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(54) **FIBER BUNDLE FOR ARTIFICIAL HAIR AND HAIR ORNAMENT PRODUCT INCLUDING THE SAME**

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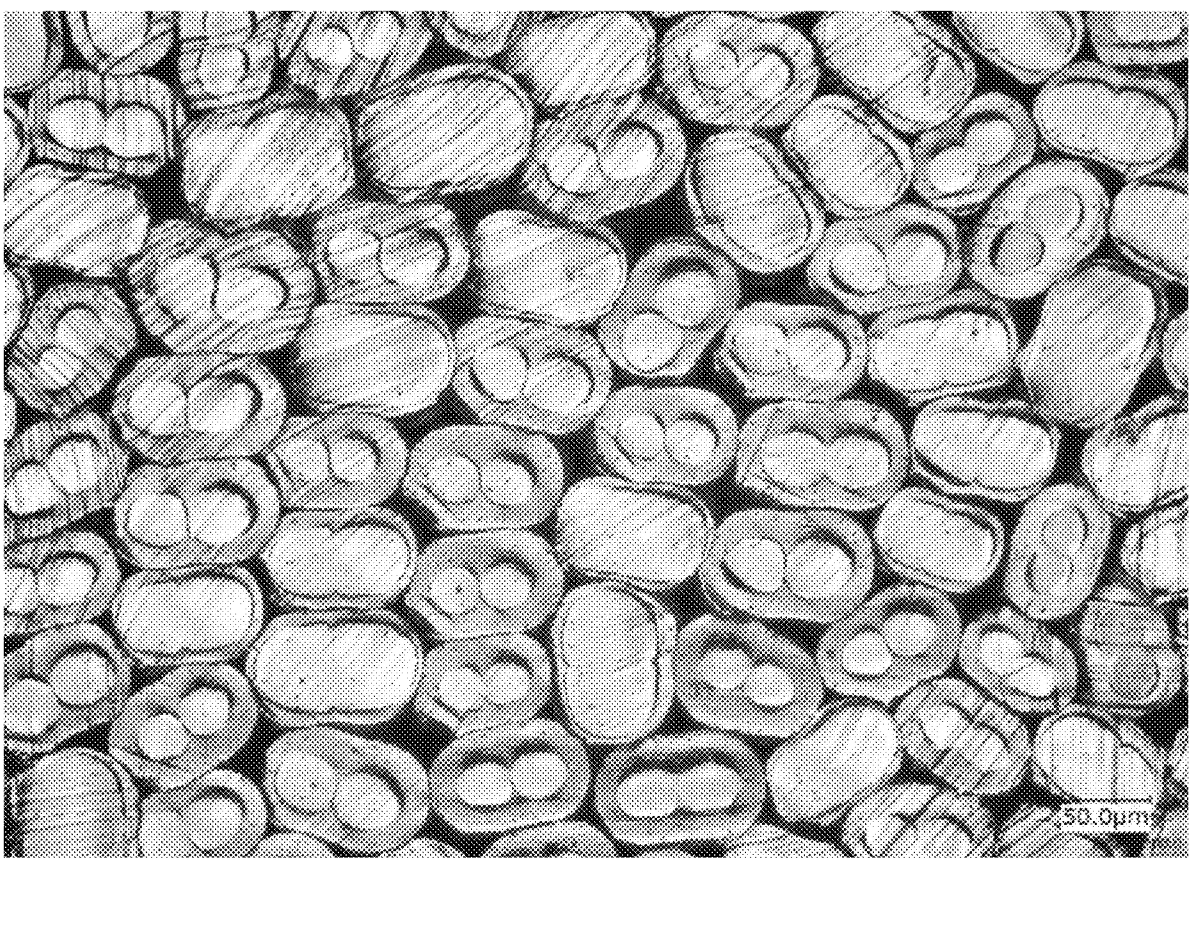
(57) **ABSTRACT**

A fiber bundle for artificial hair contains two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios. Each of the core-sheath conjugate fibers includes a core and a sheath, and the core-to-sheath area ratio is represented by the area ratio between the core and the sheath. In each of the core-sheath conjugate fibers, the core includes a polyester resin composition containing a polyester resin, and the sheath includes a polyamide resin composition containing a polyamide resin. The standard deviation of the ratios of the core cross-sectional area to the fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle for artificial hair is 0.15 or more. The fiber bundle for artificial hair has touch and appearance similar to those of human hair, and have favorable curl setting properties and usage durability, and a hair ornament product including the same are provided.



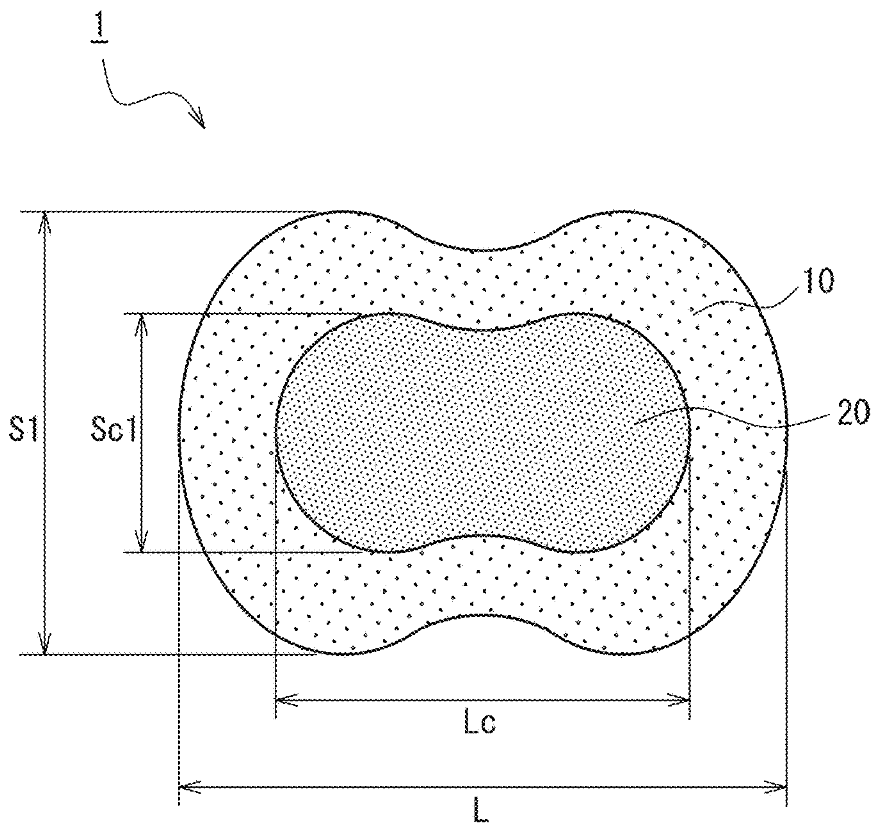


FIG. 1

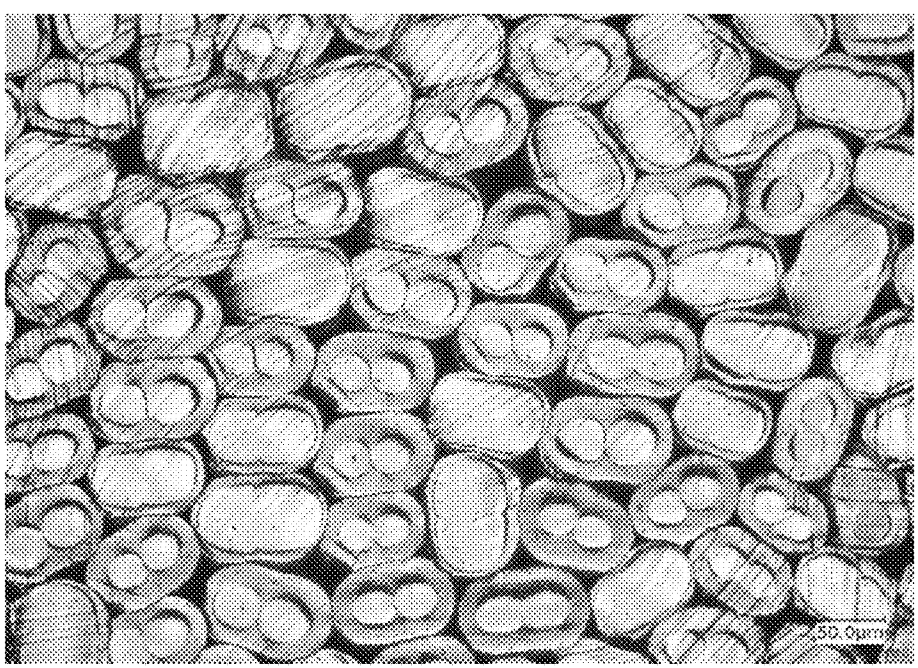


FIG. 2

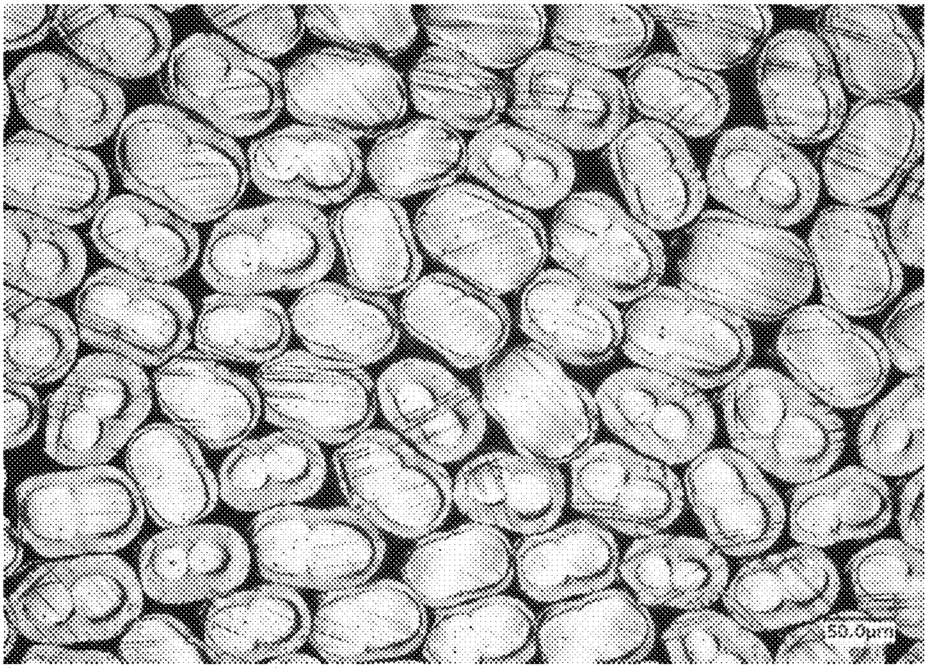


FIG. 3

FIG. 4

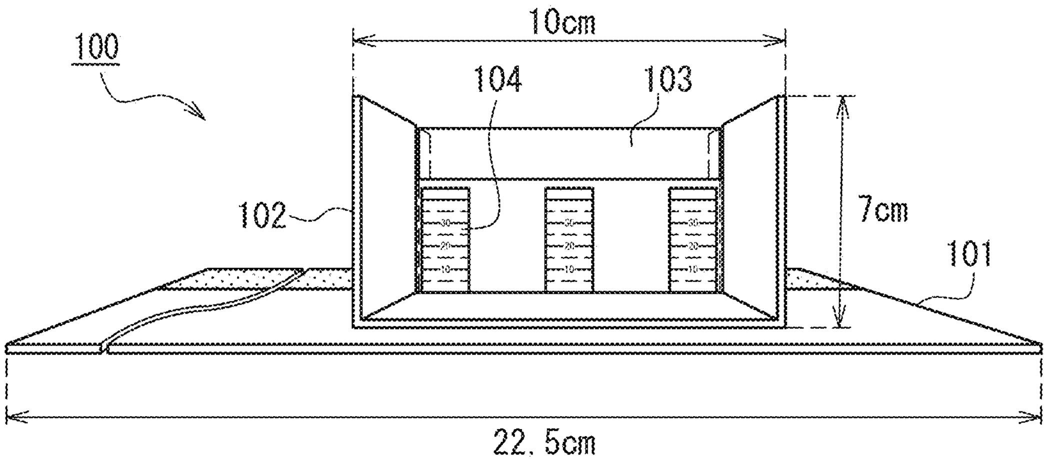


FIG. 5A

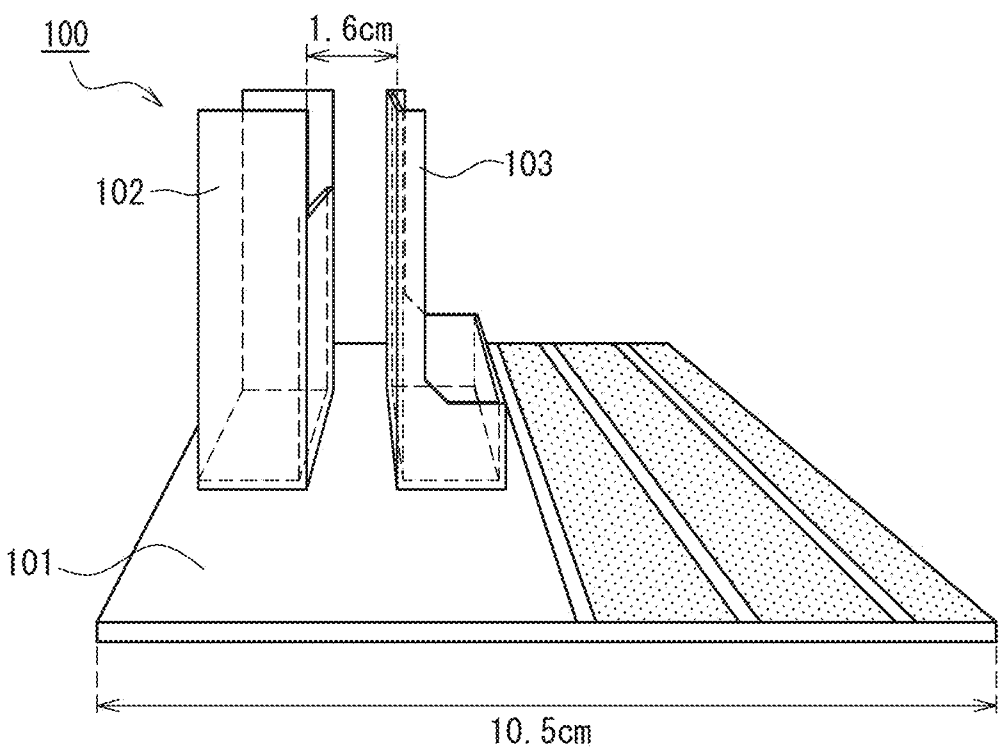


FIG. 5B

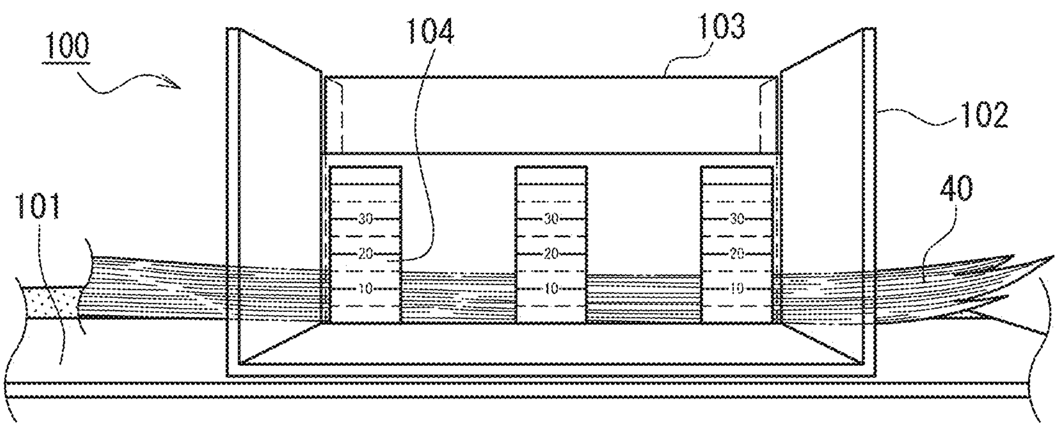


FIG. 5C

FIBER BUNDLE FOR ARTIFICIAL HAIR AND HAIR ORNAMENT PRODUCT INCLUDING THE SAME

TECHNICAL FIELD

[0001] One or more embodiments of the present invention relate to a fiber bundle for artificial hair containing core-sheath conjugate fibers, and a hair ornament product including the same.

BACKGROUND

[0002] In addition to human hair, artificial hair is widely used for hair ornament products such as hairpieces, hair wigs, hair extensions, hairbands, and doll hair. Acrylic fibers, vinyl chloride fibers, vinylidene chloride fibers, polyester fibers, polyamide fibers, polyolefin fibers, and the like are used as the material of artificial hair. In particular, it is known that the polyamide fibers have excellent touch and usage durability and have soft texture, and the polyester fibers have favorable curl setting properties and curl holding properties. Polyamide and polyester are combined together in order to obtain artificial hair having both the characteristics of the polyamide fibers and the characteristics of the polyester fibers. For example, Patent Documents 1 and 2 propose, as fibers for artificial hair, core-sheath conjugate fibers in which polyester is used as a core component and polyamide is used as a sheath component.

PATENT DOCUMENTS

[0003] Patent Document 1: JP H3-185103A

[0004] Patent Document 2: WO 2017/187843

[0005] However, the core-sheath conjugate fibers disclosed in Patent Documents 1 and 2 are have poor curl setting properties and usage durability depending on the core-to-sheath area ratio, and do not have natural appearance and touch as those of human hair.

SUMMARY

[0006] One or more embodiments of the present invention provide a fiber bundle for artificial hair that contains core-sheath conjugate fibers, has touch and appearance similar to those of human hair, and have favorable curl setting properties and usage durability, and a hair ornament product including the same.

[0007] One or more embodiments of the present invention relate to a fiber bundle for artificial hair, including two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios, wherein each of the core-sheath conjugate fibers includes a core and a sheath and the core-to-sheath area ratio is represented by an area ratio between the core and the sheath, in each of the core-sheath conjugate fibers, the core includes a polyester resin composition containing a polyester resin and the sheath includes a polyamide resin composition containing a polyamide resin, and a standard deviation of ratios of a core cross-sectional area to a fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle for artificial hair is 0.15 or more.

[0008] One or more embodiments of the present invention relate to a hair ornament product including the above-mentioned fiber bundle for artificial hair.

[0009] With one or more embodiments of the present invention, it is possible to provide a fiber bundle for artificial hair that contains core-sheath conjugate fibers, has touch and appearance similar to those of human hair, and have favorable curl setting properties and usage durability, and a hair ornament product including the same.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. **1** is a schematic diagram showing the fiber cross-section of a core-sheath conjugate fiber according to an example of one or more embodiments.

[0011] FIG. **2** is a micrograph (500-fold magnification) of the cross-section of a fiber bundle of Example 1.

[0012] FIG. **3** is a micrograph (500-fold magnification) of the cross-section of a fiber bundle of Example 2.

[0013] FIG. **4** is a micrograph (500-fold magnification) of the cross-section of a fiber bundle of Comparative Example 1.

[0014] FIG. **5**A is a schematic diagram illustrating a bulkiness meter.

[0015] FIG. **5**B is a schematic diagram illustrating the bulkiness meter.

[0016] FIG. **5**C is a schematic diagram illustrating the bulkiness meter.

DETAILED DESCRIPTION

[0017] The inventors of one or more embodiments of the present invention found that, depending on circumstances, a fiber bundle for artificial hair containing one type of core-sheath conjugate fibers, namely a fiber bundle for artificial hair containing only fibers having the same core-to-sheath area ratio, has poor curl setting properties and usage durability, and does not have natural appearance and touch as those of human hair, and conducted numerous studies. As a result, they found that a fiber bundle for artificial hair containing core-sheath conjugate fibers that have a core-sheath structure with a core made of a polyester resin composition and a sheath made of a polyamide resin composition develops touch and appearance similar to those of human hair and has favorable curl setting properties and usage durability when two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios are used together and the standard deviation of the ratios (also referred to merely as a "core cross-sectional area ratios" hereinafter) of the core cross-sectional area to the fiber cross-sectional area of the core-sheath conjugate fibers is set to a predetermined value.

[0018] The above cannot be addressed only by using two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios together, and it is important to set the standard deviation of the core cross-sectional area ratios of the core-sheath conjugate fibers contained in the fiber bundle for artificial hair to a predetermined value.

[0019] In the fiber bundle for artificial hair containing two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios, setting the standard deviation of the core cross-sectional area ratios of the core-sheath conjugate fibers to 0.15 or more makes it possible to effectively utilize the characteristics of the core and the characteristics of the sheath.

Fiber Bundle for Artificial Hair

[0020] The fiber bundle for artificial hair (also referred to merely as the "fiber bundle" hereinafter) contains two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios. Each of the core-sheath conjugate fibers includes a core and a sheath. The core-to-sheath area ratio is represented by the area ratio between the core and the sheath. The fiber bundle for artificial hair contains two or more types of core-sheath conjugate fibers that differ in the area ratio between the core and the sheath.

[0021] The standard deviation of the core cross-sectional area ratios of the core-sheath conjugate fibers in the fiber bundle can be calculated by observing the cross-section of the fiber bundle using a laser microscope and analyzing the cross-section using an image analyzer. A specific procedure of the above-mentioned calculation is as follows: the cross-section of the fiber bundle is observed using a laser microscope, a region that includes about 100 fibers (e.g., 80 to 120 fibers) is selected as a measurement region, the areas of the fiber cross-section, the core cross-section, and the sheath cross-section of each of the core-sheath conjugate fibers are calculated using an image analyzer (manufactured by Mitani Corporation; image analysis software "Win ROOF"), and the standard deviation of the core cross-sectional area ratios in the fiber bundle containing all the core-sheath conjugate fibers in the measurement region is determined using Formula (1) below.

[Formula 1]

$$S = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{1}$$

[0022] S: Standard deviation

[0023] n: Number of fibers

[0024] X_i: Each core cross-sectional area ratio

[0025] $\bar{x}$: Average value of core cross-sectional area ratios

[0026] In the fiber bundle, the standard deviation of the core cross-sectional area ratios is 0.15 or more. As a result, the fiber bundle develops touch and appearance similar to those of human hair and has favorable curl setting properties and usage durability. The standard deviation of the core cross-sectional area ratios in the fiber bundle is preferably 0.16 or more and more preferably 0.17 or more from the viewpoint of making the touch and the appearance more similar to those of human hair. The upper limit of the standard deviation of the core cross-sectional area ratios is not particularly limited, but may be 0.20 or less, for example, from the viewpoint of enabling the development of favorable touch, appearance, curl setting properties, and usage durability.

[0027] In the fiber bundle, the number of types of core-sheath conjugate fibers having different core-to-sheath area ratios need only be two or more and is not particularly limited. For example, two to six types of core-sheath conjugate fibers may be contained, and two, three, four, five, or six types of core-sheath conjugate fibers may be contained. In each of the core-sheath conjugate fibers, the core-to-sheath area ratio between the core and the sheath is preferably within a range of 3:7 to 8:2. Touch, texture, and the like that are similar to those of human hair are likely to be achieved by using two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios and setting the core-to-sheath area ratios within this range.

[0028] The blend ratio of the core-sheath conjugate fibers having different core-to-sheath area ratios in the fiber bundle is not particularly limited, and can be set as appropriate such that the standard deviation of the core cross-sectional area ratios is within the above-described range. The content of core-sheath conjugate fibers having the same core-to-sheath area ratio with respect to the overall weight of the fiber bundle is preferably 5 wt % or more and 90 wt % or less, more preferably 10 wt % or more and 80 wt % or less, even more preferably 10 wt % or more and 70 wt % or less, even more preferably 10 wt % or more and 60 wt % or less, even more preferably 10 wt % or more and 50 wt % or less, and even more preferably 10 wt % or more and 40 wt % or less, from the viewpoint of making the appearance more similar to that of human hair.

[0029] It is preferable that, in the fiber cross-section of each core-sheath conjugate fiber, the core is inside the sheath. The core-sheath conjugate fiber may have a concentric structure in which the center of the core coincides with the center of the fiber, or an eccentric structure in which the center of the core does not coincide with the center of the fiber and is situated away therefrom. The core-sheath conjugate fiber preferably has the concentric structure in which the center of the core coincides with the center of the fiber from the viewpoint of spinning stability and curl setting properties. In order to prevent the core and the sheath from being separated from each other, it is preferable that, in the fiber cross-section of each core-sheath conjugate fiber, the core is not exposed to the surface of the fiber and is completely covered by the sheath.

[0030] The cross-sectional shape of each core-sheath conjugate fiber may be a circular shape or any other shape. An example of the other shape is a flat shape such as an elliptical shape or a flat multilobed shape. Examples of the flat multilobed shape include a flat two-lobed shape and a flat four-lobed shape. Also, the cross-sectional shape of the core may be a circular shape or any other shape. An example of the other shape is a flat shape such as an elliptical shape or a flat multilobed shape. Examples of the flat multilobed shape include a flat two-lobed shape and a flat four-lobed shape. The cross-sectional shapes of the core-sheath conjugate fiber and the core are preferably a flat shape from the viewpoint of the touch. The cross-sectional shape of the core-sheath conjugate fiber and the cross-sectional shape of the core may be the same or different.

[0031] In the flat multilobed shape, two or more lobal portions having a shape selected from the group consisting of a circular shape and an elliptical shape are connected via recessed portions. In the flat two-lobed shape, two lobal portions having a shape selected from the group consisting of a circular shape and an elliptical shape are connected via recessed portions. The circular shapes and/or the elliptical shapes may partially overlap each other at the connection portion. Also, the circular or elliptical shape does not absolutely have to be a continuous arc, and may also be a substantially circular shape or a substantially elliptical shape that is partially deformed, as long as no acute angle is formed. Regarding the cross-sectional shapes, no consideration is given to asperities with a size of 2 μm or less generated at the outer circumference of the fiber and the outer circumference of the core due to an additive or the like. The cross-sectional shapes of the fiber and the core can be controlled by using a nozzle (pores) with a shape similar to the target cross-sectional shape.

[0032] FIG. **1** is a schematic diagram showing the fiber cross-section of a core-sheath conjugate fiber for artificial hair according to an example of one or more embodiments of the present invention. A core-sheath conjugate fiber **1** includes a sheath **10** and a core **20**, and both the fiber **1** and the core **20** have a cross-section with a flat two-lobed shape in which two elliptical shapes are connected via recessed portions. The elliptical shapes partially overlap each other at the connection portion.

[0033] In the fiber cross-section with a flat two-lobed shape, it is preferable that a length L of a major axis of the fiber cross-section, which is a straight line with the maximum length among an axisymmetric axis and straight lines connecting any two points on the outer circumference of the fiber cross-section so as to be in parallel to the axisymmetric axis, and a length S**1** of a first minor axis of the fiber cross-section, which is a straight line connecting two points so as to have the maximum length when connecting any two points on the outer circumference of the fiber cross-section so as to be perpendicular to the major axis of the fiber cross-section, satisfy Equation (2) below.

$$L/S1 = 1.1 \text{ or more and } 2.0 \text{ or less} \tag{2}$$

[0034] In the core cross-section with a flat two-lobed shape, it is preferable that a length Lc of a major axis of the core cross-section, which is a straight line with the maximum length among an axisymmetric axis and straight lines connecting any two points on the outer circumference of the core cross-section so as to be in parallel to the axisymmetric axis, and a length Scl of a first minor axis of the core cross-section, which is a straight line connecting two points so as to have the maximum length when connecting any two points on the outer circumference of the core cross-section so as to be perpendicular to the major axis of the core cross-section, satisfy Equation (3) below.

$$Lc/Sc1 = 1.3 \text{ or more and } 2.0 \text{ or less} \tag{3}$$

[0035] The single fiber fineness of the core-sheath conjugate fibers is preferably 10 dtex or more and 150 dtex or less, more preferably 30 dtex or more and 120 dtex or less, even more preferably 40 dtex or more and 100 dtex or less, and particularly preferably 50 dtex or more and 90 dtex or less, from the viewpoint of making the core-sheath conjugate fibers suitable for artificial hair.

[0036] Even when the core-sheath conjugate fibers have the same core-to-sheath area ratio, all the fibers do not necessarily have the same fineness and cross-sectional shape, and fibers that are different in fineness and cross-sectional shape may be mixed.

[0037] The core is made of a polyester resin composition containing a polyester resin, and is specifically made of a polyester resin composition containing a polyester resin as a main component. The wording "a polyester resin composition containing a polyester resin as a main component" means that the polyester resin composition contains the polyester resin in an amount of more than 50 wt % when the overall weight of the polyester resin composition is taken as 100 wt %, and the content of the polyester resin is preferably 60 wt % or more, preferably 70 wt % or more, more preferably 80 wt % or more, even more preferably 90 wt % or more, and even more preferably 95 wt % or more.

[0038] One or more of polyester resins selected from the group consisting of polyalkylene terephthalate and copolymerized polyesters mainly containing polyalkylene terephthalate are preferably used as the polyester resin. The wording "copolymerized polyesters mainly containing polyalkylene terephthalate" refers to copolymerized polyesters containing polyalkylene terephthalate in an amount of 80 mol % or more.

[0039] The polyalkylene terephthalate is not particularly limited, and examples thereof include polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate, and polycyclohexane dimethylene terephthalate.

[0040] The copolymerized polyester mainly containing polyalkylene terephthalate is not particularly limited, and examples thereof include copolymerized polyesters that contain polyalkylene terephthalate such as polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate or polycyclohexane dimethylene terephthalate as a main component, and further contain other copolymerizable components.

[0041] Examples of the other copolymerizable components include: polycarboxylic acids such as isophthalic acid, orthophthalic acid, naphthalenedicarboxylic acid, paraphenylenedicarboxylic acid, trimellitic acid, pyromellitic acid, succinic acid, glutaric acid, adipic acid, suberic acid, azelaic acid, sebacic acid, and dodecanedioic acid, and their derivatives; dicarboxylic acids and their derivatives containing sulfonates such as 5-sodiumsulfoisophthalic acid and dihydroxyethyl 5-sodiumsulfoisophthalate; polyalcohols such as 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol, 1,4-cyclohexanedimethanol, diethylene glycol, polyethylene glycol, trimethylolpropane, and pentaerythritol; 4-hydroxybenzoic acid, ε-caprolactone, and an ethylene glycol ether of bisphenol A.

[0042] The copolymerized polyester is preferably produced by adding a small amount of other copolymerizable components to polyalkylene terephthalate serving as a main component, and allowing them to react with each other, from the viewpoint of stability and ease of operation. Examples of the polyalkylene terephthalate include polymers of terephthalic acid and/or its derivatives (e.g., methyl terephthalate) and alkylene glycol. The copolymerized polyester may be produced by adding a small amount of monomer or oligomer component serving as other copolymerizable components, to a mixture of terephthalic acid and/or its derivative (e.g., methyl terephthalate) and alkylene glycol, used for polymerization for producing polyalkylene terephthalate serving as a main component, and subjecting them to polymerization.

[0043] It is sufficient that the copolymerized polyester has a structure in which the other copolymerizable components are polycondensed on the main chain and/or side chain of polyalkylene terephthalate serving as a main component, and the copolymerization method and the like are not particularly limited.

[0044] Specific examples of the copolymerized polyester mainly containing polyalkylene terephthalate include polyesters obtained through copolymerization of polyethylene terephthalate serving as a main component with one compound selected from the group consisting of an ethylene glycol ether of bisphenol A, 1,4-cyclohexanedimethanol, isophthalic acid, and dihydroxyethyl 5-sodiumsulfoisophthalate. One of polyalkylene terephthalate and the copolymerized polyesters mainly containing polyalkylene terephthalate may be used alone, or two or more of polyalkylene terephthalate and the copolymerized polyesters mainly containing polyalkylene terephthalate may be used in combination. In particular, it is preferable to use one selected from the following group alone or two or more selected therefrom in combination, the group consisting of: polyethylene terephthalate; polypropylene terephthalate; polybutylene terephthalate; a polyester obtained through copolymerization of polyethylene terephthalate serving as a main component with an ethylene glycol ether of bisphenol A; a polyester obtained through copolymerization of polyethylene terephthalate serving as a main component with 1,4-cyclohexanedimethanol; a polyester obtained through copolymerization of polyethylene terephthalate serving as a main component with isophthalic acid; and a polyester obtained through copolymerization of polyethylene terephthalate serving as a main component with dihydroxyethyl 5-sodiumsulfoisophthalate.

[0045] The intrinsic viscosity (alternatively referred to as "IV value") of the polyester resin is not particularly limited but is preferably 0.3 dL/g or more and 1.2 dL/g or less, and more preferably 0.4 dL/g or more and 1.0 dL/g or less. When the intrinsic viscosity is 0.3 dL/g or more, the mechanical strength of the obtained fiber does not decrease, and there is no risk of dripping during a flammability test. When the intrinsic viscosity is 1.2 dL/g or less, the molecular weight is not too large, the melt viscosity is not too high, melt spinning can be easily performed, and the fineness is likely to be uniform.

[0046] The polyester resin composition may further contain other resins in addition to the polyester resin. Examples of the other resins include a polyamide resin, a vinyl chloride resin, a modacrylic resin, a polycarbonate resin, a polyolefin resin, and a polyphenylenesulfide resin. One of these resins may be used alone, or two or more of these resins may be used in combination.

[0047] The sheath is made of a polyamide resin composition containing a polyamide resin, and is specifically made of a polyamide resin composition containing a polyamide resin as a main component. The wording "a polyamide resin composition containing a polyamide resin as a main component" means that the polyamide resin composition contains the polyamide resin in an amount of more than 50 wt % when the overall weight of the polyamide resin composition is taken as 100 wt %, and the content of the polyamide resin is preferably 60 wt % or more, more preferably 70 wt % or more, even more preferably 80 wt % or more, even more preferably 90 wt % or more, and even more preferably 95 wt % or more.

[0048] The polyamide resin means a nylon resin obtained through polymerization of one or more selected from the group consisting of a lactam, aminocarboxylic acid, a mixture of dicarboxylic acid and diamine, a mixture of a dicarboxylic acid derivative and diamine, and a salt of dicarboxylic acid and diamine.

[0049] Specific examples of the lactam include 2-azetidinone, 2-pyrrolidinone, δ-valerolactam, ε-caprolactam, enantholactam, capryllactam, undecalactam, and laurolactam, but there is no particular limitation thereto. Of these lactams, ε-caprolactam, undecalactam, and laurolactam are preferable, and ε-caprolactam is particularly preferable. One of these lactams may be used alone, or a mixture of two or more of these lactams can also be used.

[0050] Specific examples of the aminocarboxylic acid include 6-aminocaproic acid, 7-aminoheptanoic acid, 8-aminooctanoic acid, 9-aminononanoic acid, 10-aminodecanoic acid, 11-aminoundecanoic acid, and 12-aminododecanoic acid, but there is no particular limitation thereto. Of these aminocarboxylic acids, 6-aminocaproic acid, 11-aminoundecanoic acid, and 12-aminododecanoic acid are preferable, and 6-aminocaproic acid is particularly preferable. One of these aminocarboxylic acids may be used alone, or a mixture of two or more of these aminocarboxylic acids can also be used.

[0051] Specific examples of the dicarboxylic acid that can be used for the mixture of dicarboxylic acid and diamine, the mixture of a dicarboxylic acid derivative and diamine, or the salt of dicarboxylic acid and diamine include: aliphatic dicarboxylic acids such as oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, brasylic acid, tetradecanedioic acid, pentadecanedioic acid, and octadecanedioic acid; alicyclic dicarboxylic acids such as cyclohexane dicarboxylic acid; and aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, terephthalic acid, and naphthalenedicarboxylic acid, but there is no particular limitation thereto. Of these dicarboxylic acids, adipic acid, sebacic acid, dodecanedioic acid, terephthalic acid, and isophthalic acid are preferable, and adipic acid, terephthalic acid, and isophthalic acid are particularly preferable. One of these dicarboxylic acids may be used alone, or a mixture of two or more of these dicarboxylic acids can also be used.

[0052] Specific examples of the diamine that can be used for the mixture of dicarboxylic acid and diamine, the mixture of a dicarboxylic acid derivative and diamine, or the salt of dicarboxylic acid and diamine include: aliphatic diamines such as 1,4-diaminobutane, 1,5-diaminopentane, 1,6-diaminohexane, 2-methyl-1,5-diaminopentane (MDP), 1,7-diaminoheptane, 1,8-diaminooctane, 1,9-diaminononan, 1,10-diaminodecane, 1,11-diaminoundecane, 1,12-diaminododecane, 1,13-diaminotridecane, 1,14-diaminotetradecane, 1,15-diaminopentadecane, 1,16-diaminohexadecane, 1,17-diaminoheptadecane, 1,18-diaminooctadecane, 1,19-diaminononadecane, and 1,20-diaminoeicosane; alicyclic diamines such as cyclohexanediamine and bis-(4-aminohexyl)methane; and aromatic diamines such as m-xylylenediamine and p-xylylenediamine, but there is no particular limitation thereto. Of these diamines, the aliphatic diamines are particularly preferable, and in particular, it is preferable to use hexamethylenediamine. One of these diamines may be used alone, or a mixture of two or more of these diamines can also be used.

[0053] The polyamide resin (alternatively referred to as a "nylon resin") is not particularly limited, but it is preferable to use, for example, nylon 6, nylon 66, nylon 11, nylon 12, nylon 6/10, nylon 6/12, semi-aromatic nylon containing the nylon 6T and/or 6I unit, copolymers of these nylon resins, or the like. In particular, nylon 6, nylon 66, and a copolymer of nylon 6 and nylon 66 are more preferable.

[0054] The polyamide resin can be produced using, for example, a polyamide resin polymerization method in which a polyamide resin raw material is heated in the presence or absence of a catalyst. During the polymerization, stirring may or may not be performed, but it is preferable to perform stirring in order to obtain a uniform product. The polymerization temperature can be set as appropriate according to the degree of polymerization of a target polymer, the reaction yield, and the reaction time, but it is preferable to set the polymerization temperature to a low temperature in consideration of the quality of a finally obtained polyamide resin. The reaction ratio can also be set as appropriate. The pressure is not limited, but it is preferable to reduce the pressure in the system in order to efficiently let volatile components move to the outside of the system.

[0055] The polyamide resin may have a terminal end that is capped by an end-capping agent such as a carboxylic acid compound or an amine compound if necessary. The concentration of terminal end amino groups or terminal end carboxyl groups in a nylon resin obtained when a terminal end is capped by adding monocarboxylic acid or monoamine is lower than that when such an end-capping agent is not used. On the other hand, the total concentration of terminal end amino groups and terminal end carboxyl groups does not change when a terminal end is capped by dicarboxylic acid or diamine, but the concentration ratio between terminal end amino groups and terminal end carboxyl groups changes.

[0056] Specific examples of the carboxylic acid compound include: aliphatic monocarboxylic acids such as acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, enanthic acid, caprylic acid, pelargonic acid, undecanoic acid, lauric acid, tridecanoic acid, myristic acid, myristoleic acid, palmitic acid, stearic acid, oleic acid, linoleic acid, and arachic acid; alicyclic monocarboxylic acids such as cyclohexanecarboxylic acid and methylcyclohexanecarboxylic acid; aromatic monocarboxylic acids such as benzoic acid, toluic acid, ethylbenzoic acid, and phenylacetic acid; aliphatic dicarboxylic acids such as oxalic acid, malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, undecanedioic acid, dodecanedioic acid, brasylic acid, tetradecanedioic acid, pentadecanedioic acid, and octadecanedioic acid; alicyclic dicarboxylic acids such as cyclohexanedicarboxylic acid; and aromatic dicarboxylic acids such as phthalic acid, isophthalic acid, terephthalic acid, and naphthalenedicarboxylic acid, but there is no particular limitation thereto.

[0057] Specific examples of the amine compound include: aliphatic monoamines such as butylamine, pentylamine, hexylamine, heptylamine, octylamine, 2-ethylhexylamine, nonylamine, decylamine, undecylamine, dodecylamine, tridecylamine, tetradecylamine, pentadecylamine, hexadecylamine, octadecylamine, nonadecylamine, and icosylamine; alicyclic monoamines such as cyclohexylamine and methylcyclohexylamine; aromatic monoamines such as benzylamine and ß-phenylethylamine; aliphatic diamines such as 1,4-diaminobutane, 1,5-diaminopentane, 1,6-diaminohexane, 1,7-diaminoheptane, 1,8-diaminooctane, 1,9-diaminononan, 1,10-diaminodecane, 1,11-diaminoundecane, 1,12-diaminododecane, 1,13-diaminotridecane, 1,14-diaminotetradecane, 1,15-diamino pentadecane, 1,16-diaminohexadecane, 1,17-diaminoheptadecane, 1,18-diaminooctadecane, 1,19-diaminononadecane, and 1,20-diaminoeicosane; alicyclic diamines such as cyclohexanediamine and bis-(4-aminohexyl)methane; and aromatic diamines such as xylylenediamine, but there is no particular limitation thereto.

[0058] The terminal end group concentration of the polyamide resin is not particularly limited, but it is preferable that the terminal end amino group concentration is high in the case where it is necessary to increase the dyeability for fiber uses or a material suitable for alloying for resin uses is designed. Conversely, it is preferable that the terminal end amino group concentration is low when it is required to suppress coloring or gelation under extended aging conditions. Furthermore, it is preferable that both the terminal end carboxyl group concentration and the terminal end amino group concentration are low when it is required to suppress reproduction of lactam during re-melting, fiber breakage caused by production of oligomer during melt spinning, mold deposit during continuous injection molding, and generation of die marks during continuous extrusion of a film. It is preferable to adjust the terminal end group concentration according to the applications, but the terminal end amino group concentration and the terminal end carboxyl group concentration are both preferably 1.0×10 5 to 15.0×10 5 eq/g, more preferably 2.0×10 5 to 12.0×10 5 eq/g, and even more preferably 3.0×10 5 to 11.0×10 5 eq/g. In this specification, a numerical range indicated by " . . . to . . . " includes two end values in a manner similar to the numerical range indicated by " . . . or more and . . . or less".

[0059] Furthermore, the end-capping agent may be added using a method in which the end-capping agent is added simultaneously with raw materials such as caprolactam at the initial stage of polymerization, a method in which the end-capping agent is added during polymerization, a method in which the end-capping agent is added when a nylon resin in a molten state is caused to pass through a vertical stirring thin-film evaporator, or the like. The end-capping agent may be added without any treatment, or in the form of a solution produced by dissolving the agent in a small amount of solvent.

[0060] The polyamide resin composition may contain other resins in addition to the polyamide resin. Examples of the other resins include a polyester resin, a vinyl chloride resin, a modacrylic resin, a polycarbonate resin, a polyolefin resin, and a polyphenylenesulfide resin. One of these resins may be used alone, or two or more of these resins may be used in combination.

[0061] From the viewpoint of making the touch and the appearance more similar to those of human hair, it is preferable that the core of each core-sheath conjugate fiber is made of a polyester resin composition containing, as a main component, one or more polyester resins selected from the group consisting of polyalkylene terephthalate and copolymerized polyesters mainly containing polyalkylene terephthalate, and it is more preferable that the sheath is made of a polyamide resin composition containing, as a main component, a polyamide resin mainly containing at least one selected from the group consisting of nylon 6 and nylon 66. The wording "a polyamide resin mainly containing at least one selected from the group consisting of nylon 6 and nylon 66" means a polyamide resin containing nylon 6 and/or nylon 66 in an amount of 80 mol % or more.

[0062] The core-sheath conjugate fibers may contain a flame retardant from the viewpoint of flame retardance. Examples of the flame retardant include bromine-containing flame retardants and phosphorus-containing flame retardants. Examples of the phosphorus-containing flame retardants include phosphoric acid ester amide compounds and organic cyclic phosphorus compounds. Examples of the bromine-based flame retardants include: a brominated epoxy-based flame retardant; bromine-containing phosphate esters such as pentabromotoluene, hexabromobenzene, decabromodiphenyl, decabromodiphenyl ether, bis(tribromophenoxy)ethane, tetrabromophthalic anhydride, ethylene bis(tetrabromophthalimide), ethylene bis(pentabromophenyl), octabromotrimethylphenylindan, and tris(tribromoneopentyl)phosphate; brominated polystyrenes; brominated polybenzyl acrylates; brominated phenoxy resins; brominated polycarbonate oligomers; tetrabromobisphenol A and tetrabromobisphenol A derivatives such as tetrabromobisphenol A-bis(2,3-dibromopropyl ether), tetrabromobisphenol A-bis(allyl ether), and tetrabromobisphenol A-bis(hydroxyethyl ether); bromine-containing triazine compounds such as tris(tribromophenoxy)triazine; and bromine-containing isocyanuric acid compounds such as tris(2,3-dibromopropyl)isocyanurate, but there is no particular limitation thereto. In particular, it is preferable to use the brominated epoxy-based flame retardant from the viewpoint of heat resistance and flame retardance.

[0063] The content of the bromine-based epoxy flame retardant is not particularly limited but is, for example, 5 parts by weight or more and 40 parts by weight or less with respect to 100 parts by weight of the main component resin in the core and/or the sheath. For example, from the viewpoint of heat resistance and flame retardance, it is preferable that the core is made of a polyester resin composition containing one or more polyester resins selected from the group consisting of polyalkylene terephthalate and copolymerized polyesters mainly containing polyalkylene terephthalate in an amount of 100 parts by weight and a bromine-based epoxy flame retardant in an amount of 5 parts by weight or more and 40 parts by weight or less, and the sheath is made of a polyamide resin composition containing a polyamide resin mainly containing at least one selected from the group consisting of nylon 6 and nylon 66 in an amount of 100 parts by weight and a bromine-based epoxy flame retardant in an amount of 5 parts by weight or more and 40 parts by weight or less.

[0064] The core-sheath conjugate fibers may contain a flame retardant auxiliary. Although the flame retardant auxiliary is not particularly limited, it is preferable to use, for example, an antimony compound or a composite metal containing antimony from the viewpoint of flame retardance. Examples of the antimony compound include antimony trioxide, antimony tetroxide, antimony pentoxide, sodium antimonate, potassium antimonate, and calcium antimonate. In terms of the influences on the flame retardance improving effect and the touch, one or more selected from the group consisting of antimony trioxide, antimony pentoxide, and sodium antimonate are more preferable.

[0065] The content of the flame retardant auxiliary is not particularly limited but is, for example, 0.1 parts by weight or more and 10 parts by weight or less with respect to 100 parts by weight of the main component resin in the core and/or the sheath.

[0066] In particular, as a result of adding a flame retardant auxiliary to the polyamide resin composition contained in the sheath, an appropriate surface unevenness is formed on the fiber surface, thus obtaining a core-sheath conjugate fiber for artificial hair having flame retardance and a low-gloss appearance similar to that of human hair.

[0067] The core-sheath conjugate fibers may contain various types of additives such as a pigment, a heat-resistant agent, a stabilizer, a fluorescent agent, an antioxidant, and an antistatic agent if necessary, within a range that does not inhibit the effects of one or more embodiments of the present invention.

[0068] Although there is no particular limitation on the method for producing the core-sheath conjugate fibers, the core-sheath conjugate fibers can be produced by, for example, melt-kneading each of the resin compositions that are to be respectively contained in the core and the sheath using various types of ordinary kneaders, and then performing melt spinning using a core-sheath conjugate spinning nozzle. For example, a core component is prepared by dry blending components such as a polyester resin and a brominated epoxy-based flame retardant and melt-kneading the obtained polyester resin composition using any of various types of ordinary kneaders, while a sheath component is prepared by dry blending components such as a polyamide resin, a pigment, and a brominated epoxy-based flame retardant and melt-kneading the obtained polyamide resin composition using any of various types of ordinary kneaders. Examples of the kneaders include a single-screw extruder, a twin-screw extruder, a roll, a Banbury mixer, and a kneader. In particular, a twin-screw extruder is preferable from the viewpoint of adjustment of the kneading degree and ease of operation.

[0069] In the melt spinning process, the temperatures of the extruder, the gear pump, the nozzle, and the like for the polyester resin composition are set to 250° C. or higher and 300° C. or lower, and the temperatures of the extruder, the gear pump, the nozzle, and the like for the polyamide resin composition are set to 260° C. or higher and 320° C. or lower. Then, the resin compositions are extruded through the core-sheath conjugate spinning nozzle, are cooled to temperatures lower than the respective glass transition points of the resins, and are then wound up at a speed of 20 m/minute or more and 5000 m/minute or less, or 30 m/minute or more and 2000 m/minute or less. Thus, spun filaments (undrawn filaments) are obtained. During the melt spinning, the polyester resin composition for forming the core is supplied from an extruder for the core of a melt spinning machine, the polyamide resin composition for forming the sheath is supplied from an extruder for the sheath of the melt spinning machine, and the molten polymer is extruded through a core-sheath conjugate spinning nozzle with a predetermined shape. Thus, the spun filaments (undrawn filaments) are obtained.

[0070] It is preferable that the spun filaments (undrawn filaments) are hot-drawn. The hot-drawing may be performed through a two-step method or a direct spinning-drawing method. In the two-step method, the spun filaments are once wound, and then drawn. In the direct spinning-drawing method, the spun filaments are drawn continuously without being wound. The hot-drawing is performed through a single-stage drawing method or a multi-stage drawing method that includes two or more stages.

[0071] A heating roller, a heat plate, a steam jet apparatus, a hot water bath, and the like can be used as the heating means in the hot drawing, and these means can also be used in combination as appropriate.

[0072] An oil such as a fiber treatment agent and a softening agent may be applied to the core-sheath conjugate fibers to make the touch and texture more similar to those of human hair. Examples of the fiber treatment agent include a silicone-based fiber treatment agent or a non-silicone-based fiber treatment agent for improving the touch and the combing properties.

[0073] The core-sheath conjugate fibers may be subjected to gear crimping. The gear crimping imparts gentle curves and natural appearance to the fiber, and also reduces the adhesion between the fibers, thereby also improving the combing properties. In the gear crimping, the fibers are generally heated to a temperature higher than the softening temperature and passed between two engaged gears, so that the shape of the gears is transferred to the fibers. This can create curls on the fibers. Also, in the fiber processing stage, if necessary, curls with different shapes can be created by heating the core-sheath conjugate fibers for artificial hair at different temperatures.

[0074] The fiber bundle can be produced by producing different types of core-sheath conjugate fibers having respective core-to-sheath area ratios, and then mixing two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios at a predetermined blend ratio. Alternatively, the fiber bundle containing two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios may be produced using a nozzle with various pore sizes and land lengths in a core-sheath conjugate spinning nozzle (pores). In each case, the obtained fiber bundle may be subjected to hackling 20 times or more and 100 times or less if necessary.

[0075] The total fineness of the fiber bundle is not particularly limited and need only be determined as appropriate if necessary. For example, the total fineness may be 300000 dtex or more and 400000 dtex or less, 320000 dtex or more and 380000 dtex or less, or 340000 dtex or more and 360000 dtex or less, from the viewpoint of enabling the development of favorable touch, appearance, curl setting properties, and usage durability.

[0076] Hair Ornament Product

[0077] In one or more embodiments of the present invention, the above-described fiber bundle for artificial hair can be used for hair ornament products without particular limitation. Examples of the hair ornament products include hair wigs, hairpieces, weaving hair, hair extensions, braided hair, hair accessories, and doll hair.

[0078] The above-described fiber bundle for artificial hair alone may be used as artificial hair, or the fiber bundle for artificial hair may be used with other fibers for artificial hair or natural fibers such as human hair and animal hair in combination. Examples of the other fibers for artificial hair include acrylic fibers and vinyl chloride fibers.

[0079] In one or more embodiments of the present invention, the hair ornament product may contain only the fiber bundle for artificial hair according to one or more embodiments of the present invention. Also, the hair ornament product may contain a combination of the fiber bundle for artificial hair according to one or more embodiments of the present invention and other fibers for artificial hair or natural fibers such as human hair and animal hair.

EXAMPLES

[0080] Hereinafter, one or more embodiments of the present invention will be described more specifically based on examples. Note that one or more embodiments of the present invention are not limited to these examples.

[0081] The following describes the measurement methods and the evaluation methods used for examples and comparative examples.

[0082] Cross Section of Fiber Bundle

[0083] At room temperature (23° C.), fibers were bundled, were fixed with a shrinkable tube to prevent the fibers from being displaced in the fiber bundle, and were then cut using a cutter. Thus, a fiber bundle for cross-section observation was produced. An image of this fiber bundle was captured using a laser microscope ("VK-9500", manufactured by Keyence Corporation) at 500-fold magnification, and thus a photograph of the cross-section was obtained.

[0084] A region that included about 100 fibers was randomly selected as a measurement region in the obtained photograph of the cross-section of the fiber bundle, the areas of the fiber cross-section, the core cross-section, and the sheath cross-section in each of the core-sheath conjugate fibers were calculated using an image analyzer (manufactured by Mitani Corporation; image analysis software "Win ROOF"), and the core-to-sheath area ratio was calculated based on the calculated areas. This makes it possible to confirm the types of fibers having different core-to-sheath area ratios in the fiber bundle. Also, the standard deviation of the core cross-sectional area ratios in the fiber bundle was calculated using Formula (1) below.

[Formula 2]

$$S = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2} \tag{1}$$

[0085] S: Standard deviation

[0086] n: Number of fibers

[0087] X_i: Each core cross-sectional area ratio

[0088] $\overline{x}$: Average value of core cross-sectional area ratios

Curl Setting Properties

[0089] Filaments formed into a hair tress were wrapped around a pipe with a diameter of 32 mm at room temperature (23° C.), were curled at 120° C. for 60 minutes, and aged at room temperature (23° C.) for 60 minutes. Then, the curled filaments were suspended with one end thereof being fixed, and the length of the curled filaments was measured. The filament length was used as an indicator of the curl setting properties, and when the filament length was 17.0 cm or less, the filaments were determined as being capable of being curled.

[0090] Touch

[0091] Sensory evaluation was performed by a professional cosmetologist, and the touch was evaluated according to the following three levels.

[0092] A: The touch was very good and equivalent to that of human hair.

[0093] B: The touch was good but slightly inferior to that of human hair.

[0094] C: The touch was poor and was inferior to that of human hair.

[0095] Combing Properties

[0096] Fibers whose curls were completely stretched were cut to have a length of 70 cm, and 25 g of thus obtained fibers with a fiber length of 70 cm were bundled. Subsequently, the fiber bundle was bound with a string at the middle thereof, folded in half, and fixed at the string portion, and thus a fiber bundle for hair iron treatment was prepared. Next, the fiber bundle was heated and crimped five times from the root at which the fiber bundle was fixed to the end of the fiber bundle, using a hair iron ("IZUNAMI ITC450 flat iron" manufactured by IZUNAMI. INC, U.S.) heated to 180° C., and thus a fiber bundle for evaluation of the combing properties was prepared. Subsequently, the fiber bundle for evaluation of the combing properties was combed with a comb for combing hair ("MATADOR PROFESSIONAL 386.8 1/2F" made in Germany) 100 times from the root at which the fiber bundle was fixed to the end of the fiber bundle, the combing properties were evaluated according to the following three levels based on the number of fibers deformed or split.

[0097] A: The number of fibers deformed or split was less than 10 after the fiber bundle was combed 100 times, and the fiber bundle could be combed down to the end without resistance.

[0098] B: The number of fibers deformed or split was 10 or more and less than 30 after the fiber bundle was combed 100 times, and the fiber bundle could be combed down although the resistance somewhat significantly increased midway.

[0099] C: The number of fibers deformed or split was 30 or more after the fiber bundle was combed 100 times, and the fiber bundle could not always be combed down due to the resistance having increased midway.

[0100] Evaluation of Appearance

[0101] Sensory evaluation was performed by a professional cosmetologist, and the appearances of the fibers of examples and comparative examples were evaluated according to the following three levels.

[0102] A: The appearance was equivalent to that of human hair.

[0103] B: The appearance was substantially equivalent to that of human hair.

[0104] C: The appearance was inferior to that of human hair.

[0105] Durability A hair sample (fiber bundle) was damaged according to the following procedure, and the durability was evaluated based on the bulkiness change ratio calculated from the bulkiness values obtained before and after damaging the hair sample.

[0106] (1) Fibers were bundled to produce a hair sample (with a total length of 16 inches and a weight of 15 g) in which one end was bound with a rubber string and was taken as a root, and a layered portion was formed at the other end by partially displacing the fibers, and the initial bulkiness value of the layered portion (4 inches) was measured.

[0107] (2) The hair sample was backcombed using a brush to tangle the hair.

[0108] (3) The root, the layered portion, and the entire hair sample were separately rubbed 10 times to further tangle the hair.

[0109] (4) The tangled hair was combed using a brush.

[0110] (5) The operations of (2) to (4) were repeated 10 times to cause further damage to the hair sample.

[0111] (6) The bulkiness value of the layered portion of the hair sample that had been further damaged was measured and taken as the bulkiness value after damaging.

[0112] (7) The bulkiness change ratio between before and after damaging the hair sample was calculated based on Formula (4) below, and was evaluated according to the following three levels.

[0113] Bulkiness change ratio after damaging sample (%)=bulkiness value after damaging/initial bulkiness value×100 (4)

[0114] A: The bulkiness change ratio was less than 200%.

[0115] B: The bulkiness change ratio was 200% or more and less than 250%.

[0116] C: The bulkiness change ratio was 250% or more.

[0117] Measurement of Bulkiness Value

[0118] The bulkiness value of the hair sample (fiber bundle) was measured using a bulkiness meter shown in FIGS. **5**A to **5**C. As shown in FIGS. **5**A to **5**C, a bulkiness meter **100** includes a support base **101** and holders **102** and **103** for holding hair therebetween that are placed on the support base **101**. Scales **104** are attached to the holder **102** using transparent tape (not illustrated). The support base **101** and the holders **102** and **103** are all made of an acrylic resin. As shown in FIG. **5**C, a hair sample **40** was placed between the holders **102** and **103** such that the center of the holder **102** in the length direction coincided with the center of the layered portion of the hair sample **40**, and then the bulkiness value was measured. Production Example 1

[0119] First, 100 parts by weight of polyethylene terephthalate pellets (EastPET, trade name "A-12", manufactured by East West Chemical Private Limited) were mixed with 30 parts by weight of a brominated epoxy-based flame retardant (trade name "SR-T2MP", manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.), 3 parts by weight of sodium antimonate (trade name "SA-A", manufactured by Nihon Seiko Co., Ltd.), 2.1 parts by weight of a black pigment masterbatch (trade name "PESM 22367 BLACK (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), 0.8 parts by weight of a yellow pigment masterbatch (trade name "PESM 1001 YELLOW (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), and 0.6 parts by weight of a red pigment masterbatch (trade name "PESM 3005 RED (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.). The mixture was dry blended and was then fed into a twin-screw extruder, where it was melt-kneaded at a barrel temperature of 280° C. and was pelletized. Thus, a polyester resin composition was obtained.

[0120] Then, 100 parts by weight of nylon 6 (trade name "A1030BRL", manufactured by Unitika Ltd.) were mixed with 12 parts by weight of a brominated epoxy-based flame retardant (trade name "SR-T2MP", manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.), 2 parts by weight of sodium antimonate (trade name "SA-A", manufactured by Nihon Seiko Co., Ltd.), 2.1 parts by weight of a black pigment masterbatch (trade name "PESM 22367 BLACK (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), 0.8 parts by weight of a yellow pigment masterbatch (trade name "PESM 1001 YELLOW (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.), and 0.6 parts by weight of a red pigment masterbatch (trade name "PESM 3005 RED (20)", manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd.). The mixture was dry blended and was then fed into a twin-screw extruder, where it was melt-kneaded at a barrel temperature of 260° C. and was pelletized. Thus, a polyamide resin composition was obtained.

[0121] Next, the obtained polyester resin composition in the form of pellets and the obtained polyamide resin composition in the form of pellets were fed into extruders, were extruded through a core-sheath conjugate spinning nozzle (pores) having a flat two-lobed shape at a nozzle temperature of 270° C., and were wound up at a speed of 40 to 200 m/minute. This resulted in undrawn filaments of core-sheath conjugate fibers having a core made of the polyester resin composition and a sheath made of the polyamide resin composition with a core-to-sheath area ratio between the core and the sheath of 8:2.

[0122] The obtained undrawn filaments were drawn to 3 times their original length and taken up at a speed of 45 m/minute by using a heating roller at 85° C. Subsequently, the drawn filaments were further heat-treated and wound up at a speed of 45 m/minute by using a heating roller heated to 205° C. A polyether oil (trade name "KWC-Q", manufactured by Marubishi Oil Chemical Corporation) was applied to the drawn filaments such that the amount of oil applied was 0.20% omf (i.e., the weight percentage of the oil (pure content) with respect to the dry fiber weight). Then, the resulting filaments were dried, and thus core-sheath conjugate fibers (with a single fiber fineness of 64 dtex) were obtained.

Production Example 2

[0123] Core-sheath conjugate fibers (with a single fiber fineness of 62 dtex) were obtained in the same manner as in Production Example 1, except that the core-to-sheath area ratio between the core and the sheath was 7:3.

Production Example 3

[0124] Core-sheath conjugate fibers (with a single fiber fineness of 60 dtex) were obtained in the same manner as in Production Example 1, except that the core-to-sheath area ratio between the core and the sheath was 6:4.

Production Example 4

[0125] Core-sheath conjugate fibers (with a single fiber fineness of 58 dtex) were obtained in the same manner as in Production Example 1, except that the core-to-sheath area ratio between the core and the sheath was 5:5.

Production Example 5

[0126] Core-sheath conjugate fibers (with a single fiber fineness of 57 dtex) were obtained in the same manner as in Production Example 1, except that the core-to-sheath area ratio between the core and the sheath was 4:6.

Production Example 6

[0127] Core-sheath conjugate fibers (with a single fiber fineness of 55 dtex) were obtained in the same manner as in Production Example 1, except that the core-to-sheath area ratio between the core and the sheath was 3:7.

Production Example 7

[0128] Core-sheath conjugate fibers (with a single fiber fineness of 64 dtex) were obtained in the same manner as in Production Example 1, except that the resin used for the sheath was changed to nylon 66 (product name "Amilan CM3001", manufactured by Toray Industries, Inc.), and the melt kneading was performed at a barrel temperature of 280° C.

Production Example 8

[0129] Core-sheath conjugate fibers (with a single fiber fineness of 55 dtex) were obtained in the same manner as in Production Example 7, except that the core-to-sheath area ratio between the core and the sheath was 3:7.

Production Example 9

[0130] Core-sheath conjugate fibers (with a single fiber fineness of 64 dtex) were obtained in the same manner as in Production Example 1, except that the resin used for the core was changed to polybutylene terephthalate pellets (trade name "Novaduran 5020", manufactured by Mitsubishi Chemical Corporation), the core was formed by using a polyester resin composition obtained through melt-kneading performed at a barrel temperature of 260° C. and pelletization, and the nozzle temperature was 260° C.

Production Example 10

[0131] Core-sheath conjugate fibers (with a single fiber fineness of 62 dtex) were obtained in the same manner as in Production Example 9, except that the core-to-sheath area ratio between the cores and the sheath was 7:3.

Production Example 11

[0132] Core-sheath conjugate fibers (with a single fiber fineness of 60 dtex) were obtained in the same manner as in Production Example 9, except that the core-to-sheath area ratio between the core and the sheath was 6:4.

Production Example 12

[0133] Core-sheath conjugate fibers (with a single fiber fineness of 58 dtex) were obtained in the same manner as in Production Example 9, except that the core-to-sheath area ratio between the core and the sheath was 5:5.

Production Example 13

[0134] Core-sheath conjugate fibers (with a single fiber fineness of 57 dtex) were obtained in the same manner as in Production Example 9, except that the core-to-sheath area ratio between the core and the sheath was 4:6.

Production Example 14

[0135] Core-sheath conjugate fibers (with a single fiber fineness of 55 dtex) were obtained in the same manner as in Production Example 9, except that the core-to-sheath area ratio between the core and the sheath was 3:7.

Example 1

[0136] The core-sheath conjugate fibers of Production Examples 2 and 6 were cut into a desired length, were stacked at a weight ratio of 50:50, were placed on a hackling base with a length of 53 cm, a width of 7.5 cm, and a height of 7 cm, and were then hackled 20 times. Thus, a fiber bundle containing two types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 2 and 6 was substantially equal to the weight ratio, and therefore, the standard deviation of the core cross-sectional area ratios based on Formula (1) above could be determined specifically as follows. The core cross-sectional area ratios of the core-sheath conjugate fibers of Production Examples 2 and 6 were 0.7 and 0.3, respectively, and the average value of the core cross-sectional area ratios was 0.5. Therefore, the standard deviation of the core cross-sectional area ratios could be determined as follows, and was 0.20.

[Formula 3]

$$\text{Standard deviation} = \sqrt{\frac{1}{100}\left\{(0.7-0.5)^2 * 50 + (0.3-0.5)^2 * 50\right\}} = 0.20$$

Example 2

[0137] A fiber bundle containing three types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 2, 4, and 6 were used at a weight ratio of 33:33:33. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 2, 4, and 6 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Example 3

[0138] A fiber bundle containing six types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 1 to 6 were used at a weight ratio of 10:10:10:10:10:50. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 1 to 6 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Example 4

[0139] A fiber bundle containing two types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 7 and 8 were used at a weight ratio of 90:10. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 7 and 8 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Example 5

[0140] A fiber bundle containing six types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 9 to 14 were used at a weight ratio of 16:16:16:16:16:16. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 9 to 14 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Comparative Example 1

[0141] A fiber bundle was obtained in the same manner as in Example 1, except that only the core-sheath conjugate fibers of Production Example 4 were used.

Comparative Example 2

[0142] A fiber bundle containing three types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 3 to 5 were used at a weight ratio of 70:20:10. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 3 to 5 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Comparative Example 3

[0143] A fiber bundle containing five types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 1 to 5 were used at a weight ratio of 5:10:10:10:65. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 1 to 5 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

Comparative Example 4

[0144] A fiber bundle containing two types of core-sheath conjugate fibers having different core-to-sheath area ratios was obtained in the same manner as in Example 1, except that the core-sheath conjugate fibers of Production Examples 1 and 6 were used at a weight ratio of 95:5. In the obtained fiber bundle, the ratio between the numbers of the core-sheath conjugate fibers of Production Examples 1 and 6 was substantially equal to the weight ratio, and the standard deviation of the core cross-sectional area ratios could be determined using the same calculation method as that used in Example 1.

[0145] Regarding the fiber bundles of the examples and the comparative examples, the fiber cross-sectional shape, the curl setting properties, the touch, the combing properties, the appearance, and the durability were measured and evaluated as described above. Table 1 below and FIGS. **2** to **4** show the results.

TABLE 1

			Ex.					Comp. Ex.			
			1	2	3	4	5	1	2	3	4
Core-sheath conjugate fiber	Main component resin (core)		PET	PET	PET	PET	PBT	PET	PET	PET	PET
	Main component resin (sheath)		PA6	PA6	PA6	PA66	PA6	PA6	PA6	PA6	PA6
	Production Example	Core-to-sheath area ratio	Blend ratio (parts by weight)					Blend ratio (parts by weight)			
	1	8:2			10					5	95
	2	7:3	50	33	10					10	
	3	6:4			10				70	10	
	4	5:5		33	10			100	20	10	
	5	4:6			10				10	65	
	6	3:7	50	33	50						5
	7	8:2				90					
	8	3:7				10					
	9	8:2					16				
	10	7:3					16				
	11	6:4					16				
	12	5:5					16				
	13	4:6					16				
	14	3:7					16				
Fiber bundle	Standard deviation of ratios of core cross-sectional area to fiber cross-sectional area in fiber bundle		0.20	0.16	0.18	0.15	0.17	0.00	0.07	0.13	0.11
	Photograph of cross-section		FIG. 2	FIG. 3	—	—	—	FIG. 4	—	—	—
	Curl length (cm)		16.9	15.8	16.5	14.2	15.5	18.2	18.7	17.5	14.0
	Curl setting properties		Good	Good	Good	Good	Good	Poor	Poor	Poor	Good
	Touch		B	B	A	B	A	B	A	A	C
	Combing properties		B	B	A	B	A	B	A	B	C
	Appearance		A	A	A	B	A	C	C	C	C
	Durability		A	A	A	B	B	B	B	B	C

[0146] FIG. **2** is a laser micrograph of the fiber cross-section of the fiber bundle of Example 1. As can be seen from FIG. **2**, the fiber bundle contained two types of core-sheath conjugate fibers having different core-to-sheath area ratios. FIG. **3** is a laser micrograph of the fiber cross-section of the fiber bundle of Example 2. As can be seen from FIG. **3**, the fiber bundle contained three types of core-sheath conjugate fibers having different core-to-sheath area ratios. FIG. **4** is a laser micrograph of the fiber cross-section of the fiber bundle of Comparative Example 1. As can be seen from FIG. **4**, the fiber bundle contained core-sheath conjugate fibers having the same core-to-sheath area ratio.

[0147] As can be seen from Table 1, the fiber bundles of Examples 1 to 5 had favorable curl setting properties, had touch, combing properties, and appearance that were similar to those of human hair, and had favorable durability.

[0148] Meanwhile, the fiber bundle of Comparative Example 1 that contained only the core-sheath conjugate fibers having a core-to-sheath area ratio of 5:5 had favorable touch, combing properties, and durability, but had poor curl setting properties and appearance. The fiber bundle of Comparative Example 2 in which three types of core-sheath conjugate fibers having different core-to-sheath area ratios were contained but the standard deviation of the ratios of the cross-sectional area of the core to the fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle was 0.07 had favorable touch, combing properties, and durability, but had poor curl setting properties and appearance. The fiber bundle of Comparative Example 3 in which five types of core-sheath conjugate fibers having different core-to-sheath area ratios were contained but the standard deviation of the ratios of the cross-sectional area of the core to the fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle was 0.13 had favorable touch, combing properties, and durability, but had poor curl setting properties and appearance. The fiber bundle of Comparative Example 4 in which two types of core-sheath conjugate fibers having different core-to-sheath area ratios were contained but the standard deviation of the ratios of the cross-sectional area of the core to the fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle was 0.11 had favorable curl setting properties, but had poor touch, combing properties, appearance, and durability.

[0149] One or more embodiments of the present invention are not particularly limited, but may encompass at least the following embodiments.

[0150] [1] A fiber bundle for artificial hair, including two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios, wherein each of the core-sheath conjugate fibers includes a core and a sheath and the core-to-sheath area ratio is represented by an area ratio between the core and the sheath, in each of the core-sheath conjugate fibers, the core is made of a polyester resin composition containing a polyester resin and the sheath is made of a polyamide resin composition containing a polyamide resin, and a standard deviation of ratios of a core cross-sectional area to a fiber cross-sectional area of the core-sheath conjugate fibers contained in the fiber bundle for artificial hair is 0.15 or more.

[0151] [2] The fiber bundle for artificial hair according to [1], wherein, in each of the core-sheath conjugate fibers, the core-to-sheath area ratio between the core and the sheath is within a range of 3:7 to 8:2.

[0152] [3] The fiber bundle for artificial hair according to [1] or [**2**], wherein a content of core-sheath conjugate fibers having the same core-to-sheath area ratio with respect to an overall weight of the fiber bundle for artificial hair is 5 wt % or more and 90 wt % or less.

[0153] [4] The fiber bundle for artificial hair according to any one of [1] to [**3**], wherein each of the core-sheath conjugate fibers has a flat cross-sectional shape.

[0154] [5] The fiber bundle for artificial hair according to any one of [1] to [**4**], wherein, in each of the core-sheath conjugate fibers, the core has a flat cross-sectional shape.

[0155] [6] The fiber bundle for artificial hair according to any one of [1] to [**5**], wherein the polyester resin includes one or more of polyester resins selected from the group consisting of polyalkylene terephthalate and copolymerized polyesters mainly containing polyalkylene terephthalate.

[0156] [7] The fiber bundle for artificial hair according to any one of [1] to [**6**], wherein the polyamide resin includes a polyamide resin mainly containing at least one selected from the group consisting of nylon 6 and nylon 66.

[0157] [8] The fiber bundle for artificial hair according to any one of [1] to [**7**], wherein each of the core-sheath conjugate fibers has a fiber cross-section having a concentric structure in which a center of the core coincides with a center of the fiber.

[0158] [9] The fiber bundle for artificial hair according to any one of [1] to [8], wherein each of the core-sheath conjugate fibers has a single fiber fineness of 10 dtex or more and 150 dtex or less.

[0159] [10] The fiber bundle for artificial hair according to any one of [1] to [9], wherein the fiber bundle for artificial hair has a total fineness of 30000 dtex or more and 400000 dtex or less.

[0160] [11] A hair ornament product including the fiber bundle for artificial hair according to any one of [1] to [10].

[0161] [12] The hair ornament product according to [11], wherein the hair ornament product is one selected from the group consisting of a hair wig, a hairpiece, weaving hair, a hair extension, braided hair, a hair accessory, and doll hair.

[0162] Although the disclosure has been described with respect to only a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that various other embodiments may be devised without departing from the scope of the present disclosure. Accordingly, the scope of the invention should be limited only by the attached claims.

LIST OF REFERENCE NUMERALS

[0163] **1** Core-sheath conjugate fiber for artificial hair (cross-section)

[0164] **10** Sheath

[0165] **20** Core

[0166] **100** Bulkiness meter

[0167] **40** Hair sample (fiber bundle)

[0168] **101** Support base

[0169] **102**, **103** Holder

[0170] **104** Scale

1. A fiber bundle for artificial hair, comprising two or more types of core-sheath conjugate fibers, each of the two or more types of core-sheath conjugate fibers having different core-to-sheath area ratios, wherein:

each of the two or more types of core-sheath conjugate fibers includes a core and a sheath;

each of the two or more types of core-sheath conjugate fibers has a core-to-sheath area ratio represented by an area ratio between the core and the sheath;

in each of the two or more types of core-sheath conjugate fibers, the core comprises a polyester resin composition containing a polyester resin and the sheath comprises a polyamide resin composition containing a polyamide resin; and

a standard deviation of ratios of a core cross-sectional area to a fiber cross-sectional area of the two or more types of core-sheath conjugate fibers contained in the fiber bundle for artificial hair is 0.15 or more.

2. The fiber bundle for artificial hair according to claim **1**, wherein, in each of the two or more types of core-sheath conjugate fibers, the core-to-sheath area ratio between the core and the sheath is within a range of 3:7 to 8:2.

3. The fiber bundle for artificial hair according to claim **1**, wherein a content of core-sheath conjugate fibers having a same core-to-sheath area ratio with respect to an overall weight of the fiber bundle for artificial hair is 5 wt % or more and 90 wt % or less.

4. The fiber bundle for artificial hair according to claim **1**, wherein each of the two or more types of core-sheath conjugate fibers has a flat cross-sectional shape.

5. The fiber bundle for artificial hair according to claim **1**, wherein, in each of the two or more types of core-sheath conjugate fibers, the core has a flat cross-sectional shape.

6. The fiber bundle for artificial hair according to claim **1**, wherein the polyester resin comprises one or more of polyester resins selected from the group consisting of polyalkylene terephthalate and copolymerized polyesters mainly containing polyalkylene terephthalate.

7. The fiber bundle for artificial hair according to claim **1**, wherein the polyamide resin comprises a polyamide resin mainly containing at least one selected from the group consisting of nylon 6 and nylon **66**.

8. The fiber bundle for artificial hair according to claim **1**, wherein each of the two or more types of core-sheath conjugate fibers has a fiber cross-section having a concentric structure in which a center of the core coincides with a center of the each of the two or more types of core-sheath conjugate fibers.

9. The fiber bundle for artificial hair according to claim **1**, wherein each of the two or more types of core-sheath conjugate fibers has a single fiber fineness of 10 dtex or more and 150 dtex or less.

10. The fiber bundle for artificial hair according to claim **1**, wherein the fiber bundle for artificial hair has a total fineness of 30000 dtex or more and 400000 dtex or less.

11. A hair ornament product comprising the fiber bundle for artificial hair according to claim **1**.

12. The hair ornament product according to claim **11**, wherein the hair ornament product is one selected from the group consisting of a hair wig, a hairpiece, weaving hair, a hair extension, braided hair, a hair accessory, and doll hair.

13. The hair ornament product according to claim **11**, wherein, in each of the two or more types of core-sheath conjugate fibers, the core-to-sheath area ratio between the core and the sheath is within a range of 3:7 to 8:2.

14. The hair ornament product according to claim **11**, wherein a content of core-sheath conjugate fibers having a same core-to-sheath area ratio with respect to an overall weight of the fiber bundle for artificial hair is 5 wt % or more and 90 wt % or less.

15. The hair ornament product according to claim **11**, wherein each of the two or more types of core-sheath conjugate fibers has a flat cross-sectional shape.

16. The hair ornament product according to claim **11**, wherein, in each of the two or more types of core-sheath conjugate fibers, the core has a flat cross-sectional shape.

17. The hair ornament product according to claim **11**, wherein each of the two or more types of core-sheath conjugate fibers has a fiber cross-section having a concentric structure in which a center of the core coincides with a center of the each of the two or more types of core-sheath conjugate fibers.

18. The hair ornament product according to claim **11**, wherein each of the two or more types of core-sheath conjugate fibers has a single fiber fineness of 10 dtex or more and 150 dtex or less.

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