of the polymer but also in the subsequent melting processes. In particular, when the discharge amount of the polymer is small or when a polymer having a high viscosity is used, deteriorated substances are more remarkably generated, and the fiber diameter uniformity is impaired. Therefore, unless filtration conditions immediately before the polymer is discharged from a spinneret are defined, monofilaments having high strength raw yarns with a small fineness and having the excellent fiber diameter uniformity cannot be obtained.

PRIOR ART DOCUMENT

PATENT DOCUMENTS

[0010]

Patent Document 1: Japanese Patent Laid-open Publication No. 2003-213528
Patent Document 2: Japanese Patent Laid-open Publication No. 2012-117196
Patent Document 3: WO 2019/044449 A

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0011] In order to obtain a polyester monofilament suitable for a very fine high mesh filter or a high mesh screen gauze for high-quality printing, raw yarns having a small fineness and a high strength is required.

[0012] However, when spinning small fineness yarns suitable for a very fine high mesh filter or a high mesh screen gauze for high-quality printing, amount of the polymer to be melt-spun decreases, and thus the residence time in the polymer liquid feeding pipe becomes long. As a result, thermal deterioration of the polymer proceeds, and fiber diameter abnormal portions are likely to occur. Furthermore, in order to improve the strength of the yarns, it is necessary to melt-spin a polymer having a high viscosity, but in a polymer having a high viscosity, a gelled product is likely to occur due to abnormal retention, and a fiber diameter abnormal portion is likely to occur. Furthermore, as the fineness is reduced, a size ratio of the gelled product deteriorated with respect to the fiber diameter relatively increases, so that even a minute gelled product that has not been a problem in prior art is likely to appear as fiber diameter abnormal portions. When fiber diameter abnormal portions such as a fiber diameter abnormal portion are included, fatal problems such as deterioration of filtration/permeation performance in a case of filter applications and occurrence of printing defects in a case of screen printing applications are induced, and thus it is necessary to enhance the fiber diameter uniformity of the monofilament as much as possible.

[0013] In the present invention, the problems mentioned above are improved, and a polyester monofilament having the high fiber diameter uniformity that is not obtained by conventional polyester monofilaments and is suitable for a very fine high mesh filter or a high mesh screen gauze for high-quality printing is provided.

SOLUTIONS TO THE PROBLEMS

[0014] A polyester monofilament having a fineness of 3.0 to 13.0 dtex, a strength of 5.0 to 9.0 cN/dtex, and a strength at 5% stretching of 2.7 to 6.0 cN/dtex, wherein a total length L of an abnormal portion existing in 1 million m in a fiber longitudinal direction and having a fiber diameter of 110% or more relative to the fiber diameter is 2,000 mm or less.

EFFECTS OF THE INVENTION

[0015] It is possible to provide a polyester monofilament having the excellent fiber diameter uniformity that is suitable for a very fine high mesh filter or a high mesh screen gauze for high-quality printing.

BRIEF DESCRIPTION OF THE DRAWING

[0016] Fig. 1 shows a schematic view of a fiber diameter chart for explaining a definition of a fiber diameter abnormal portion.

EMBODIMENTS OF THE INVENTION

[0017] The polyester monofilament of the present invention will be described.

[0018] The polyester used in the polyester monofilament of the present invention may be a polyester containing a polyethylenelene terephthalate (hereinafter referred to as PET) as a main component.

[0019] As PET used in the present invention, it is possible to use a polyester which contains terephthalic acid as a main acid component and ethylene glycol as a main glycol component, and 90 mol% or more of ethylene terephthalate repeating units. PET may, however, contain a copolymerization component capable of forming another ester bond in a proportion of less than 10 mol%. Examples of such copolymerization components include, as an acid component, bifunctional aromatic carboxylic acids such as an isophthalic acid, a phthalic acid, a dibromoterephthalic acid, a naphthalene dicarboxylic acid, and an o-ethoxybenzoic acid, bifunctional aliphatic carboxylic acids such as a sebacic acid, an oxalic acid, an adipic acid, and a dimer acid, and dicarboxylic acids such as a cyclohexanedicarboxylic acid, and as a glycol component, an ethylene glycol, a diethylene glycol, a propanediol, a butanediol, a neopentyl glycol, a bisphenol A, a cyclohexane dimethanol, and polyoxyalkylene glycols such as a polyethylene glycol and a polypropylene glycol, and the like, but the copolymer components are not limited thereto.

[0020] PET may contain, as additives, a titanium dioxide as a matting agent, a silica or alumina fine particles as a lubricant, a hindered phenol derivative as an antioxidant, and furthermore, a flame retardant, an antistatic agent, an ultraviolet absorber, a coloring pigment, and the like as required.

[0021] Polyester monofilaments include single component monofilaments formed from a single polyester, and composite polyester monofilaments formed from two types of polyesters, but the present invention is not limited to either. However, as the strength is increased, reed scraping during weaving is likely to occur. Therefore, by forming a core-sheath type composite polyester monofilament in which a high-viscosity polymer is disposed as a core component responsible for strength and a low-viscosity polymer excellent in abrasion resistance is disposed so as to cover the core component as necessary, it is possible to achieve both high strength and abrasion resistance.

[0022] Here, the core-sheath type means that it is sufficient that the core component is completely covered with a sheath component, and it is not always necessary that the core components are arranged concentrically. Furthermore, there are several cross-sectional shapes such as a circle, a flat shape, a triangle shape, a square shape, and a pentagonal shape, but a circular cross section is preferable from a viewpoint of uniformity of mesh opening of the screen gauze.

[0023] From a viewpoint of achieving both scum suppressing effect by the sheath components and high strength by the core component, a composite ratio of the core component to the sheath component is preferably in a range of 60 : 40 to 95 : 5, and more preferably in a range of 70 : 30 to 90 : 10. Here, the composite ratio is a cross-sectional area ratio of two types of polyesters constituting the composite polyester monofilament in a transverse cross-sectional photograph of the filament.

[0024] Next, physical properties of the polyester monofilament of the present invention will be described. As a result of intensive studies by the present inventors on monofilaments suitable for a very fine high mesh filter and a high mesh screen for high-quality printing, the present inventors have found that when the length of the fiber diameter abnormal portion is within a specific range, a woven fabric having small variations in the opening and being good for obtaining a very fine high mesh filter and a high mesh screen gauze for high-quality printing can be obtained. Specifically, by setting the fiber diameter abnormal portion having a large fiber diameter of 10% or more with respect to the fiber diameter, which exists in 1 million m in the fiber longitudinal direction of the monofilament, to 2,000 mm or less, it is possible to obtain a woven fabric excellent in the uniformity of mesh opening when woven. The fiber diameter abnormal portion is preferably 1,500 mm or less, and more preferably 1,000 mm or less.

[0025] In addition, the polyester monofilament has a fineness of 3.0 to 13.0 dtex. It is preferably in a range of 3.0 to 8.0 dtex. Within such a range, a high mesh filter and a screen gauze of #400 (400 yarns per 1 inch = 2.54 cm) or more suitable for a very fine filter and high-quality printing are obtained. Furthermore, when the fineness is 8 dtex or less, it is possible to even achieve the high mesh filters. The lower limit of the fineness is preferably 3.0 dtex or more from a viewpoint of weaving properties, in particular, running properties of weft yarn in a Sulzer type loom. Furthermore, the strength is 5.0 to 9.0 cN/dtex, and the strength (modulus) at 5% stretching is 2.7 to 6.0 cN/dtex. When the strength is less than 5.0 cN/dtex, there is a concern that the weaving properties are deteriorated, and particularly in a small fineness variety of 13 dtex or less, woven fabric breakage may occur due to a decrease in strength. When the strength (the modulus) at the time of 5% stretching is less than 2.7 cN/dtex, a mesh gap is likely to occur at the time of stretching the gauze, clogging of an opening portion and a temporal change in the dimension after stretching the gauze increase, and thus the dimensional stability over time may not be obtained. An upper limit value is desirably 9.0 cN/dtex or less in strength and 6.0 cN/dtex or less in strength at 5% stretching from a viewpoint of scum during weaving.

[0026] Next, a preferable method for producing the polyester monofilament of the present invention will be described. An intrinsic viscosity (IV) of the polyester is desirably 0.75 to 1.50. When the intrinsic viscosity is 0.75 or more, a high strength and a high modulus can be achieved, and when the intrinsic viscosity is 1.50 or less, a melt molding is facilitated. Furthermore, when a core-sheath composite monofilament is formed, the intrinsic viscosity of the polyester used in the sheath component is preferably lower than the intrinsic viscosity of the polyester used in the core component, and difference thereof is preferably 0.20 to 1.00. When the difference in the intrinsic viscosity is 0.20 or more, a degree of orientation and a degree of crystallinity of the surface of the polyester of the sheath component, that is, a composite polyester monofilament fiber, can be suppressed, and a good scum resistance can be obtained. Furthermore, since the sheath component bears a shear stress on an inner wall surface of a spinneret discharge hole of a melt spinning, a shear force received by the core component is reduced. Accordingly, since the core component has a low molecular chain orientation degree and is spun in a uniform state, the strength of the finally obtained composite polyester monofilament is improved. When the difference in the intrinsic viscosity is 1.00 or less, the orientation of the sheath component appropriately proceeds, and a high strength is obtained. The difference is more preferably 0.30 to 0.70.

[0027] The polyester monofilament of the present invention is obtained by melting and extruding a polymer using a spinning machine, sending the polymer to a predetermined spinning pack, filtering the polymer in the pack, and then spinning the polymer from the spinneret. The yarns can also be produced by any production method such as a two-step method in which a yarn discharged from a spinneret is once wound as an unstretched yarn and then stretched, or a direct spinning and stretching method in which the yarns discharged from the spinneret is continuously stretched without being once wound.

[0028] The polyester monofilament of the present invention is filtered in a melt spinning pack provided with a nonwoven fabric filter layer (hereinafter, a gel capturing filter) formed by sintering metal short fibers having a circular cross section and a filter layer (hereinafter, a gel subdividing filter) formed by sintering metal short fibers having a polygonal cross section, which are provided in the melt spinning pack, in a molten polymer spun from the spinneret. With the two types of filter layers having different cross sections of metal short fibers, it is possible to capture and subdivide a gel-like material generated during melting, so that the fiber diameter abnormal portion having a large fiber diameter of 10% or more with respect to the fiber diameter is reduced, and uniformity of the monofilament is improved.

[0029] A first feature of the method for producing the polyester monofilament of the present invention is to pass a molten polymer spun from the spinneret through the filter layer (hereinafter, the gel subdividing filter) formed by sintering metal short fibers having a polygonal cross section placed in a melt spinning pack to cut and subdivide a gel-like material generated by thermal deterioration of the polymer before spinning.

[0030] A desired filtration accuracy of the gel subdividing filter is 40 um or less. Within such range, the fiber diameter abnormal portion having a large fiber diameter by 10% or more with respect to the fiber diameter can be reduced, and the fiber diameter uniformity of the monofilament is improved. When the filtration accuracy exceeds 40 um, the size of the gel-like material passing through without being subdivided increases. Incidentally, the filtration accuracy of 40 um means that it has performance of removing 980 or more of gel-like material (foreign matters) of 40 um or more. Furthermore, by setting a thickness of the gel subdividing filter to 2 mm or more, a filtration flow path becomes long, and a sufficient effect of subdividing the gel-like material can be obtained. When the thickness is less than 2 mm, the filtration flow path becomes short, a sufficient effect of subdividing the gel-like material cannot be obtained, and the uniformity of the monofilament cannot be obtained. In addition, although the effect of subdividing the gel-like material is improved when the thickness is increased, a pack pressure also increases, and thus a preferable upper limit is 3 mm from a viewpoint of the pack pressure.

[0031] The cross-sectional shape of the metal short fibers constituting the filter is polygonal. When the metal short fibers having a polygonal shape are used, entanglement between the metal fibers occurs, and filterability and dispersibility are improved. The gel-like material can be finely dispersed by a void portion formed by laminating and sintering the polygonal metal short fibers, and the gel-like material generated by thermal deterioration of the polymer is cut by further forming the polygonal metal short fibers into an acute-angle cross-sectional shape, so that the effect of subdividing the gel-like material is obtained.

[0032] The effect of subdividing the gel-like material cannot be obtained only by a filter layer formed by simply sintering the metal short fibers having a circular cross section, but is not sufficiently realized only by reducing a basis weight of a filter formed by sintering the metal short fibers having the circular cross section, and only causes a further increase in the pack pressure due to the clogging. By forming the cross section of the metal short fibers into a polygonal shape, a sufficient effect of subdividing the gel-like material can be exerted with a filter having low filtration accuracy (a coarse basis weight), and the uniformity of the monofilament is improved.

[0033] A second feature of the method for producing the polyester monofilament of the present invention is that a gel-like material generated by thermal deterioration of a polymer is sufficiently captured by passing the molten polymer spun from the spinneret through the gel capturing filter formed by sintering the metal short fibers having a circular cross section placed in the melt spinning pack.

[0034] The desired filtration accuracy of the gel capturing filter is 10 um or less. Within such range, a large gelled product is captured, a fiber diameter abnormal portion having a large fiber diameter of 10% or more with respect to the fiber diameter can be reduced, and the fiber diameter uniformity of the monofilament is improved. When the filtration accuracy of the gel capturing filter exceeds 10 μm, a large gelled product is not captured but passes through, and the fiber diameter uniformity of the monofilament is deteriorated. Furthermore, by setting the thickness of the gel capturing filter to 2 mm or more, the filtration flow path becomes long, a sufficient gel-like material capturing effect is obtained, and the uniformity of the monofilament is improved. When the thickness is less than 2 mm, the filtration flow path becomes short, a sufficient gel capturing effect cannot be obtained, and good monofilament uniformity cannot be obtained. In addition, although the effect of supplementing the gel-like material is improved as the thickness increases, the pack pressure also increases, and thus a preferable upper limit is 3 mm from the viewpoint of the puck pressure.

[0035] Since the two kinds of filter layers having different cross sections of the metal short fibers respectively exhibit separate effects of "capturing" and "subdividing" of the gel-like material, order of the filter layers is not largely depended on, but it is more preferable to install the gel capturing filter upstream. This is because, by installing the gel capturing filter on the upstream side, the gel-like material having a large size is reliably captured by the gel capturing filter with high filtration accuracy, and the gel-like material that cannot be captured and separated by the gel capturing filter is cut and subdivided by the gel subdividing filter installed on the downstream side, whereby the capturing and subdividing of the gel-like material can be more efficiently advanced. However, it should be noted that although the effect of improving the fiber diameter abnormal portion is one step superior when the gel subdividing filter is disposed upstream, the effect is accompanied by an increase in the pack pressure as compared with a case where the gel subdividing filter is disposed downstream. In that case, for example, by using a filter processed into a wave shape and having an increased filtration area as compared with a normal flat cross section filter, foreign matters holding capacity of the filter is increased, and the pressure increase of the pack is reduced, so that a production application is possible.

[0036] In particular, in the melt spinning of small fineness and high viscosity polyesters, the abnormal retention is likely to occur due to the high viscosity. Furthermore, when the fineness is smaller, the size ratio of the gelled product deteriorated with respect to the fiber diameter relatively increases, so that it is necessary to capture the gelled product with higher accuracy. However, in a general method of simply using a filtration filter with a higher basis weight in order to improve filtration accuracy, a significant increase in the pack pressure is caused, leading to an extreme decrease in productivity. Therefore, as a result of intensive studies from both quality and productivity, as described above, the present inventors have achieved both improvement in filtration accuracy and productivity by using filtration filters having different purposes of capturing and subdividing of the gelled product, defining the thickness (the filtration flow path length) of each filtration filter, and using a filtration filter processed into the wave shape.

[0037] As a result, the polyester monofilament of the present invention can be suitably used for a very fine high mesh filter or a high mesh screen gauze for high-quality printing, in which there are few fiber diameter abnormal portions having a large fiber diameter of 10% or more with respect to the fiber diameter, and the mesh opening is uniform when woven.

EXAMPLES

[0038] Hereinafter, the present invention will be described more specifically by means of examples. The measured values in the examples were measured through the following methods.

(1) Fineness

[0039] Yarns were wound up into a 500-m skein, and a value obtained by multiplying a mass (g) of the skein by 20 was defined as a fineness.

(2) Average fiber diameter

[0040] Calculation was performed using the following formula.

[Mathematical Formula 1]

$$Average\ fiber\ diameter\ (\mu m) = 20 \times \sqrt{\frac{x}{\rho \times \pi}}$$

(x: fineness
ρ: density of polyester monofilament)

(3) Total length L of fiber diameter abnormal portion

[0041] As the fiber diameter of the monofilament, an optical outer shape measuring instrument (PSD-200) manufactured by Sensoptic SA, which measures the fiber diameter by irradiating a traveling thread with light and detecting a light amount change of a reflected light from the yarns, was used.

[0042] Fig. 1 shows a schematic view of a fiber diameter chart obtained by an optical outer shape measuring instrument. A horizontal axis represents time, and a vertical axis represents fiber diameter, and fiber diameter values obtained by an optical outer shape measuring instrument are continuously shown as charts.

[0043] A point at which a fiber diameter value 1 obtained by the optical outer shape measuring instrument exceeds a threshold 3, which is a fiber diameter value 10% higher than an average fiber diameter 2, is defined as a starting point 4 of the fiber diameter abnormal portion, and a point at which the fiber diameter value 1 falls below the threshold 3 is defined as an ending point 5 of the fiber diameter abnormal portion.

[0044] The length of one fiber diameter abnormal portion was calculated from the time and a traveling speed of the yarns with the starting point 4 to the ending point 5 of the fiber diameter abnormal portion as the length of the one fiber diameter abnormal portion.

[0045] In order to detect a local abnormal portion without omission, a sampling period of the measuring instrument was set to 200 kHz (200,000 times/second), the traveling speed of the yarns was set to 500 m/min, and the fiber diameter for 1 million m was measured at intervals of a yarn length of 0.04 mm. Furthermore, the total length of all the fiber diameter abnormal portions existing in the fiber length of 1 million m was defined as the total length L of the fiber diameter abnormal portion.

(4) Intrinsic viscosity (IV)

[0046] In 10 mL of o-chlorophenol (hereinafter abbreviated as OCP) having a purity of 980 or more, 0.8 g of a sample polymer was dissolved. A relative viscosity (ηr) and an intrinsic viscosity (IV) of the polymer were determined and calculated according to the following formula using an Ostwald viscometer at a temperature of 25°C.

$$\text{Relative viscosity } (\eta r) = \eta/\eta_0 = (t \times d)/(t_0 \times d_0)$$

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

[0047] In the formula, η is the viscosity of a polymer solution, η_0 is the viscosity of OCP, t is a dropping time of the solution (second), d is a density of the solution (g/cm^3), t_0 is a dropping time of OCP (second), and d_0 is a density of OCP (g/cm^3).

(5) Strength (cN/dtex) and strength (modulus) at 5% stretching (cN/dtex)

[0048] Measurement was performed according to JIS L1013(2010) using Tensilon UCT-100 manufactured by ORIENTEC CORPORATION.

(6) Number of defects of woven fabric (gauze quality)

[0049] A polyester monofilament according to each of the examples and the comparative examples of the present invention was used for both warp and weft, and a mesh woven fabric having a weaving width of 1.8 m and #400 (a warp density: 400 yarns/2.54 cm, a weft density: 400 yarns/2.54 cm) at a rotation speed of the loom of 200 revolutions/min was woven with the Sulzer type loom. Thereafter, the obtained mesh woven fabric was set in a fabric inspection machine, and the number of defects (the number of abnormal portions in the openings) of the mesh woven fabric was visually counted. When an abnormal portion of the mesh opening was present, the mesh opening spread and appeared as a black streak on the woven fabric. Therefore, a portion where the black streak was observed in the woven fabric was counted as the number of defects. A case where the number of defects per 1 m of the woven fabric was 0.010 or less was rated A, a case where the number of defects per 1 m of the woven fabric was 0.030 or less was rated B, a case where the number of defects per 1 m of the woven fabric was 0.050 or less was rated C, and a case where the number of defects per 1 m of the woven fabric was more than 0.050 was rated D, and A and B were regarded as acceptable.

(Example 1)

[0050] PET having an intrinsic viscosity of 1.00 (glass transition temperature: 80°C) 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, respectively, using an extruder, and then subjected to pump measurement at a polymer temperature of 280°C such that the composite ratio was core component : sheath component = 80 : 20, and the melted materials were caused to flow into a known composite spinneret so as to be the core-sheath type.

[0051] In a molten polymer spun from the spinneret, the gel-like material was sufficiently captured by passing through the gel capturing filter (with the filtration accuracy of 10 um, and the thickness of 2 mm) layer formed by sintering the metal fibers having a circular cross section placed in a melt spinning pack, and the gel-like material generated by the thermal deterioration of a polymer was captured and subdivided by passing through the gel subdividing filter (with the filtration accuracy of 40 um, and the thickness of 2 mm) layer formed by sintering the metal fiber having a polygonal cross section placed downstream of the gel capturing filter and in which a gelled product that could not be captured and separated by the gel capturing filter was placed. In addition, both the gel capturing filter and the gel subdividing filter were processed into the wave shape, and a filter having the same diameter as that of the filter having a planar cross section and having a filtration area increased by 2.5 times was used.

[0052] Composite polyester monofilament yarns discharged from the spinneret was heated and kept by a heating body such that ambient temperature immediately below the spinneret was 290°C, and then cooled by a yarn cooling blower. A finishing agent was applied by an oil agent applying device. Thereafter, the composite polyester monofilament yarns were taken up at a speed of 552 m/minute, and appropriately stretched so as to have a desired strength without being wound once, and heat-set to obtain a polyester monofilament having a fineness of 8.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex. The characteristics of the polyester monofilament are as shown in Table 1, and the polyester monofilament had a small fineness, a high strength, and a high modulus, and was very excellent in the weaving properties with a #400 high mesh. Furthermore, the woven fabric was also excellent in the fiber diameter uniformity, the length L of the abnormal portion of the fiber diameter included in a yarn length of 1 million m was 646.9 mm, and the number of defects of the woven fabric confirmed after weaving was 0.008/m, which was very good.

(Example 2)

[0053] A polyester monofilament having a fineness of 8.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex were obtained in the same manner as in Example 1 except that the order of the gel subdividing filter and the gel capturing filter was reversed to the downstream side and the filter having a planar cross section was used. The properties of the polyester monofilament are shown in Table 1. The length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 818.8 mm, and the number of defects of the woven fabric confirmed after weaving was 0.011/m, which was a sufficiently practical level.

(Example 3)

[0054] A polyester monofilament having a fineness of 13.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex were obtained in the same manner as in Example 1 except that the discharge amount was changed to change the fineness. The properties of the obtained polyester monofilament are shown in Table 1. Although inferior to Example 1, the high mesh weaving properties of #400 was good. In addition, the length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 283.7 mm, and the number of defects of the woven fabric confirmed after weaving was 0.004/m, which was very good.

(Example 4)

[0055] A polyester monofilament having 3.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex were obtained in the same manner as in Example 1 except that the discharge amount was changed to change the fineness. The properties of the obtained polyester monofilament are shown in Table 1. The high mesh weaving properties of #400 was very good. The length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 1334.2 mm, and the number of defects of the woven fabric confirmed after weaving was 0.018/m, which was a sufficiently practical level.

(Example 5)

[0056] A polyester monofilament having a strength of 6.0 cN/dtex, a strength at 5% stretching of 3.6 cN/dtex, and a fineness of 8.0 dtex was obtained in the same manner as in Example 1 except that the intrinsic viscosity of the core component polyester was changed to 0.78. The properties of the obtained polyester monofilament are shown in Table 1. Compared to Example 1, the temporal change of the woven fabric dimension after weaving was slightly large, and the printing accuracy when applied as the screen gauze was one step inferior, but it was at a level that was sufficiently durable for practical use. The length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 385.8 mm, and the number of defects of the woven fabric confirmed after weaving was 0.005/m, which was very good.

(Example 6)

[0057] A polyester monofilament having a strength of 8.9 cN/dtex, a strength at 5% stretching of 5.9 cN/dtex, and a fineness of 8.0 dtex was obtained in the same manner as in Example 1 except that the intrinsic viscosity of the core component polyester was changed to 1.20. The properties of the obtained polyester monofilament are shown in Table 1. There was no breakage of the woven fabric, and the temporal change of the woven fabric dimension after weaving was very small as compared to Example 1, and the printing accuracy when applied as the screen gauze was a more superior result. The length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 944.7 mm, and the number of defects of the woven fabric confirmed after weaving was 0.014/m, which was a sufficiently practical level.

(Example 7)

[0058] A single-component polyester monofilament having a fineness of 8.0 dtex, a strength at 5% stretching of 5.3 cN/dtex, and a strength of 8.1 cN/dtex was obtained in the same manner as in Example 1 except that PET having an intrinsic viscosity of 1.00 (a glass transition temperature: 80°C) was melted at a temperature of 295°C using an extruder, then subjected to pump measurement at a polymer temperature of 280°C, and introduced into a known single-component spinneret. The properties of the obtained polyester monofilament are shown in Table 1. The high mesh weaving properties of #400 was good, and the temporal change of the woven fabric dimension after weaving was also very small. The length L of the abnormal portion of the fiber diameter included in the yarn length of 1 million m was 764.4 mm, and the number of defects of the woven fabric confirmed after weaving was 0.010/m, which was very good.

(Comparative Example 1)

[0059] A polyester monofilament having a fineness of 8.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex was obtained in the same manner as in Example 1 except that a generally applied filtration filter provided with only a gel capturing filter (with a filtration accuracy of 10 um, and a thickness of 1 mm) obtained by sintering a metal fiber having a circular cross section was used. The characteristics of the polyester monofilament are as shown in Table 1, the length L of the abnormal portion of the fiber diameter contained in the yarn length of 1 million m was 18180.0 mm, which greatly exceeded 2000 mm, and the number of defects of the confirmed woven fabric was 0.430/m, which was extremely inferior to Example 1.

(Comparative Example 2)

[0060] A polyester monofilament having a fineness of 13.0 dtex, a strength at 5% stretching of 2.9 cN/dtex, and a strength of 5.0 cN/dtex were obtained in the same manner as in Comparative Example 1, except that the intrinsic viscosity of the core component polyester was changed to 0.70 and the fineness was changed by changing the discharge amount. The characteristics of the polyester monofilament are as shown in Table 1. The length L of the abnormal portion of the fiber diameter contained in the yarn length of 1 million m was 2810.0 mm, which exceeded 2000 mm, and the number of defects of the woven fabric confirmed after weaving was 0.040/m, which was inferior to that of Example 1.

(Comparative Example 3)

[0061] A polyester monofilament having a fineness of 8.0 dtex, a strength at 5% stretching of 4.6 cN/dtex, and a strength of 7.5 cN/dtex were obtained in the same manner as in Example 2, except that the thickness of the gel capturing filter was changed to 1 mm. The characteristics of the obtained polyester monofilament are as shown in Table 1, the length L of the abnormal portion of the fiber diameter contained in the yarn length of 1 million m was 3902.5 mm, which exceeded 2000 mm, and the number of defects of the woven fabric confirmed after weaving was 0.067/m, which was inferior to Example 1.

[Table 1-1]

			Example 1	Example 2	Example 3	Example 4	Example 5
			Composite monofilament	Composite monofilament	Composite monofilament	Composite monofilament	Composite monofilament
Spinning conditions	Gel capturing filter	Filtration accuracy (μm)	10	10	10	10	10
		Thickness (mm)	2	2	2	2	2
		Cross-sectional shape	Circular	Circular	Circular	Circular	Circular
	Gel subdividing filter	Filtration accuracy (μm)	40	40	40	40	40
		Thickness (mm)	2	2	2	2	2
		Cross-sectional shape	Substantially polygonal	Substantially polygonal	Substantially polygonal	Substantially polygonal	Substantially polygonal
	Filter order		Capturing → subdividing	Subdividing → capturing	Capturing → subdividing	Capturing → subdividing	Capturing → subdividing
	Filter cross-sectional shape		Wave shape	Planar	Wave shape	Wave shape	Wave shape
Physical properties of yarns	Fineness (dtex)		8.0	8.0	13.0	3.0	8.0
	Strength (cN/dtex)		7.5	7.5	7.5	7.5	6.0
	Strength at 5% stretching (cN/dtex)		4.6	4.6	4.6	4.6	3.6
	Fiber diameter abnormal portion (mm/1 million m)		646.9	818.8	283.7	1334.2	385.8
Gauze quality (Number of defects of woven fabric)			A (0.008/m)	B (0.011/m)	A (0.004/m)	B (0.018/m)	A (0.005/m)

[Table 1-2]

			Example 6	Example 7	Comparative Example 1	Comparative Example 2	Comparative Example 3
			Composite monofilament	Single component monofilament	Composite monofilament	Composite monofilament	Composite monofilament
Spinning conditions	Gel capturing filter	Filtration accuracy (μm)	10	10	10	10	10
		Thickness (mm)	2	2	1	1	1
		Cross-sectional shape	Circular	Circular	Circular	Circular	Circular
	Gel subdividing filter	Filtration accuracy (μm)	40	40	-	-	40
		Thickness (mm)	2	2	-	-	2
		Cross-sectional shape	Substantially polygonal	Substantially polygonal	-	-	Substantially polygonal
	Filter order		Capturing → subdividing	Capturing → subdividing	Capturing only	Capturing only	Subdividing → capturing
	Filter cross-sectional shape		Wave shape	Wave shape	Planar	Planar	Planar
Physical properties of yarns	Fineness (dtex)		8.0	8.0	8.0	13.0	8.0
	Strength (cN/dtex)		8.9	8.1	7.5	5.0	7.5
	Strength at 5% stretching (cN/dtex)		5.9	5.3	4.6	2.9	4.6
	Fiber diameter abnormal portion (mm/1 million m)		944.7	764.4	18180.0	2810.0	3902.5
Gauze quality (Number of defects of woven fabric)			B (0.014/m)	A (0.010/m)	D (0.430/m)	C (0.040/m)	C (0.067/m)

DESCRIPTION OF REFERENCE SIGNS

[0062]

1: Fiber diameter value
2: Average fiber diameter
3: Threshold (fiber diameter value 10% higher than average fiber diameter)
4: Starting point of fiber diameter abnormal portion
5: Ending point of fiber diameter abnormal portion

INDUSTRIAL APPLICABILITY

[0063] The polyester monofilament of the present invention can be applied to a very fine high mesh filter or a high mesh screen gauze for high-quality printing.

Claims

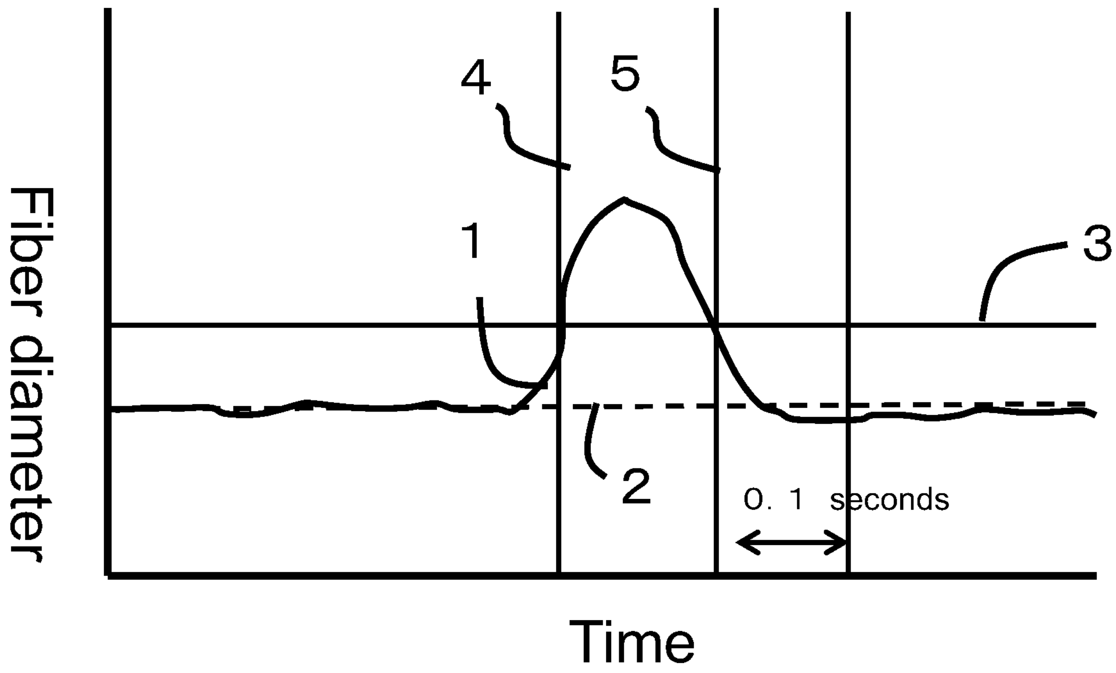
1. A polyester monofilament having a fineness of 3.0 to 13.0 dtex, a strength of 5.0 to 9.0 cN/dtex, and a strength at 5% stretching of 2.7 to 6.0 cN/dtex,
wherein a total length L of an abnormal portion existing in 1 million m in a fiber longitudinal direction and having a fiber diameter of 110% or more relative to the fiber diameter is 2,000 mm or less.

2. The polyester monofilament according to claim 1, wherein the polyester monofilament has a fineness of 8 dtex or less.

3. A method for producing the polyester monofilament according to claim 1 or 2, wherein in a method for melt spinning a polyester monofilament, a molten polymer is filtered through a filter layer having the characteristics of the following items A to D, and then spun from a spinneret, including:

   A. a filter layer is formed by sintering metal short fibers having a circular cross section, and includes a gel capturing filter having a filtration accuracy of 10 um or less and a thickness of 2 mm or more;
   B. a filter layer is formed by sintering metal short fibers having a polygonal cross section, and includes a gel subdividing filter having a filtration accuracy of 40 um or less and a thickness of 2 mm or more;
   C. a gel capturing filter and a gel subdividing filter are disposed from an upstream side of a filtering portion; and
   D. at least one of the gel capturing filter and the gel subdividing filter has a wave shape.

Figure 1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/020583

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. D01F6/62(2006.01)i, D01D1/10(2006.01)i, D01F8/14(2006.01)i
FI: D01F6/62302E, D01D1/10102, D01F8/14B

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. D01F1/00-9/04, D01D1/00-13/02, D03D1/00-13/02, B01D39/00-41/04

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 1971-2021
Registered utility model specifications of Japan 1996-2021
Published registered utility model applications of Japan 1994-2021

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.
X A	JP 201 1-21296 A (TEIJIN FIBERS LTD.) 03 February 2011 (2011-02-03), claim 1	1-2 3
X A	JP 2008-101288 A (TEIJIN FIBERS LTD.) 01 May 2008 (2008-05-01), claim 1	1-2 3
X A	JP 2008-69491 A (TEIJIN FIBERS LTD.) 27 March 2008 (2008-03-27), claims 1, 5, 6, paragraph [0031], examples 2, 3	1-2 3
X A	JP 2008-95242 A (TEIJIN FIBERS LTD.) 24 April 2008 (2008-04-24), claims 1-3, examples 1-5	1 2-3
A	WO 2019/044449 A1 (TORAY INDUSTRIES, INC.) 07 March 2019 (2019-03-07), claim 1, examples	1-3

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

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Date of the actual completion of the international search	Date of mailing of the international search report
09 July 2021	20 July 2021
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/020583

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 2016/052269 A1 (TORAY INDUSTRIES, INC.) 07 April 2016 (2016-04-07), examples	1-3
A	JP 2015-81399 A (TMT MACHINERY INC.) 27 April 2015 (2015-04-27), claims, paragraph [0060], examples	1-3
A	JP 5-253418 A (TOKYO SEIKO CO., LTD.) 05 October 1993 (1993-10-05), claims	1-3
P, X P, A	WO 2020/175370 A1 (TORAY INDUSTRIES, INC.) 03 September 2020 (2020-09-03), claims 1, 2, examples	1-2 3
P, A	JP 2020-143403 A (TORAY INDUSTRIES, INC.) 10 September 2020 (2020-09-10), claims, examples	1-3

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/020583

JP 2011-21296 A	03 February 2011	(Family: none)
JP 2008-101288 A	01 May 2008	(Family: none)
JP 2008-69491 A	27 March 2008	(Family: none)
JP 2008-95242 A	24 April 2008	(Family: none)
WO 2019/044449 A1	07 March 2019	EP 3677709 A1 claim 1, examples CN 110770376 A TW 201919748 A
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JP 5-253418 A	05 October 1993	(Family: none)
WO 2020/175370 A1	03 September 2020	(Family: none)
JP 2020-143403 A	10 September 2020	(Family: none)

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REFERENCES CITED IN THE DESCRIPTION

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