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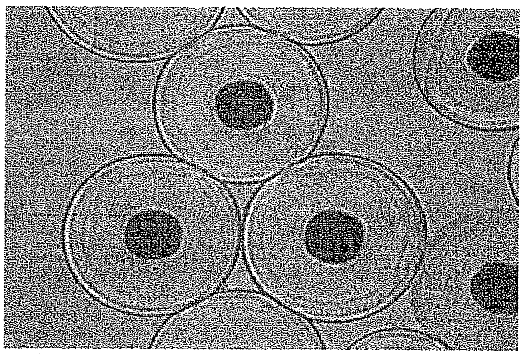
(54) POLYESTER COMPOSITE FIBER WITH EXCELLENT HEAT-SHIELDING PROPERTY AND COLORATION

(57) To provide a polyester composite fiber having a heat-shielding property due to high reflectance in an infrared wavelength range (800 to 3000 nm) easy to be changed into thermal energy, and having color development property comparable to that of conventional polyester fibers. The composite fiber is a core-sheath type composite fiber including a core component and a sheath component of 10: 90 to 30: 70 (mass ratio). The core component includes a thermoplastic polymer including a sunlight shielding material having an average particle size of 0.5 μm or smaller in 8-70 wt%. The sheath component includes a polyester-type polymer including heat-shielding fine particles in 0.5-10 wt%, the heat-shielding fine particles capable of maintaining color development property and having an average particle size of 0.1 μm or smaller which is smaller than that of the sunlight shielding material.

Fig. 2



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Description

CROSS REFERENCE TO THE RELATED APPLICATION

[0001] This application is based on and claims Convention priority to Japanese patent application No. 2012-014682, filed on January 27, 2012, the entire disclosure of which is herein incorporated by reference as a part of this application.

FIELD OF THE INVENTION

[0002] The present invention relates to a polyester composite fiber (or conjugated or bicomponent or heterofil fiber) having a heat-shielding property due to high reflectance in an infrared wavelength range (800 to 3000 nm) which is easy to be changed into thermal energy, as well as having color development property comparable to that of conventional polyester fibers.

BACKGROUND ART

[0003] Hitherto, many fabrics providing a cool sensation have been suggested. There have been known, for example, a method for giving a fabric a cool sensation obtainable from a heat insulating effect by contriving a fiber shape or a way of weaving (Patent Document 1); a method for increasing infrared ray reflectivity by covering a fabric composed of fibers having its surface plated with silver (Patent Document 2); and a method for reflecting infrared rays of wavelengths (800 to 3000 nm) by incorporating titanium oxide into both core and sheath components (Patent Document 3).

[0004] Patent Document 1 states that by use of a specific bulky polyester multifilament crimped yarn made of a single filament containing a sunlight shielding material in an amount of 3% by weight or more based on the whole while containing the sunlight shielding material in an amount of 0.8% by weight or less based on a sheath part thereof, a fabric can be obtained which has a large volume of air inside yarns constituting the fabric to exhibit a heat insulating effect, thereby giving an excellent cool sensation.

[0005] Patent Document 2 states that a fabric product having infrared ray reflectivity which comprises a fabric material made of a fiber having its surface plated with silver can be used as a temporary-type tent building, a roof material of a domed building, or a leisure tent building so as to make infrared rays of solar heat reflected resulting in adjustment of the temperature inside of those buildings.

[0006] Patent Document 3 states that a fiber comprising a core part containing 3% by weight or more of titanium oxide having an average particle size of 0.8 to 1.8 μm and a sheath part containing 0.5 to 10% by weight of titanium oxide having an average particle size of 0.4 μm or smaller reflects the wavelengths of infrared rays, which are easy to be changed into thermal energy, to gain a heat-shielding effect.

[0007] Patent Document 4 discloses a knitted fabric including 40% by weight or more of a core-sheath synthetic fiber comprising a core part containing an inorganic oxide fine particle in an amount of 3 to 20% by weight and a sheath part containing an inorganic oxide fine particle in an amount of 2% by weight or less, wherein an infrared absorbent being caused to adhere evenly onto this knitted fabric. The document states that this knitted fabric can reflect both visible rays and ultraviolet rays by the core-sheath synthetic fiber, as well as can prevent infrared ray penetration due to the adhesion of the infrared absorbent.

[0008] However, according to Patent Document 1, in order to make the yarn bulky, Patent Document 1 requires a step of supplying a highly oriented undrawn yarn to a heat treatment machine so as to be subjected to over-feed treatment, drawing the treated yarn, and false-twisting the drawn yarn. This increases the cost.

[0009] According to Patent Document 2, the silver-plated fabric is essentially used so as to require a step of silver plating, resulting in increase of the cost. Additionally, a drawback is also generated that the fabric unfavorably shields light by the silver plating applied to the fabric.

[0010] Patent Document 3 has a drawback that the fiber has a deteriorated color development property when it dyed since the sheath component contains 0.5 to 10% by weight of titanium oxide.

[0011] According to Patent Document 4, since the sheath component only contains 3 to 20% by weight of the inorganic oxide fine particles, this core-sheath synthetic fiber does not have sufficient infrared ray reflectivity by itself, as is evident from the fact that the infrared absorbent is applied to the knitted fiber.

RELATED ART DOCUMENTS

PATENT DOCUMENTS

[0012]

[Patent Document 1] JP Laid-open Patent Publication No. 8-158186
[Patent Document 2] JP Laid-open Patent Publication No. 8-92842
[Patent Document 3] JP Laid-open Patent Publication No. 2011-241530
[Patent Document 4] JP Laid-open Patent Publication No. 2008-223171

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0013] The present invention is to solve such problems in the conventional technology.

[0014] An object of the invention is to provide a core-sheath type composite fiber (or core-sheath type conjugated or bicomponent fiber) being capable of reflecting infrared rays so as to achieve a heat-shielding effect as well as being capable of developing a vivid color without causing opacity caused by whitening.

[0015] Another object of the invention is to provide a core-sheath type composite fiber which is good in spinnability, and can attain an excellent heat-shielding property and color development property.

MEANS FOR SOLVING THE PROBLEMS

[0016] In order to solve the above-mentioned problems, the inventors have made eager investigations to find out that: it has been considered impossible in the conventional technology to improve color development property by incorporating a sunlight shielding material into a fiber because the fiber is inevitably whitened by reflectivity of the sunlight shielding material; however, the inventors have found that a specific core-sheath type fiber can achieve both heat-shielding effect and coloration by (i) incorporating a sunlight shielding material having a specific mean particle size into the core component, (ii) incorporating, into the sheath component, heat-shielding fine particles having a specific mean particle size smaller than the mean particle size of those in the core, and further (iii) comprising the sheath component having a larger amount than the core component, so that the core part effectively reflects sunlight to while the sheath part can improve the heat-shielding property of the fiber and maintain the color development property thereof. Thus, the present invention has been accomplished.

[0017] Accordingly, the present invention is a core-sheath type composite fiber comprising a core component and a sheath component, wherein the core component (component A) comprises a thermoplastic polymer including a sunlight shielding material having an average particle size of 0.5 μm or smaller (preferably, greater than 0.1 μm and 0.5 μm or smaller) in an amount of 8% by weight to 70% by weight;
the sheath component (component B) comprises a polyester-type (or polyester-based) polymer including heat-shielding fine particles in an amount of 0.5% by weight to 10% by weight, the heat-shielding fine particles being capable of maintaining color development property and having an average particle size of 0.1 μm or smaller which is smaller than that of the sunlight shielding material. The mass ratio of the core component to the sheath component is 10 : 90 to 30 : 70. The core component may contain the sunlight shielding material in an amount of more than 20% by weight and 70% by weight or less (i.e., less than or equal to 70% by weight). Preferably, the fiber may have an official moisture regain of 0.3% or more as the entire fiber.

[0018] The sunlight shielding material may comprise at least one member selected from the group consisting of titanium oxide, zinc oxide, and barium sulfate. The heat-shielding fine particles may comprise at least one member selected from the group consisting of silicon dioxide and barium sulfate.

[0019] More preferably, the core-sheath type composite fiber may satisfy the following formula:

$$R/r \geq 1.8$$

wherein "R" represents the linear distance between a centroidal point "G" and a point of the fiber circumference at the farthest from the centroidal point "G", and "r" represents the linear distance between the centroidal point "G" and a point of the core external boundary at the farthest from the centroidal point "G".

[0020] The core-sheath type composite fiber may have an average reflectance of 70% or higher against an infrared ray having a wavelength of 800 to 1200 nm. The fiber may have an L* value of 16.5 or less.

[0021] In the present invention, the meaning of the wording "can maintain the color development property" is equivalent to the meaning that the coloring matter is secured to exhibit its coloring to fiber so that the fiber is not substantially lowered in color development property. For example, titanium oxide functions as a delustering agent to hinder the color development property of the fiber; thus, titanium oxide does not fall under the category of the heat-shielding fine particles. When an inorganic compound has a function that it is capable of maintaining the color development property and a function of shielding sunlight at the same time, the sunlight shielding material and the heat-shielding fine particles may be made of the same inorganic compound with each other.

[0022] Any combination of at least two constituent elements disclosed in the claims and/or the specification is included in the present invention. In particular, any combination of two or more claims recited in the claims is included in the present invention.

EFFECTS OF THE INVENTION

[0023] According to the present invention, a core-sheath type composite fiber comprises a sheath part which comprises a polyester-type polymer including heat-shielding fine particles having a specific particle size in a specific proportion and a core part which comprises a thermoplastic polymer including a sunlight shielding material having a specific particle size in a specific proportion, and the core-sheath type composite fiber further satisfies the specific relationship that the mass proportion of the sheath is larger than that of the core. Therefore, the core-sheath type composite fiber has a high reflectance against infrared rays, which are easy to be changed into thermal energy, so that the fiber can achieve a heat-shielding effect, and further the fiber can have good color development property comparable to that of conventional polyesters.

[0024] In the present invention, since the core-sheath type composite fiber comprises the sheath and core parts in the specific relationship that the mass proportion of the sheath is larger than that of the core, even when a large quantity of the shielding material is incorporated into the core component, the fiber can maintain color development property as well as spinnability.

[0025] When the core-sheath type composite fiber has the specific official moisture regain, the fiber can be further improved in the heat-shielding effect.

[0026] Furthermore, when the core-sheath type composite fiber has the specific cross-sectional shape, the fiber can be further improved in color development property.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] This invention will be more clearly understood from the following description of preferred embodiments with reference to the attached drawings. However, the embodiments and the drawings are given only for the purpose of illustration and explanation, and should not be used to limit the scope of the invention. The scope of the invention is determined by the appended claims.

Fig. 1 is a schematic view illustrating an example of the form of a cross section of the composite fiber of one embodiment of the present invention; and

Fig. 2 is a sectional photograph showing an example of the form of a cross section of the composite fiber of one embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0028] In the core-sheath type composite fiber of the present invention, the core component (component A) comprises a thermoplastic polymer including a specific amount of a sunlight shielding material having an average particle size of 0.5 μm or smaller; the sheath component (component B) is a polyester-type polymer including a specific amount of heat-shielding fine particles capable of maintaining color development property of the fiber, the heat-shielding fine particles having an average particle size of 0.1 μm or smaller, the mean particle size being smaller than that of the sunlight shielding material; and the mass ratio of the core component to the sheath component is 10 : 90 to 30 : 70.

[Core (Component A)]

[0029] A description will be made about the thermoplastic polymer constituting the core (component A) in the core-sheath type composite fiber of the present invention, and including the sunlight shielding material (the polymer may be referred to merely as the component A polymer hereinafter). The component A polymer, i.e., the sunlight shielding material-including thermoplastic polymer may be, for example, a polyamide, a polyester or a polypropylene. Particularly preferred are a polyamide and a polyester such as a polyethylene terephthalate, since the sunlight shielding material can be filled in these polymers in a high proportion, and these polymers are advantageous in cost and high in versatility.

[0030] The sunlight shielding material (preferably, an infrared shielding substance) referred to in the present invention needs to be fine particles that do not reflect or transmit the wavelengths of infrared rays (800 to 3000 nm, particularly, 800 to 1200 nm) which are easy to be changed into thermal energy, and further that can be filled into the thermoplastic polymer in a high proportion. Examples thereof include titanium oxide, zinc oxide and barium sulfate, as simple substance, and a mixture of these substances of two or more. Particularly preferred is titanium oxide, which is used as a delustering agent, and is high in versatility.

[0031] In the present invention, since the component A polymer includes a sunlight shielding material having an average particle size of 0.5 μm or smaller in an amount of 8 to 70% by weight, the sheath-core composite fiber efficiently reflects infrared rays, which are easy to be changed into thermal energy, so as to exhibit a heat-shielding effect. If the content of the sunlight shielding material is less than 8% by weight, the fiber cannot efficiently reflect the wavelengths of infrared rays and cannot gain a sufficient heat-shielding effect. Contrarily, if the content of the sunlight shielding material is more than 70% by weight, the composition for the fiber is extremely deteriorated in spinnability (or thread-forming property), and is further lowered in color development property when dyed. The content may be preferably 10% by weight or more, and more preferably more than 20% by weight. In order to improve spinnability, the content of the sunlight shielding material may be preferably 60% by weight or less, and is more preferably 50% by weight or less.

[0032] If the mean particle size of the sunlight shielding material is more than 0.5 μm, the fiber composition is lowered in spinnability and cannot efficiently reflect rays in the wavelengths of infrared rays, resulting in insufficient heat-shielding effect. The mean particle size of the sunlight shielding material is preferably 0.4 μm or smaller, more preferably 0.3 μm or smaller. The mean particle size of the sunlight shielding material is not limited to a specific one as far as the material can reflect infrared rays. The mean particle size may be preferably 0.05 μm or greater, more preferably greater than 0.1 μm.

[0033] It should be noted that when incident lights in wavelengths of near infrared rays enter from the surface of the fiber, those lights have a tendency of passing through the center of the fiber in accordance with a difference in refractive index therefrom. Accordingly, the fiber can effectively reflect the near infrared rays to gain a high heat-shielding effect by incorporating the sunlight shielding material, such as titanium oxide, into the core component in a higher proportion rather than dispersing the material into the whole fiber. Further, when the concentration of the sunlight shielding material in the core is higher than that of the heat-shielding fine particles in the sheath, the fiber composition can maintain not only color development property but also the good spinnability.

[Sheath (Component B)]

[0034] The following will describe the polyester polymer constituting the sheath (component B) of the core-sheath type composite fiber of the present invention and including the heat-shielding fine particles (hereinafter, the polymer may be referred to merely as the component B polymer).

[0035] The component B polymer, i.e., the polyester polymer including the heat-shielding fine particles capable of maintaining the color development property is preferably a polyester such as a polyethylene terephthalate or a polybutene terephthalate, or a copolymerized polyester having, at its main skeleton, such a polyester and modified with a third component such as an aromatic dicarboxylic acid such as isophthalic acid or isophthalic acid having a metal sulfonate group, an aliphatic dicarboxylic acid such as adipic acid or sebacic acid, or a polyhydric alcohol such as diethylene glycol, butanediol, hexanediol, cyclohexanedimethanol, bisphenol A, a polyalkylene glycol or pentaerythritol.

[0036] The heat-shielding fine particles contained in the component B referred to in the present invention are desirably inorganic fine particles capable of maintaining the color development property. It is particularly preferred to use, for example, silicon dioxide or barium sulfate as a simple substance, or a mixture of these substances.

[0037] The mean particle size of the heat-shielding fine particles is 0.1 μm or smaller, and is preferably 0.03 to 0.08 μm both inclusive.

[0038] Furthermore, since the component B contains heat-shielding fine particles made of a heat-shielding material such as silicon dioxide in an amount of 0.5 to 10% by weight both inclusive (preferably less than 10% by weight), the component B can exhibit a heat-shielding effect while maintaining the original dye-ability of a polyester. If the content of the heat-shielding fine particles is less than 0.5% by weight, the fiber composition is lowered in spinnability, and cannot gain a heat-shielding effect by the heat-shielding fine particles. On the contrary, if the content of the heat-shielding fine particles is more than 10% by weight, the fiber composition is extremely deteriorated in spinnability (or thread-forming property). Alternatively, even when the fiber composition can be spun, a problem may be caused that the resultant filament may be broken when drawn. Additionally, the drawn yarn may not gain a sufficient quality. The content is preferably 0.5 to 8% by weight both inclusive, more preferably 1 to 7% by weight both inclusive.

[Core-sheath type composite fiber]

[0039] The core-sheath type composite fiber of the present invention can be produced by a production method that will be described later. The core-sheath type composite fiber of the invention may have preferably an official moisture regain of 0.4% or more in the entire fiber. If the official moisture regain in the conjugate fiber is less than 0.3%, the vaporization latent heat which follows the vaporization of the contained water is small so that the fiber may fail to gain a sufficient heat-shielding effect.

[0040] According to the present invention, as illustrated in Fig. 1 showing a cross section of the fiber, "R" represents the linear distance between a centroidal point "G" and a point of the fiber circumference at the farthest from the centroidal point "G", and "r" represents the linear distance between the centroidal point "G" and a point of the core external boundary (interface) at the farthest from the centroidal point "G". In this case, the fiber preferably satisfies the formula of $R/r \geq 2$, and more preferably satisfies the formula of $R/r \geq 3$. If the fiber satisfies the formula of $R/r < 1.8$, the conjugate fiber may be unfavorably poor in color development property by the effect of the sunlight shielding material (for example, titanium oxide) contained in the core.

[0041] In the core-sheath type composite fiber of the present invention, the mass ratio of the component A to the component B, i.e., "(Component A) : (Component B)" ranges of 10 : 90 to 30 : 70, preferably 10 : 90 to 25 : 75, even more preferably 10 : 90 to 20 : 80. If the proportion of the component A polymer is less than 10% by mass, the core is unfavorably lowered in the heat-shielding effect. If the proportion of the component A polymer is more than 30% by mass, the composite fiber is unfavorably poor in color development property.

[0042] In the composite fiber, the fineness of the fiber is not particularly limited to the specific one, and may be any fineness. In order to gain a fiber good in color development property, the fineness of monofilaments of the composite fiber may be preferably set into the range of about 0.3 to 11 dtex. The effects of the present invention can be expected regardless of whether the fiber is a long or continuous fiber (filament) or a short fiber (staple).

[0043] The core-sheath type composite fiber of the present invention is high in reflectance against infrared rays. The average reflectance thereof may be 70% or higher, preferably 70.5% or higher, even more preferably 71% or higher against an infrared ray having a wavelength of 800 to 1200 nm.

[0044] The core-sheath type composite fiber of the present invention can be restrained from being whitened to be opaque in color. For example, the L* value thereof may be 16.5 or less, and may be preferably 16 or less.

[0045] The composite fiber obtained in the present invention may be preferably classified in the level 4 or higher with respect to all of the criteria of change in color, color fastness to washing against adherence pollution, and color fastness to washing against liquid pollution. If any one of these properties is in the level 3 or lower, the composite fiber is not preferred for being used for ordinary clothes from the viewpoint of the handle-ability.

[0046] The composite fiber obtained in the present invention may be preferably classified in the level 4 or higher with respect to the criterion of color fastness to light. If the fastness to light is in the level 3 or lower, the composite fiber is not preferred for being used for ordinary clothes from the viewpoint of the handle-ability.

[0047] The core-sheath type composite fiber of the present invention also has a sufficient breaking strength for practical use. The breaking strength may be, for example, about 1.5 to 10 cN/dtex, preferably about 1.8 to 8 cN/dtex, more preferably about 2 to 6 cN/dtex, when the breaking strength is calculated from a load-elongation curve obtained by use of an Instron type tensile tester.

[0048] The core-sheath type composite fiber of the present invention also has a sufficient breaking elongation for practical use. The breaking elongation may be, for example, about 10 to 80%, preferably about 20 to 70%, more preferably about 30 to 60%, when the breaking elongation is measured from a load-elongation curve obtained by use of an Instron type tensile tester.

[0049] Hereinafter, a description will be made about a method for producing the composite fiber of the present invention.

[0050] First, a component A polymer and a component B polymer are independently melt-extruded in different extruders, respectively, and introduced into respective parts of a spinning head. By feeding each component into a spinneret having an arrangement or channel inside for forming a target composite or conjugate fiber, melt-spinning procedure is conducted to produce a composite or conjugate fiber. In addition, in order for the fiber to ensure a quality required for a final product and good process-ability, an optimal spinning/drawing method is selectable. More specifically, the composite fiber product having a good heat-shielding effect and color development property can be obtained by any one of a one-step or direct spinning-drawing manner performing spinning and drawing in one-step process; a two-step spinning-drawing manner performing spinning and drawing separately, in which collected spun filaments are drawn as another step; or a non-drawing step in which undrawn raw spun filaments (as-spun filaments) are directly wound at a winding speed of 2000 m/min. or faster.

[0051] The spinning step of the production method of the present invention can employ an ordinary melt-spinning machine used to spin out the fiber through a spinneret. The cross-sectional shape and the diameter of the resultant fiber can be set as desirable one depending on the shape or size of the spinneret.

[0052] The composite fiber obtained in the present invention is usable as various fiber assemblies (fibrous structures). Examples of the fiber assembly may include a woven, knitted or nonwoven fabric consisting essentially of the fiber of the present invention; a woven, knitted or nonwoven fabric comprising a part consisting essentially of the fiber of the present invention (for example, a woven or knitted fabric comprising a fiber of the invention and another fiber other than the fiber of the present invention such as a natural fiber, chemical fiber or synthetic fiber, a woven or knitted fabric comprising a blended yarn or a combined filament yarn comprising a fiber of the invention and another fiber other than the fiber of the present invention, or a cotton-mixed nonwoven fabric). The proportion of the fiber of the invention in such a woven, knitted or nonwoven fabric is preferably 10% by weight or more, more preferably 30% by weight or more.

[0053] The fiber of the present invention may be mainly used in a continuous fiber form (filament), alone or as a part, to produce a woven or knitted fabric or the like to be a material suitable for clothes having a good texture or feeling. The fiber may be used in a short fiber form as staples for clothes, or used for a dry nonwoven fabric or wet nonwoven fabric, or for some other; and can preferably be used not only as clothing material but also as non-clothing material, such as various residential materials and industrial materials.

[0054] Hereinafter, the present invention will be described in detail by way of working examples. However, the invention is never limited by the examples. Measured values in the examples were measured by methods described below.

<Heat-Shielding Property Evaluation>

(ΔT measurement)

[0055] With respect to the ΔT of a sample, the following procedure was conducted. A composite fiber with the uniformly adjusted fiber diameter was knitted to form a cylindrical knitted fabric having a basis weight of 200 g/m^2, and then the resultant fabric was scoured to give a sample. The resultant sample was irradiated with a reflective type lamp. After 15 minutes, the temperature of a point just below the sample was measured. The temperature was measured with an adhesive-type sensor TNA-8A manufactured by Tasco Japan Co., Ltd. The sample was evaluated by analyzing the temperature difference (ΔT °C) denoting a temperature difference of the sample from a control sample made of a polyethylene terephthalate fiber containing 0.05% by weight of TiO_2.

(Reflectance and Transmittance)

[0056] A composite fiber with the uniformly adjusted fiber diameter was knitted to form a cylindrical knitted fabric having a basis weight of 200 g/m^2, and then the resultant fabric was scoured to give a sample. Thereafter, the reflectance and the transmittance thereof were measured using the following measuring instrument.

[0057] Spectral reflectance meter: Spectrophotometer C-2000S Color Analyzer, HITACHI

<Dyeing Method>

[0058] Dye: Diacryl Black BSL-F; 7% omf

[0059] Dispersing aid: Disper TL (manufactured by Meisei Chemical Works, Ltd.): 1 g/L

[0060] pH adjustor: ULTRA MT LEVEL: 1 g/L
Bath ratio: 1/50; Temperature: 130°C for 40 minutes

[0061] Reduction cleaning:

Hydrosulfide: 1 g/L
AMIRADINE (manufactured by Dai-ichi Kogyo Seiyaku Co., Ltd.): 1 g/L
NaOH: 1 g/L
Bath ratio: 1/30; Temperature: 80°C for 120 minutes

<Color Development Property>

(L* Value)

[0062] The L* value of the resultant dyed fabric was obtained by making a measurement using a Hitachi 307-model color analyzer (automatic recoding type spectrophotometer, manufactured by Hitachi Ltd.).

<Color Fastness to Washing>

[0063] The fastness to washing was measured by a measuring method in accordance with JIS L-0844.

< Color Fastness to Light>

[0064] The fastness to light was measured by a measuring method in accordance with JIS L-0842.

<Fineness>

[0065] The fineness was measured by a measuring method in accordance with JIS L-1013.

<Breaking Strength>

[0066] The breaking strength (tenacity) was analyzed from a load-elongation curve obtained using an Instron type tensile tester.

<Breaking Elongation>

[0067] The breaking elongation was analyzed from a load-elongation curve obtained using an Instron type tensile tester.

<Spinnability>

[0068] Each sample was evaluated about the spinnability thereof in accordance with the following criterion:

AA: Very good in spinnability because the spinning was continuously conducted for 24 hours without fiber breakage. In addition, the obtained composite fibers had neither fluffs nor loops;
A: Substantially good in spinnability because fiber breakage was occurred at a frequency of only once or less during 24-hour continuous spinning. In addition, the obtained composite fibers had neither fluffs nor loops, or slightly had fluffs and loops;
B: Poor in spinnability because fiber breakage was occurred at a frequency of three times or less during 24-hour continuous spinning; or
C: Very poor in spinnability because fiber breakage was occurred at a frequency of more than 3 times during 24-hour continuous spinning.

(Example 1)

[0069] A polyamide (component A polymer) containing 70% by weight of titanium oxide having an average particle size of 0.4 μm and a polyethylene terephthalate (component B polymer) containing 1.0% by weight of silicon dioxide were fed to a spinneret as core component and sheath component, respectively under the condition that the composite ratio (mass ratio) of the component A polymer to the component B polymer was 10 : 90. The spinning procedure of the fed polymers was conducted with the spinneret having 24 holes (hole diameter: 0.25 mm) at a spinning temperature of 260°C and a discharge rate of 1.42 g/minute per hole. The discharged filaments were then blown with cooling wind having a temperature of 25°C and a humidity of 60% at a rate of 0.4 m/second to make the filaments have a temperature of 60°C or lower. Thereafter, the cooled filaments were introduced into a tube heater, 1.0 m in length and 30 mm in inner diameter (internal temperature: 185°C), which had an inlet-guide diameter of 8 mm and an outlet-guide diameter of 10 mm and was set at a position apart downward from the spinneret by 1.2 m, so as to be drawn inside the tube heater. An oil was supplied through an oil nozzle to the filaments drawn in the tube heater, and then the filaments were wound at a rate of 4000 m/min. by aid of two take-off rolls to obtain 84T/24f composite fibers of multi-filaments (strength: 2.53 cN/dtex, elongation: 40.2%). The resultant composite fibers were knitted to form a cylindrical knitted fabric having a basis weight of 200 g/m^2, and then the resultant fabric was scoured to be subjected to the various measurements. This composite fiber had an R/r value of 3.2 wherein "R" represents the linear distance between a centroidal point "G" and a point of the fiber circumference at the farthest from the point "G", and "r" represents the linear distance between the point "G" and a point of the core external boundary (interface) at the farthest from the point "G" in the cross section of the fiber. The L* value at this time, the reflectance, the ΔT (°C) and the spinnability of the obtained fiber are shown in Table 1. The L* value of the composite fiber obtained by the production method of the present invention was 15.56, which exhibited color development property comparable to that of conventional polyester fibers. The ΔT was -3.6°C, which showed a high heat-shielding effect. Furthermore, the fastness to washing and the fastness to light were each classified in the level 4 or higher.

(Examples 2 to 11)

[0070] Composite fiber filaments (84T/24f) were produced in the same spinning way as in Example 1 except that the respective particle species added into the components A and B and/or the respective contents thereof were changed from Example 1. Physical properties of the resultant fibers are shown in Table 1. The fibers each had a good L* value and a good ΔT to show a quality causing no problem. In Example 10, the use of barium sulfate for the fine particles incorporated into the sheath made it possible that the fiber gained a high heat-shielding effect while maintaining color development property. Furthermore, the fastness to washing and the fastness to light of each of the fibers were each classified in the level 4 or higher.

(Examples 12 to 13)

[0071] Composite fiber filaments (84T/24f) were produced in the same spinning way as in Example 1 except that the ratio of the core to the sheath in the composite fiber was changed. The resultant fibers were each excellent in heat-shielding property and color development property to show a quality causing no problem. The fastness to washing and the fastness to light of each of the fibers were each classified in the level 4 or higher.

(Comparative Examples 1 to 8)

[0072] Composite fiber filaments (84T/24f) were produced in the same spinning way as in Example 1 except that the component A and B polymers, the respective particle species added into the components A and B, and the respective contents thereof were changed. Physical properties of the resultant fibers are shown in Table 1.

[0073] In Comparative Example 1, since the proportion of titanium oxide contained in the core was 0%, the fiber failed to gain a heat-shielding effect. In Comparative Example 2, the content of titanium oxide was an excessively large amount of 80% by weight; thus, the fiber composition was extremely deteriorated in spinnability, so as to be impossible to produce fibers.

[0074] In Comparative Example 3, since the proportion of silicon dioxide contained in the sheath was 0%, the fiber had an insufficient heat-shielding effect. This fiber failed to be yielded in direct spinning and drawing step (conducting spinning and drawing in one- step process), which was different from the situation of Examples 1 to 13. In Comparative Example 4, the content of silicon dioxide was an excessively large amount of 15% by weight; thus, the fiber composition was extremely deteriorated in spinnability, so as to be impossible to produce fibers.

[0075] In Comparative Example 5, the mass ratio of the core to the sheath was 50 : 50, so that the fiber showed a good heat-shielding effect; however, the fiber resulted in poor color development property since the proportion of the core was too large.

[0076] In Comparative Example 6, since the sheath part contained titanium oxide, the fiber showed a good heat-shielding effect but had poor color development property.

[0077] In Comparative Example 7, silicon dioxide which was contained in the core was not any sunlight shielding material in the present invention; thus, the fiber was poor in the heat-shielding effect.

[0078] In Comparative Example 8, the particle size of titanium oxide contained in the core was 0.5 μm or greater; thus, the fiber failed to gain a heat-shielding effect.

[Table 1]

	Core (A) component				Sheath (B) component				Core/sheath ratio	Cross-sectional shape R/r	L* value	Reflectance*	Official moisture regain [%]	ΔT (°C)	Spinnability
	Polymer	Fine particles			Polymer	Fine particles									
		Species	Particle size	Content		Species	Particle size	Content							
Example 1	Nylon 6	TiO_2	0.3 μm	70 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.56	74.3	0.49	-3.6	A
Example 2	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.60	73.4	0.67	-2.8	AA
Example 3	Nylon 6	TiO_2	0.3 μm	8 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.40	71.3	0.77	-2.0	AA
Example 4	PET	TiO_2	0.3 μm	40 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.52	72.4	0.38	-2.2	AA
Example 5	PP	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.69	70.1	0.16	-2.1	AA
Example 6	Nylon 6	$BaSO_4$	0.3 μm	30 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.58	71.4	0.67	-2.0	AA
Example 7	Nylon 6	ZnO_2	0.3 μm	30 wt%	PET	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.67	72.9	0.67	-2.0	AA
Example 8	Nylon 6	TiO_2	0.3 μm	30 wt%	PBT	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.45	72.5	0.67	-2.6	A
Example 9	Nylon 6	TiO_2	0.3 μm	30 wt%	PTT	SiO_2	0.06 μm	1.0 wt%	1/9	3.2	15.65	73.1	0.67	-2.6	AA
Example 10	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	$BaSO_4$	0.08 μm	5.0 wt%	1/9	3.2	15.73	73.2	0.66	-2.9	AA
Example 11	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.03 μm	10 wt%	1/9	3.2	15.60	73.4	0.64	-3.1	AA
Example 12	Nylon 6	TiO_2	0.3 μm	35 wt%	PET	SiO_2	0.08 μm	1.0 wt%	2/8	2.2	15.85	74.5	0.90	-3.5	AA
Example 13	Nylon 6	TiO_2	0.3 μm	35 wt%	PET	SiO_2	0.06 μm	1.0 wt%	3/7	1.8	15.90	75.1	1.15	-4.0	A
Comparative Example 1	Nylon 6	-	-	0 wt%	PET	SiO_2	0.10 μm	1.0 wt%	1/9	3.2	15.61	67.4	0.80	-0.3	AA
Comparative Example 2	Nylon 6	TiO_2	0.3 μm	80 wt%	PET	SiO_2	0.50 μm	1.0 wt%	1/9	3.2	-	-	-	-	C
Comparative Example 3	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	-	-	0 wt%	1/9	3.2	15.97	71.1	0.66	-1.5	C
Comparative Example 4	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.06 μm	15 wt%	1/9	3.2	-	-	-	-	C
Comparative Example 5	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.60 μm	1.0 wt%	5/5	1.4	16.71	75.2	1.77	-4.1	B
Comparative Example 6	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	TiO_2	0.30 μm	5.0 wt%	1/9	3.2	16.83	75.5	0.66	-4.4	A
Comparative Example 7	Nylon 6	SiO_2	0.3 μm	30 wt%	PET	SiO_2	0.60 μm	1.0 wt%	1/9	3.2	15.68	68.7	0.67	-0.5	AA
Comparative Example 8	Nylon 6	TiO_2	0.3 μm	30 wt%	PET	SiO_2	0.50 μm	1.0 wt%	1/9	3.2	15.46	69.8	0.67	-1.0	A

* Reflectance*: average in the range of wavelengths of 800 to 1200 nm

INDUSTRIAL APPLICABILITY

[0079] The composite fiber obtained according to the present invention has a high reflectance in an infrared wavelength range (for example, 800 to 3000 nm, in particular, 800 to 1200 nm) which is easy to be changed into thermal energy, and further has color development property comparable to that of conventional polyesters. Thus, the fiber is suitable for various clothing materials.

[0080] As described above, the preferred examples of the present invention have been described with reference to the drawings. However, referring to the present specification, those skilled in the art would easily conceive various changes and modifications within a scope self-evident therefrom. Accordingly, such changes and modifications are interpreted to fall within the scope of the present invention, which is specified by the claims.

Claims

1. A core-sheath type composite fiber comprising a core component and a sheath component, wherein
the core component comprises a thermoplastic polymer including a sunlight shielding material having an average particle size of 0.5 μm or smaller in an amount of 8% by weight to 70% by weight;
the sheath component comprises a polyester-type polymer including heat-shielding fine particles in an amount of 0.5% by weight to 10% by weight, the heat-shielding fine particles being capable of maintaining color development property and having an average particle size of 0.1 μm or smaller which is smaller than that of the sunlight shielding material; and
the mass ratio of the core component to the sheath component is 10 : 90 to 30 : 70.

2. The core-sheath type composite fiber according to claim 1, wherein the core component comprises the sunlight shielding material in an amount of more than 20% by weight and 70% by weight or less.

3. The core-sheath type composite fiber according to claim 1 or 2, which has an official moisture regain of 0.4% or more as the entire fiber.

4. The core-sheath type composite fiber according to any one of claims 1 to 3, wherein the sunlight shielding material comprises at least one member selected from the group consisting of titanium oxide, zinc oxide, and barium sulfate.

5. The core-sheath type composite fiber according to any one of claims 1 to 4, wherein the heat-shielding fine particles comprise at least one selected from the group consisting of silicon dioxide and barium sulfate.

6. The core-sheath type composite fiber according to any one of claims 1 to 5, wherein the mean particle size of the sunlight shielding material is more than 0.1 μm.

7. The core-sheath type composite fiber according to any one of claims 1 to 6, wherein the fiber satisfies the following formula:

$$R/r \geq 1.8$$

wherein "R" represents the linear distance between a centroidal point "G" and a point of the fiber circumference at the farthest from the centroidal point "G", and "r" represents the linear distance between the centroidal point "G" and a point of the core external boundary at the farthest from the centroidal point "G".

8. The core-sheath type composite fiber according to any one of claims 1 to 7, which has an average reflectance of 70% or higher against an infrared ray having a wavelength of 800 to 1200 nm.

9. The core-sheath type composite fiber according to any one of claims 1 to 8, which has an L* value of 16.5 or less.

Fig. 1

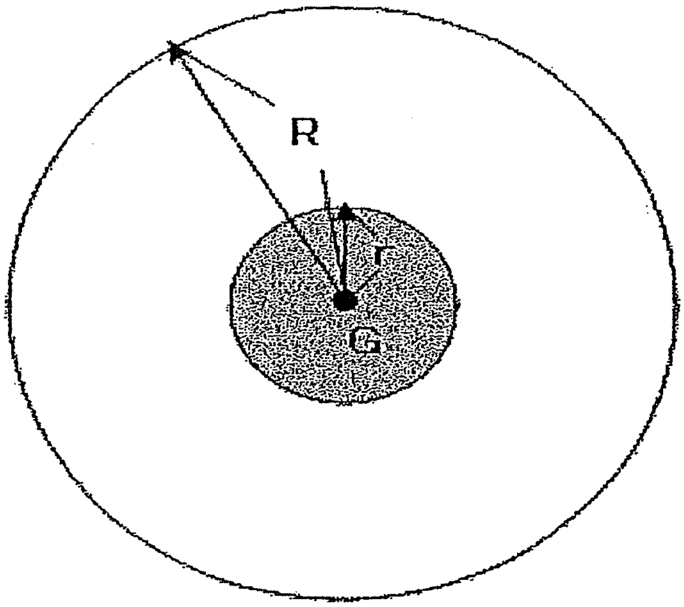
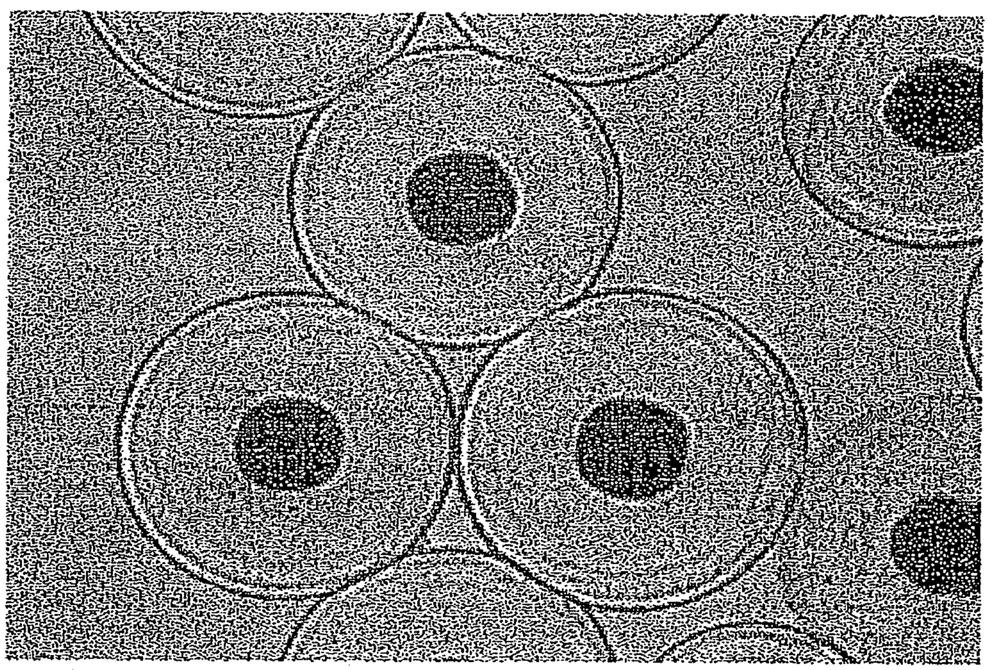


Fig. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/050752

A. CLASSIFICATION OF SUBJECT MATTER
D01F8/14(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)
D01F8/00-8/18

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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 2011-241529 A (KB Seiren, Ltd.), 01 December 2011 (01.12.2011), claims; paragraphs [0010], [0011] (Family: none)	1-9
A	JP 5-239724 A (Unitika Ltd.), 17 September 1993 (17.09.1993), claims (Family: none)	1-9
A	JP 2000-282345 A (Asahi Chemical Industry Co., Ltd.), 10 October 2000 (10.10.2000), claims (Family: none)	1-9

☐ 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	Date of mailing of the international search report
01 March, 2013 (01.03.13)	12 March, 2013 (12.03.13)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/050752

Subject to be covered by this search:

In claim 1, the core/sheath type composite fiber has been specified by that the core component contains a sunlight-shielding substance and the sheath component contains heat-shielding fine particles capable of maintaining coloration.

In the description (examples) of this international application, the only statement concerning the sunlight-shielding substance is that titanium oxide, zinc oxide, or barium sulfate can be specifically used as the sunlight-shielding substance, and the only statement concerning the heat-shielding fine particles capable of maintaining coloration is that silicon dioxide or barium sulfate can be specifically used as the heat-shielding fine particles.

In the description of this international application, there is no statement as to what substances, besides the substances described above, can be used as the sunlight-shielding substance or as the heat-shielding fine particles capable of maintaining coloration.

Furthermore, the description of this international application gives no explanation on that a substance having what material properties to what degree can be regarded as a sunlight-shielding substance. The description is unclear in this respect.

Still further, the description of this international application gives no explanation on that a substance having what material properties to what degree can be regarded as heat-shielding fine particles capable of maintaining coloration. The description is unclear in this respect.

It is considered from the above that, of the inventions in claim 1 and in claims 2-9, which depend thereon, the parts which are supported by the description in the meaning of PCT Article 6 are limited to the invention which is the core/sheath type composite fiber in which the sunlight-shielding substance is titanium oxide, zinc oxide, or barium sulfate and the heat-shielding fine particles capable of maintaining coloration are silicon dioxide or barium sulfate.

Therefore, a search was made only for the invention which is supported by the description, i.e., the core/sheath type composite fiber in which the sunlight-shielding substance is titanium oxide, zinc oxide, or barium sulfate and the heat-shielding fine particles capable of maintaining coloration are silicon dioxide or barium sulfate.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2012014682 A **[0001]**
- JP 8158186 A **[0012]**
- JP 8092842 A **[0012]**
- JP 2011241530 A **[0012]**
- JP 2008223171 A **[0012]**