

DESCRIPTION

TITLE OF THE INVENTION: FIBER FOR ARTIFICIAL HAIR, HAIR DECORATION PRODUCT, AND NOZZLE FOR MELT EXTRUSION OF FIBER FOR ARTIFICIAL HAIR

TECHNICAL FIELD

[0001]

The present invention relates to a fiber for artificial hair, a hair decoration product, and a nozzle for melt extrusion of a fiber for artificial hair.

BACKGROUND ART

[0002]

In hair decoration products such as wigs, hairpieces, hair extensions, hair bands, and doll hair, the importance of artificial hair as a substitute for human hair has been increasing. As materials constituting a fiber for artificial hair, there are acrylic resins, vinyl chloride-based resins, or polyester-based resins, and fibers for artificial hair made of these resins are commercially available.

[0003]

Patent Literature 1 discloses an artificial hair characterized by containing a hollow fiber having a hollow portion with a hollow ratio of 10% to 50%.

Furthermore, Patent Literature 2 discloses a fiber for artificial hair, wherein a void is present in a central part of a fiber cross-section, a ratio of an area of the void to a total area of the fiber cross-section is 5% or more and 50% or less, a cross-sectional shape of the fiber cross-section is a flat multilobal shape, and the void has a first side and a second side with an inclination of 70 degrees or more and 110 degrees or less with respect to a major axis of the fiber cross-section.

CITATION LIST

PATENT LITERATURE

[0004]

Patent Literature 1: JP-A-2008-285772

Patent Literature 2: WO 2014/196642

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005]

In recent years, weight reduction has been demanded for a fiber for artificial hair, and for example, Patent Literature 1 and Patent Literature 2 disclose a fiber for artificial hair having a hollow portion. However, in a fiber for artificial hair having a

hollow portion, a part of the structure having the formed hollow portion could separate or collapse, and there were cases where the structure could not be maintained.

[0006]

The present invention has been made in view of such circumstances and provides a fiber for artificial hair having a hollow portion, wherein the structure is highly maintained. According to one embodiment of the present invention, a fiber for artificial hair is provided wherein, for example, a structure having a hollow portion is maintained with high reliability without being destroyed even after undergoing steps such as a drawing step and a heat treatment step. According to one embodiment of the present invention, a hair decoration product comprising the fiber for artificial hair is provided. Further, according to one embodiment of the present invention, a nozzle for melt extrusion of the fiber for artificial hair, which can produce the fiber for artificial hair, is provided.

SOLUTION TO PROBLEM

[0007]

According to the present invention, there is provided a fiber for artificial hair, wherein the fiber for artificial hair comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair, a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one joint portion, and the joint portion comprises a strength-enhancing structure for improving joint strength.

[0008]

The present inventors, as a result of diligent studies, found that in a fiber for artificial hair having a hollow portion, providing a strength-enhancing structure for improving joint strength in its cross-section results in an fiber for artificial hair in which a hollow structure is highly maintained, and have completed the present invention.

[0009]

Hereinafter, various embodiments of the present invention will be exemplified. The embodiments shown below can be combined with each other.

[1] A fiber for artificial hair, wherein: the fiber for artificial hair comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair; a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one joint portion; and the joint portion comprises a strength-enhancing structure for improving joint strength.

[2] The fiber for artificial hair of [1], wherein the strength-enhancing structure improves the joint strength by being thicker than other portions.

[3] The fiber for artificial hair of [1] or [2], wherein the strength-enhancing structure comprises at least one of an inner protruding portion protruding toward the hollow portion and an outer protruding portion protruding toward an outside of the fiber for artificial hair.

[4] A fiber for artificial hair, wherein: the fiber for artificial hair comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair; and a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one of an inner protruding portion protruding toward the hollow portion and an outer protruding portion protruding toward an outside of the fiber for artificial hair.

[5] The fiber for artificial hair of any one of [1] to [4], wherein the hollow portion occupies an area of 5% to 50% in the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction.

[6] The fiber for artificial hair of any one of [1] to [5], wherein, when a maximum value of a central thickness X of the inner protruding portion and the outer protruding portion is X_{MAX} , and a thickness of a thinnest portion Y at a location other than the inner protruding portion and the outer protruding portion is Y , a ratio of X_{MAX} to Y is from 0.90 to 2.50.

[7] The fiber for artificial hair of any one of [1] to [6], comprising a vinyl chloride-based resin.

[8] A hair decoration product comprising the fiber for artificial hair of any one of [1] to [7].

[9] A nozzle for melt extrusion of the fiber for artificial hair of any one of [1] to [8], the nozzle comprising one or more C-shaped nozzle holes or two or more rod-shaped nozzle holes.

[10] The nozzle of [9], wherein, on an opening surface of the nozzle, when a minor axis length of the nozzle hole is A , and a length of a line connecting points equidistant from an inner surface and an outer surface of the nozzle hole on the

opening surface of the nozzle hole is B, a ratio of B to A is from 3 to 20.

[11] The nozzle of [9] or [10], wherein, on an opening surface of the nozzle, when a minor axis length of the nozzle hole is A, and a separation distance between the nozzle holes is C, a ratio of C to A is from 0.5 to 1.5.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010]

The fiber for artificial hair according to the present invention is a fiber for artificial hair having a hollow portion, wherein a part of the structure having the hollow portion is less likely to separate or collapse, and the structure is maintained. According to one embodiment of the present invention, a fiber for artificial hair is provided wherein, for example, a structure having a hollow portion is stably maintained with high reliability without being destroyed even after undergoing steps such as a drawing step and a heat treatment step. According to one embodiment of the present invention, a hair decoration product is provided comprising the fiber for artificial hair, which is lightweight, allows for the formation of a desired voluminous hairstyle with a smaller amount of wearing due to an increased volume per unit weight compared to other products, enables a wide range of hairstyles including voluminous long styles, causes less damage to natural hair and scalp, and can reduce waste and environmental load. Further, according to one embodiment of the present invention, a nozzle for melt extrusion of the fiber for artificial hair, which can produce the fiber for artificial hair, is provided.

BRIEF DESCRIPTION OF DRAWINGS

[0011]

FIG. 1 is a schematic cross-sectional view of a fiber for artificial hair having an inner protruding portion and a shape of two joined C-shapes, where FIG. 1A shows each component, FIG. 1B shows a major axis 18, a central thickness X of the protruding portion, and a thickness Y of a thin portion, and FIG. 1C shows a protruding portion height Z.

FIG. 2 is a schematic cross-sectional view of a fiber for artificial hair having an inner protruding portion and an outer protruding portion and a shape of two joined C-shapes, where FIG. 2A shows each component, FIG. 2B shows a central thickness X of the protruding portion and a thickness Y of a thin portion, and FIG. 2C shows a protruding portion height Z.

FIG. 3 is a schematic cross-sectional view of a fiber for artificial hair having an outer protruding portion and a shape of two joined C-shapes, where FIG. 3A shows each component, FIG. 3B shows a central thickness X of the protruding portion and a

thickness Y of a thin portion, and FIG. 3C shows a protruding portion height Z.

FIG. 4 is a schematic cross-sectional view of a fiber for artificial hair having no protruding portion and a shape of two joined C-shapes, corresponding to a comparative example of the present invention.

FIG. 5 is a schematic cross-sectional view of a fiber for artificial hair having an inner protruding portion and a shape of three joined C-shapes, where FIG. 5A shows each component, FIG. 5B shows a central thickness X of the protruding portion and a thickness Y of a thin portion, and FIG. 5C shows a protruding portion height Z.

FIG. 6 is a schematic cross-sectional view of a fiber for artificial hair having no protruding portion and a shape of three joined C-shapes, corresponding to a comparative example of the present invention.

FIG. 7 is a schematic cross-sectional view of a circular fiber for artificial hair having an inner protruding portion and an outer protruding portion, where FIG. 7A shows each component, FIG. 7B shows a central thickness X of the protruding portion and a thickness Y of a thin portion, and FIG. 7C shows a protruding portion height Z.

FIG. 8 is a schematic cross-sectional view of a circular fiber for artificial hair having no protruding portion, corresponding to a comparative example of the present invention.

FIG. 9 is a schematic cross-sectional view of a substantially triangular fiber for artificial hair having an inner protruding portion, where FIG. 9A shows each component, and FIG. 9B shows a central thickness X of the protruding portion, a thickness Y of a thin portion, and a protruding portion height Z.

FIG. 10 is a schematic cross-sectional view of a substantially triangular fiber for artificial hair having no protruding portion, corresponding to a comparative example of the present invention.

FIG. 11 is a schematic cross-sectional view of a substantially quadrangular fiber for artificial hair having an inner protruding portion, where FIG. 11A shows each component, and FIG. 11B shows a central thickness X of the protruding portion, a thickness Y of a thin portion, and a protruding portion height Z.

FIG. 12 is a schematic cross-sectional view of a substantially quadrangular fiber for artificial hair having no protruding portion, corresponding to a comparative example of the present invention.

FIG. 13 is a schematic view of an opening surface of a nozzle having two C-shaped nozzle holes. FIG. 13A is a schematic view of an opening surface of a nozzle having two C-shaped nozzle holes and no nozzle hole inner protruding portion and no nozzle hole outer protruding portion. FIG. 13B is a schematic view of an opening surface of a nozzle having two C-shaped nozzle holes and a nozzle hole outer protruding portion. FIG. 13C is a schematic view of an opening surface of a nozzle having two C-shaped nozzle holes and a nozzle hole inner protruding portion. FIG. 13D

is a schematic view of an opening surface of a nozzle having two C-shaped nozzle holes and a nozzle hole outer protruding portion and a nozzle hole inner protruding portion.

FIG. 14 is a schematic view of an opening surface of a nozzle having three C-shaped nozzle holes. FIG. 14A is a schematic view of an opening surface of a nozzle having three C-shaped nozzle holes and no nozzle hole inner protruding portion and no nozzle hole outer protruding portion. FIG. 14B is a schematic view of an opening surface of a nozzle having three C-shaped nozzle holes and a nozzle hole inner protruding portion.

FIG. 15 is a schematic view of an opening surface of a nozzle having four C-shaped nozzle holes.

FIG. 16 is a schematic view of an opening surface of a nozzle having three rod-shaped nozzle holes. FIG. 16A is a schematic view of an opening surface of a nozzle having three rod-shaped nozzle holes and no nozzle hole inner protruding portion and no nozzle hole outer protruding portion. FIG. 16B is a schematic view of an opening surface of a nozzle having three rod-shaped nozzle holes and a nozzle hole inner protruding portion.

FIG. 17 is a schematic view of an opening surface of a nozzle having four rod-shaped nozzle holes.

FIG. 18 is an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Example 2.

FIG. 19 is an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Example 5.

FIG. 20 is an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Example 12.

FIG. 21A is an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Comparative Example 1, and FIG. 21B is an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Comparative Example 2.

[0012]

Hereinafter, the present invention will be described in detail by exemplifying embodiments of the present invention. The present invention is not limited in any way by these descriptions. Each feature of the embodiments of the present invention shown below can be combined with each other. In addition, an invention can be established independently for each feature.

[0013]

1. First Aspect

1.1 Fiber for Artificial Hair

1.1.1 Shape

A fiber for artificial hair according to one embodiment of the present invention comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair, a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one joint portion, and the joint portion comprises a strength-enhancing structure for improving joint strength.

[0014]

The fiber for artificial hair according to the present invention has a hollow portion extending in a longitudinal direction of the fiber for artificial hair. In the present invention, the hollow portion can be present continuously for 10 cm or more in the longitudinal direction of the fiber for artificial hair. Since the fiber for artificial hair according to the present invention comprises a hollow portion, it is lightweight and brings about many advantages such as being able to form a desired voluminous hairstyle with a small amount of wearing, realizing a wide range of hairstyles including voluminous long styles, reducing damage to natural hair and the scalp, and reducing waste and environmental load.

[0015]

A cross-section of the fiber for artificial hair according to one embodiment of the present invention perpendicular to the longitudinal direction can be a circular shape (FIG. 7A to FIG. 7C) or an elliptical shape, a two-lobed shape with two joined C-shapes (FIG. 1A to FIG. 1C, FIG. 2A to FIG. 2C, FIG. 3A to FIG. 3C), a three-lobed shape with three joined C-shapes (FIG. 5A to FIG. 5C), a four-lobed shape with four or more joined C-shapes, a substantially triangular shape (FIG. 9A to FIG. 9B), a substantially quadrangular shape (FIG. 11A to FIG. 11C), or a substantially polygonal shape.

[0016]

In the fiber for artificial hair according to one embodiment of the present invention, a major axis 18 in a cross-section perpendicular to the longitudinal direction of the fiber for artificial hair can be 30 to 300 μm . The major axis is, for example, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 290, or 300 μm , and may be within a range between any two of the numerical values exemplified here.

[0017]

In the cross-section perpendicular to the longitudinal direction of the fiber for artificial hair, a hollow portion 15 can occupy an area of 5% to 50%. The area ratio of the hollow portion 15 is, for example, 5, 10, 15, 20, 25, 30, 35, 40, 45, or 50%, and

may be within a range between any two of the numerical values exemplified here. The area ratio of the hollow portion 15 can be determined by the following formula.

Area ratio of hollow portion 15 = (Area enclosed by inner surface 12) / (Area enclosed by outer surface 11) $\times$ 100

The area enclosed by the outer surface 11 means the cross-sectional area when it is assumed that the fiber for artificial hair does not have a hollow portion.

The area ratio of the hollow portion can be determined by cutting the fiber for artificial hair perpendicularly to the longitudinal direction, observing the cut surface with a laser microscope or a scanning electron microscope, and performing image analysis. Specifically, it can be determined by the method described in the Examples. By setting the area ratio of the hollow portion within the above numerical range, the advantages of having the hollow portion can be more reliably obtained. When the hollow ratio exceeds 50%, it leads to an increase in rigidity and a deterioration of tactile feeling due to an increase in fiber diameter, which is not preferable.

[0018]

The fiber for artificial hair according to one embodiment of the present invention comprises at least one joint portion 13, and the joint portion 13 comprises a strength-enhancing structure for improving joint strength. The fiber for artificial hair is generally obtained by melt-spinning a resin composition for a fiber for artificial hair. Further, the fiber for artificial hair having a hollow portion is formed by, for example, melt-extruding from a nozzle having one C-shaped nozzle hole as shown in FIG. 1 of Patent Literature 1, or a nozzle having a plurality of holes. Here, the resin composition is at least partially separated while passing through the nozzle, but after being discharged from the nozzle hole, the resin compositions come into contact with each other and fuse, whereby a hollow portion is formed. In the present invention, in the melt extrusion process, a portion including a joint surface 14 (shown by a broken line in FIG. 1A, FIG. 2A, FIG. 3A, FIG. 5A, FIG. 7A, FIG. 9A, FIG. 11A, etc.) where the resin compositions have fused is referred to as a joint portion 13.

[0019]

In the fiber for artificial hair according to one embodiment of the present invention, the cross-section perpendicular to the longitudinal direction of the fiber for artificial hair comprises at least one joint portion 13. The number of the joint portions 13 can be one or more, is preferably two or more, and can also be three or more. The number of the joint portions 13 is, for example, 1, 2, 3, 4, or 5, and may be within a range between any two of the numerical values exemplified here.

[0020]

The joint portion 13 according to one embodiment of the present invention comprises a joint strength-enhancing structure 19 for improving joint strength. The joint strength-enhancing structure is not particularly limited as long as it is a structure that enhances the joint strength of the joint portion 13. As one example, the joint strength-enhancing structure can improve the joint strength by making the joint portion 13 thicker than other portions. That is, by making the joint portion thick and increasing the area of the joint surface 14 where the resin compositions have fused, the joint strength can be improved. As described above, the joint portion is a portion where the resin compositions, which were separated during passage through the nozzle, have fused. In the fiber for artificial hair according to the prior art, the joint portion is a portion that may have the weakest strength, and for example, in a drawing step, a heat treatment step, a processing step of an undrawn fiber for artificial hair, or a post-process of imparting a wave form by sandwiching the fiber after the heat treatment step between heated gears, it could become a starting point for causing separation or collapse of a part of the structure. The fiber for artificial hair according to one embodiment of the present invention, by improving the strength of the portion that can become a starting point for structural destruction, can reduce the probability of occurrence of separation and destruction originating from the joint portion, and can stably maintain the hollow structure of the fiber for artificial hair with high reliability. The fiber for artificial hair according to one embodiment of the present invention has at least one joint portion 13 comprising the joint strength-enhancing structure 19 for improving the joint strength.

[0021]

The strength-enhancing structure according to one embodiment of the present invention can comprise at least one of an inner protruding portion 16 protruding toward the hollow portion 15 and an outer protruding portion 17 protruding toward an outside of the fiber for artificial hair. The joint strength-enhancing structure 19 may have the inner protruding portion 16 and the outer protruding portion 17 as shown in FIG. 2A and FIG. 7A, may have the inner protruding portion 16 or the outer protruding portion 17, may have only the outer protruding portion 17 as shown in FIG. 3A, preferably has at least the inner protruding portion 16, and may have only the inner protruding portion 16 as shown in FIG. 1A, FIG. 5A, FIG. 9A, and FIG. 11A. From the viewpoint of improving the tactile feeling of the fiber for artificial hair, it is preferable that a size and a frequency of the outer protruding portion are small, it is preferable that the outer protruding portion 17 is smaller or less frequent than the inner protruding portion 16, and it is more preferable to have only the inner protruding portion 16.

[0022]

In a cross-section of the fiber for artificial hair according to one embodiment of the present invention perpendicular to the longitudinal direction, when a maximum value of a central thickness X of the inner protruding portion 16 and the outer protruding portion 17 is X_{MAX} , and a thickness of a thinnest portion Y at a location other than the inner protruding portion and the outer protruding portion is Y , X_{MAX} to Y can be from 0.90 to 2.50, is preferably from 1.00 to 2.50, and is more preferably from 1.05 to 2.50. X_{MAX} to Y is, for example, 0.90, 0.95, 1.00, 1.05, 1.10, 1.20, 1.30, 1.40, 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.10, 2.20, 2.30, 2.40, or 2.50, and may be within a range between any two of the numerical values exemplified here.

[0023]

The central thickness X of the inner protruding portion 16 and the outer protruding portion 17 can be the thickness when traversing a center of the protruding portion in a direction of protrusion. When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction has a plurality of protruding portions, X_{MAX} can be the maximum value of the plurality of X 's. A thick central portion means that an area of the joint surface 14 is large.

The thickness Y of the thinnest portion at a location other than the inner protruding portion 16 and the outer protruding portion 17 can be the shortest distance between an outer surface 11 and an inner surface 12 at a location other than the inner protruding portion 16 and the outer protruding portion 17. The thickness Y of the thin portion can be the thickness of a portion farthest from any joint portion. When there is one joint portion 13, the thickness Y of the thin portion can be the thickness of a portion opposite to the joint portion. When there are two or more joint portions 13, the thickness Y of the thin portion can be the thickness of a position intermediate between adjacent joint portions. By setting a ratio of X_{MAX} to Y to be equal to or greater than the above lower limit, sufficient strength can be imparted to the joint portion 13.

In one embodiment of the present invention, when the fiber for artificial hair has a plurality of protruding portions in one cross-section, it is more preferable that a ratio of X to Y , calculated from the central thickness X of each protruding portion,

[0024]

X can be from 5 to 70 μm . X is, for example, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 μm , and may be within a range between any two of the numerical values exemplified here.

Y can be from 5 to 40 μm . Y is, for example, 5, 10, 15, 20, 25, 30, 35, or 40 μm , and may be within a range between any two of the numerical values exemplified here. Further, in the fiber for artificial hair according to one embodiment of the present

invention, the thickness of the thinnest portion can be 5 μm or more. The thickness of the thinnest portion is, for example, 5, 10, 15, 20, 25, 30, 35, or 40 μm , and may be within a range between any two of the numerical values exemplified here. In conventional fibers for artificial hair, a thin portion could become a starting point for separation or collapse of the structure, but according to the fiber for artificial hair of one embodiment of the present invention, by having the thicknesses X and Y in the above numerical ranges and/or the thickness of the thinnest portion being equal to or greater than the above lower limit, the separation and collapse of the structure can be further suppressed.

[0025]

The protruding portion will be described based on a representative embodiment. A cross-section having the inner protruding portion 16 and the outer protruding portion 17 when the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is circular is shown in FIGS. 7A to 7C, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 8. In this embodiment, having a protruding portion can indicate a case where a protruding portion height Z is 1 μm or more. The protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, the protruding portion height Z can be a distance from a tangent at an intersection of a virtual inner surface (outer surface) (broken line in FIG. 7C), which is an extension of the inner surface 12 (or the outer surface 11) other than the protruding portion assuming that there is no protruding portion, and a straight line extending in the direction of protrusion passing through the center of the protruding portion, to a vertex of the protruding portion.

[0026]

When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction has a multilobal shape in which a plurality of C-shapes are joined, a cross-section having the inner protruding portion 16 and the outer protruding portion 17 is shown in FIGS. 2A to 2C, a cross-section having only the inner protruding portion 16 is shown in FIGS. 1A to 1C and FIGS. 5A to 5C, a cross-section having only the outer protruding portion 17 is shown in FIGS. 3A to 3C, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 4. In these embodiments, having a protruding portion can indicate a case where the protruding portion height Z is 1 μm or more. The protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, Z can be a

distance from a tangent line passing through two points on two adjacent C-shaped inner surfaces (or outer surfaces) via the protruding portion to a vertex of the protruding portion (FIG. 1C, FIG. 2C, FIG. 3C, FIG. 5C). Although FIGS. 1, 2, 3, and 5 show cases where the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a two-lobed or three-lobed shape in which two or three C-shapes are joined, the protruding portion and the protruding portion height can be similarly defined when the cross-section has a four-lobed shape or more.

[0027]

When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a polygonal shape such as a substantially triangular shape or a substantially quadrangular shape, a cross-section having only the inner protruding portion 16 is shown in FIGS. 9A to 9B and FIGS. 11A to 11B, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 10 and FIG. 12. In these embodiments, having a protruding portion can indicate a case where the protruding portion height Z is 1 μm or more. The protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, Z can be a distance from a line perpendicular to an angle bisector of a corner of a polygon on a virtual inner surface (outer surface) (broken line in FIG. 9B and FIG. 11B), which is an extension of the inner surface 12 (or the outer surface 11) other than the protruding portion assuming that there is no protruding portion, and including the vertex, to a vertex of the protruding portion. Although FIGS. 9 and 11 show cases where the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a substantially triangular or substantially quadrangular cross-section, the protruding portion and the protruding portion height can be similarly defined for pentagonal shapes or more.

[0028]

The cross-sectional shape of the fiber for artificial hair can be controlled by a composition of a resin composition for a fiber for artificial hair constituting the fiber for artificial hair, conditions of melt extrusion, and a shape of a nozzle used for the melt extrusion.

[0029]

1.1.2 Composition

A resin composition constituting the fiber for artificial hair according to one embodiment of the present invention is not particularly limited, and can include at least one of a polyamide-based resin, a polyester-based resin, a vinyl chloride-based resin,

an AS-based resin (acrylonitrile-styrene-based resin), a PP resin, a PET resin, a PE resin, a PAN-based resin, and a PLA-based resin (polylactic acid-based resin). The effect of defining the shape of the fiber for artificial hair described above is exhibited regardless of the composition of the fiber for artificial hair, but the effect of the present invention is particularly useful when a tackiness of the resin composition constituting the fiber for artificial hair is weak and separation of the joint portion, collapse of the structure, and the like are likely to occur. From the viewpoint of easily obtaining such structural advantages, and also from the viewpoint of easily obtaining a die swell effect described later, it is preferable that the fiber for artificial hair according to one embodiment of the present invention contains a vinyl chloride-based resin. Further, it is preferable that the fiber for artificial hair according to one embodiment of the present invention contains a vinyl chloride-based resin and an AS-based resin (acrylonitrile-styrene-based resin).

[0030]

The polyvinyl chloride-based resin according to one embodiment of the present invention can include a vinyl chloride-based polymer containing a monomer unit derived from a vinyl chloride monomer (a vinyl chloride monomer unit). The polyvinyl chloride-based resin according to the present invention can include a homopolymer obtained by homopolymerizing a vinyl chloride monomer, and/or a copolymer containing a monomer unit derived from a vinyl chloride monomer and another monomer copolymerizable with the vinyl chloride monomer. Examples of the copolymer include copolymers of vinyl chloride and vinyl esters such as a vinyl chloride-vinyl acetate copolymer and a vinyl chloride-vinyl propionate copolymer; copolymers of vinyl chloride and olefins such as a vinyl chloride-ethylene copolymer and a vinyl chloride-propylene copolymer; and a vinyl chloride-acrylonitrile copolymer. Further, the polyvinyl chloride-based resin according to the present invention may be composed of one type of vinyl chloride-based polymer, or may include two or more types of vinyl chloride-based polymers.

[0031]

The resin composition constituting the fiber for artificial hair according to one embodiment of the present invention contains 50 to 99% by mass of a vinyl chloride-based resin in 100% by mass of the resin composition, preferably 65 to 95% by mass, and more preferably 65 to 90% by mass. Specifically, it is, for example, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, or 99% by mass, and may be within a range between any two of the numerical values exemplified here.

[0032]

The AS-based resin (acrylonitrile-styrene-based resin) is a copolymer having a styrene-based monomer unit and an acrylonitrile-based monomer unit, and may contain another monomer unit copolymerizable therewith as necessary. The AS-based resin, with respect to 100% by mass of the AS resin, contains the styrene-based monomer unit, for example, in an amount of 60, 65, 70, 75, 80, 85, or 90% by mass, and may be within a range between any two of the numerical values exemplified here. The AS-based resin, with respect to 100% by mass of the AS resin, contains the acrylonitrile-based monomer unit, for example, in an amount of 10, 15, 20, 25, 30, 35, or 40% by mass, and may be within a range between any two of the numerical values exemplified here.

[0033]

The fiber for artificial hair according to one embodiment of the present invention may also contain other components as necessary. Examples of other components include an antistatic agent, a heat stabilizer, a lubricant, a colorant, a processing aid, a plasticizer, a reinforcing agent, an ultraviolet absorber, an antioxidant, a filler, a flame retardant, a pigment, an initial coloration improving agent, a conductivity-imparting agent, a fragrance, and the like.

[0034]

1.2 Bundle of Fibers for Artificial Hair

A bundle of fibers for artificial hair according to one embodiment of the present invention includes the fiber for artificial hair described above. The bundle of fibers for artificial hair according to one embodiment of the present invention is preferably composed of the fiber for artificial hair described above.

[0035]

<Structure Retention Rate>

The bundle of fibers for artificial hair according to one embodiment of the present invention preferably has a structure retention rate of the cross-section of the fiber for artificial hair of 90% or more. The structure retention rate is, for example, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, or 100%, and may be within a range between any two of the numerical values exemplified here. The structure retention rate indicates a proportion of fibers for artificial hair having a cross-section in which the joint portions are not separated and the hollow portion is not collapsed, and can be calculated based on the following formula by the method described specifically in the Examples.

$$\text{Structure retention rate} = (300 - i - j)/300$$

i: number of fibers having one or more separated joint portions

j: number of fibers in which the hollow portion has collapsed and the inner surfaces are in contact

[0036]

The bundle of fibers for artificial hair according to one embodiment of the present invention has a high structure retention rate, and for example, the structure having a hollow portion is maintained with high reliability without being destroyed even after undergoing steps such as a drawing step and a heat treatment step, so that the advantages of having the hollow portion can be sufficiently and reliably obtained. As described above, the structure retention rate can be increased by adjusting the cross-sectional structure of the fiber for artificial hair.

[0037]

<Volume>

The bundle of fibers for artificial hair according to one embodiment of the present invention preferably has a volume of 5 cc/g or more. The volume is, for example, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 cc/g, and may be within a range between any two of the numerical values exemplified here.

[0038]

1.3 Method for Producing Fiber for Artificial Hair

A method for producing the fiber for artificial hair according to one embodiment of the present invention can include a resin composition preparation step for a fiber for artificial hair and a spinning step. In the spinning step, by melt-extruding the fiber for artificial hair using a nozzle described below, the fiber for artificial hair having the above-described structure can be obtained.

[0039]

1.3.1 Resin Composition Preparation Step for Fiber for Artificial Hair

In the resin composition preparation step for a fiber for artificial hair, a raw material containing a resin can be mixed to obtain a resin composition for a fiber for artificial hair. Here, the raw material includes a base resin and may include other components as necessary.

[0040]

A mixing method is not particularly limited, and a conventionally known method can be adopted. For example, a powdered resin composition (a powder compound) can be obtained using a known mixing device such as a Henschel mixer, a super mixer, or a ribbon blender, and the powder compound can be melt-mixed to

obtain a pellet-shaped resin composition (a pellet compound). The method for producing the powder compound may be a hot blend or a cold blend, and as one example, in order to reduce volatiles from the resin composition, a hot blend can be performed with a cut temperature during mixing set to 105 to 155°C. The method for producing the pellet compound can be the same as a general method for producing a pellet compound of a polyvinyl chloride-based resin. For example, a pellet compound can be made using a kneading machine such as a single-screw extruder, a counter-rotating twin-screw extruder, a conical twin-screw extruder, a co-rotating twin-screw extruder, a kneader, a planetary gear extruder, or a roll kneader. The conditions for producing the pellet compound are not particularly limited, but it is preferable to set the resin temperature to be 185°C or lower in order to prevent thermal degradation of the resin composition. Also, to remove metal pieces from a screw or fibers attached to protective gloves that may be mixed in a small amount in the pellet compound, a mesh can be installed near a tip of the screw. A cold cut method can be adopted for the production of the pellets. A means for removing fines (fine powder generated during pellet production) that may be mixed in during the cold cut may be adopted. Also, since a cutter may chip after being used for a long time, making it easy for fines to be generated, it is preferable to replace it as appropriate.

[0041]

1.3.2 Spinning Step

In the spinning step, the resin composition for a fiber for artificial hair is melt-spun to obtain a fiber for artificial hair. As one example, the above resin composition (for example, a pellet compound) can be extruded and melt-spun from a heated cylinder via a nozzle. As an extruder, a conventionally known extruder can be used, and examples include a single-screw extruder, a counter-rotating twin-screw extruder, a conical twin-screw extruder, and the like. The nozzle for melt extrusion will be described later.

[0042]

The conditions for melt spinning can be appropriately set according to the type of resin composition so that the resin melts and a structure joined at the joint portion is formed. As one example, a cylinder temperature can be 150 to 190°C, and a nozzle temperature can be $180 \pm 15^\circ\text{C}$.

[0043]

An undrawn yarn melt-spun from the nozzle can be introduced into a heated cylinder (for example, a heated cylinder temperature of 250°C), instantaneously heat-treated, and wound by a take-up machine installed at a position directly below the

nozzle (for example, about 4.5 m).

[0044]

1.3.3 Nozzle for Melt Extrusion

In the spinning step according to one embodiment of the present invention, it is preferable to use a nozzle described below.

The nozzle for melt extrusion of the fiber for artificial hair according to one embodiment of the present invention can have one or more C-shaped nozzle holes or two or more rod-shaped nozzle holes.

FIGS. 13A to 13D show two C-shaped nozzle holes, FIGS. 14A to 14B show three C-shaped nozzle holes, FIG. 15 shows four C-shaped nozzle holes, FIGS. 16A to 16B show three rod-shaped nozzle holes, and FIG. 17 shows four rod-shaped nozzle holes. In addition, when producing the fiber for artificial hair having a circular cross-section shown in FIG. 7, a nozzle having one C-shaped nozzle hole can be used. When producing the fiber for artificial hair having a cross-section with a shape of two joined C-shapes as shown in FIGS. 1 to 3, a nozzle having two C-shaped nozzle holes as shown in FIG. 13 can be used. When producing the fiber for artificial hair having a cross-section with a shape of three joined C-shapes as shown in FIG. 5, a nozzle having three C-shaped nozzle holes as shown in FIG. 14 can be used. When producing the fiber for artificial hair having a cross-section with a shape of four joined C-shapes, a nozzle having four C-shaped nozzle holes as shown in FIG. 15 can be used. When producing the fiber for artificial hair having a substantially triangular cross-section as shown in FIG. 9, a nozzle having three rod-shaped nozzle holes as shown in FIG. 16 can be used. When producing the fiber for artificial hair having a substantially quadrangular cross-section as shown in FIG. 11, a nozzle having four rod-shaped nozzle holes as shown in FIG. 17 can be used.

[0045]

The nozzle can have a separation portion, and can have a separation portion 23 on an opening surface. As described above, during melt extrusion, at least a part of the resin composition is separated by the separation portion 23, but after being discharged from the nozzle hole, the resin compositions come into contact with each other and fuse, whereby a hollow portion is formed. In one embodiment of the present invention, it is presumed that the resin composition discharged from the nozzle hole swells due to a die swell effect, and can form the above-described joint portion.

[0046]

In the nozzle, on an opening surface of the nozzle, it is preferable that a ratio of

B to A is from 3 to 20, where A is a minor axis length of the nozzle hole, and B is a length of a line connecting points equidistant from a nozzle hole inner surface 22 and a nozzle hole outer surface 21 on the opening surface of the nozzle. The ratio of B to A is, for example, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20, and may be within a range between any two of the numerical values exemplified here.

[0047]

The minor axis length A can be the shortest distance between the nozzle hole outer surface 21 and the nozzle hole inner surface 22, and can be the distance between the nozzle hole outer surface 21 and the nozzle hole inner surface 22 at a portion farthest from the separation portion 23. When there is one separation portion 23, the minor axis length A can be the distance between the nozzle hole outer surface 21 and the nozzle hole inner surface 22 at a portion opposite to the separation portion. When there are two or more separation portions, the minor axis length A can be the distance between the nozzle hole outer surface 21 and the nozzle hole inner surface 22 at a position intermediate between adjacent separation portions.

[0048]

B is a length of a line connecting points equidistant from the nozzle hole inner surface 22 and the nozzle hole outer surface 21 on the opening surface of the nozzle hole, and points constituting B are at least $A/2$ away from an outer periphery of each nozzle hole. That is, B starts from a point $A/2$ away from one end and ends at a point $A/2$ away from the other end.

[0049]

In addition, when there are a plurality of nozzle holes, it is preferable that a ratio of B to A of each nozzle hole is within the above numerical range. Further, it is preferable that a ratio of B_t to A_t , calculated from a total A_t of $A_1, A_2, \dots A_n$ of the plurality of nozzle holes on the nozzle opening surface and a total B_t of $B_1, B_2, \dots B_n$ of the plurality of nozzle holes, is within the above numerical range.

By having the ratio of B to A within the above numerical range, a wall thickness of the fiber for artificial hair and a size of the hollow portion are adjusted, and a fiber for artificial hair with a higher structure retention rate can be obtained while maintaining the hollow portion.

[0050]

In the nozzle, on the opening surface of the nozzle, it is preferable that a ratio of C to A is from 0.5 to 1.5, where A is the minor axis length of the nozzle hole, and C is a separation distance between the nozzle holes. The ratio of C to A is, for example, 0.5,

0.6, 0.7, 0.8, 0.9, 1, 1.1, 1.2, 1.3, 1.4, or 1.5, and may be within a range between any two of the numerical values exemplified here. In addition, when there are a plurality of nozzle holes, it is preferable that a ratio of Coverage to Aaverage, calculated from an average value Coverage of a plurality of separation distances C and an average value Aaverage of A of the plurality of nozzle holes, satisfies the above numerical range.

By having the ratio of C to A within the above numerical range, a joint portion can be formed more reliably, and a fiber for artificial hair with a higher structure retention rate can be obtained while maintaining the hollow portion.

[0051]

It is more preferable that the nozzle has at least one of a nozzle hole inner protruding portion 26 and a nozzle hole outer protruding portion 27 on the opening surface of the nozzle. By providing the nozzle hole inner protruding portion 26 and the nozzle hole outer protruding portion 27, a joint surface in the fiber for artificial hair can be further increased.

Note that the nozzle hole inner protruding portion 26 and the nozzle hole outer protruding portion 27 are not essential for forming the protruding portion of the cross-section of the fiber for artificial hair. As described above, in one embodiment of the present invention, it is considered that the resin composition swells due to a die swell effect after being protruded from the nozzle hole, thereby forming a joint portion (a protruding portion) with a further increased area of the joint surface, and even when the nozzle does not have the nozzle hole inner protruding portion 26 and the nozzle hole outer protruding portion 27 on the nozzle opening surface, the formation of the protruding portion is possible.

[0052]

The nozzle may have the nozzle hole inner protruding portion 26 and the nozzle hole outer protruding portion 27 on the opening surface of the nozzle (FIG. 13D), and may have only the nozzle hole inner protruding portion 26 (FIG. 13C, FIG. 14B, and FIG. 16B) or only the nozzle hole outer protruding portion 27 (FIG. 13B). It is preferable that the nozzle has at least the nozzle hole inner protruding portion 26 on the opening surface of the nozzle. From the viewpoint of improving the tactile feeling of the obtained fiber for artificial hair, it is preferable that the nozzle has only the nozzle hole inner protruding portion 26 and does not have the nozzle hole outer protruding portion 27 on the opening surface of the nozzle. In addition, although FIG. 13 shows an embodiment in which the nozzle hole inner protruding portion 26 and/or the nozzle hole outer protruding portion 27 are provided in a nozzle having two C-shaped nozzle holes, the nozzle hole inner protruding portion 26 and/or the nozzle hole outer protruding portion 27 can be similarly provided in other nozzles having one or more C-shaped nozzle holes or two or more rod-

shaped nozzle holes.

[0053]

1.3.4 Drawing Step and Heat Treatment Step

The method for producing the fiber for artificial hair according to one embodiment of the present invention can also include a drawing step and a heat treatment step.

In the drawing step, an undrawn fiber for artificial hair obtained in the above melt-spinning step can be drawn with a drawing machine to obtain a drawn fiber for artificial hair. As one example, in the drawing step, the undrawn fiber for artificial hair can be drawn 2 to 5 times at 90 to 110°C in an air atmosphere, for example.

Further, in the heat treatment step, the drawn fiber for artificial hair can be heat-treated using a heat treatment machine. As one example, in the heat treatment step, the drawn fiber for artificial hair can be heat-treated at 90 to 110°C in an air atmosphere so as to have a ratio of 0.5 to 3.0, and heat-shrunk until a total length of the fiber shrinks to 75% of the length before treatment, to obtain a heat-treated fiber for artificial hair having a fineness of 30 to 70 denier.

[0054]

1.3.5 Gear Processing Step

The method for producing the fiber for artificial hair according to one embodiment of the present invention can also include a gear processing step.

In the gear processing step, a crimp can be applied by passing a fiber bundle between two meshing hot gears. A material of gears used in the gear processing step, a shape of gear waves, a number of gear teeth, and the like are not particularly limited. In the gear processing step, a shape of the obtained fiber for artificial hair can be controlled by appropriately adjusting conditions such as a depth of a groove of the gear waveform, a surface temperature of the gears, a processing speed, and a pressure between the gears, in consideration of a fiber material and a fineness. These processing conditions are not particularly limited, but as one example, the depth of the groove of the gear waveform can be 0.2 mm to 6 mm, preferably 0.5 mm to 5 mm, the surface temperature of the gears can be 30°C to 100°C, preferably 40°C to 80°C, and the processing speed can be 0.5 to 10 m/min, preferably 1.0 m/min to 8.0 m/min.

[0055]

A total fineness of the fiber bundle during gear processing is not particularly limited, but can be 100,000 to 2,000,000 dtex, preferably 500,000 dtex to 1,500,000 dtex. By setting the total fineness of the fiber bundle to be equal to or greater than the

above lower limit, productivity of the gear processing can be enhanced, and furthermore, yarn breakage during the gear processing can be suppressed. On the other hand, by setting the total fineness of the fiber bundle to be equal to or less than the above lower limit, a more uniform wave shape can be obtained.

In addition, in the present invention, the fiber for artificial hair includes the fiber for artificial hair after spinning, and includes the fiber for artificial hair before the drawing step, the fiber for artificial hair after the drawing step, the fiber for artificial hair before the heat treatment step, the fiber for artificial hair after the heat treatment step, the fiber for artificial hair before the gear processing step, and the fiber for artificial hair after the gear processing step.

[0056]

1.4 Hair Decoration Product

A hair decoration product according to one embodiment of the present invention comprises the above-described fiber for artificial hair. Further, the hair decoration product according to one embodiment of the present invention comprises the above-described bundle of fibers for artificial hair.

[0057]

The fiber for artificial hair according to the present invention can be used for a hair decoration product. Examples of the hair decoration product include a wig, a hairpiece, a braid, and an extension hair. The hair decoration product obtained from the fiber for artificial hair according to the present invention, because a hollow structure is maintained with high reliability even after processing steps after melt extrusion, is lightweight and brings about many advantages such as being able to form a desired voluminous hairstyle with a small amount of wearing, realizing a wide range of hairstyles including voluminous long styles, reducing damage to natural hair and the scalp, and reducing waste and environmental load.

[0058]

2. Second Aspect

2.1 Fiber for Artificial Hair

2.1.1 Shape

A fiber for artificial hair according to one embodiment of the present invention comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair, and a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one of an inner protruding portion protruding toward the hollow portion and an outer protruding portion protruding toward an outside of the fiber for artificial hair.

Hereinafter, differences from the first aspect will be mainly described.

[0059]

The fiber for artificial hair according to the second aspect comprises a hollow portion. A form of the hollow portion and advantages of having the hollow portion are the same as in the first aspect.

[0060]

A cross-section of the fiber for artificial hair according to one embodiment of the present invention perpendicular to the longitudinal direction can be a circular shape (FIG. 7A to FIG. 7C) or an elliptical shape, a two-lobed shape with two joined C-shapes (FIG. 1A to FIG. 1C), a three-lobed shape with three joined C-shapes (FIG. 5A to FIG. 5C), a four-lobed shape with four or more joined C-shapes, a substantially triangular shape (FIG. 9A to FIG. 9B), a substantially quadrangular shape (FIG. 11A to FIG. 11C), or a substantially polygonal shape, similar to the first aspect.

[0061]

The cross-section of the fiber for artificial hair according to the second aspect perpendicular to the longitudinal direction comprises at least one of the inner protruding portion 16 protruding toward the hollow portion and the outer protruding portion 17 protruding toward the outside of the fiber for artificial hair. The fiber for artificial hair may have the inner protruding portion 16 and the outer protruding portion 17 as shown in FIG. 2 and FIG. 7, may have the inner protruding portion 16 or the outer protruding portion 17, preferably has at least the inner protruding portion 16, and may have only the inner protruding portion 16 as shown in FIG. 1, FIG. 5, FIG. 9, and FIG. 11. From the viewpoint of improving the tactile feeling of the fiber for artificial hair, it is preferable that a size and a frequency of the outer protruding portion are small, it is preferable that the outer protruding portion 17 is smaller or less frequent than the inner protruding portion 16, and it is more preferable to have only the inner protruding portion 16.

[0062]

The protruding portion is as described in the first aspect, but will be described based on a representative embodiment. A cross-section having the inner protruding portion 16 and the outer protruding portion 17 when the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is circular is shown in FIGS. 7A to 7C, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 8. In this embodiment, having a protruding portion can indicate a case where a protruding portion height Z is 1 μm or more. The

protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, the protruding portion height Z can be a distance from a tangent at an intersection of a virtual inner surface (outer surface) (broken line in FIG. 7C), which is an extension of the inner surface 12 (or the outer surface 11) other than the protruding portion assuming that there is no protruding portion, and a straight line extending in the direction of protrusion passing through the center of the protruding portion, to a vertex of the protruding portion.

[0063]

When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction has a multilobal shape in which a plurality of C-shapes are joined, a cross-section having the inner protruding portion 16 and the outer protruding portion 17 is shown in FIGS. 2A to 2C, a cross-section having only the inner protruding portion 16 is shown in FIGS. 1A to 1C and FIGS. 5A to 5C, a cross-section having only the outer protruding portion 17 is shown in FIGS. 3A to 3C, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 4. In these embodiments, having a protruding portion can indicate a case where the protruding portion height Z is 1 μm or more. The protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, Z can be a distance from a tangent passing through two points on two adjacent C-shaped inner surfaces (or outer surfaces) via the protruding portion to a vertex of the protruding portion (FIG. 1C, FIG. 2C, FIG. 3C, FIG. 5C). Although FIGS. 1, 2, 3, and 5 show cases where the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a two-lobed or three-lobed shape in which two or three C-shapes are joined, the protruding portion and the protruding portion height can be similarly defined when the cross-section has a four-lobed shape or more.

[0064]

When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a polygonal shape such as a substantially triangular shape or a substantially quadrangular shape, a cross-section having only the inner protruding portion 16 is shown in FIGS. 9A to 9B and FIGS. 11A to 11B, and a cross-section corresponding to a comparative example having no protruding portions is shown in FIG. 10 and FIG. 12. In these embodiments, having a protruding portion can indicate a case where the protruding portion height Z is 1 μm or more. The protruding portion height Z is, for example, 1, 2, 3, 5, 10, 15, 20, 25, 30, 35, 40, or 50 μm , and may be within a range between any two of the numerical values exemplified here. Here, Z can

be a distance from a line perpendicular to an angle bisector of a corner of a polygon on a virtual inner surface (outer surface) (broken line in FIG. 9B and FIG. 11B), which is an extension of the inner surface 12 (or the outer surface 11) other than the protruding portion assuming that there is no protruding portion, and including the vertex, to a vertex of the protruding portion. Although FIGS. 9 and 11 show cases where the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction is a substantially triangular or substantially quadrangular cross-section, the protruding portion and the protruding portion height can be similarly defined for pentagonal shapes or more.

[0065]

The protruding portion may include a joint surface and a joint portion where resin compositions have come into contact and fused. In the second aspect, the cross-section of the fiber for artificial hair may include a protruding portion that does not include a joint surface and a joint portion. The fiber for artificial hair according to one embodiment of the present invention, by having a structure with a hollow portion and a protruding portion, can significantly improve a structure retention rate of the fiber for artificial hair and stably maintain a hollow structure of the fiber for artificial hair with high reliability.

[0066]

In the second aspect, in a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction, when a maximum value of a central thickness X of the inner protruding portion 16 and the outer protruding portion 17 is X_{MAX} , and a thickness of a thinnest portion Y at a location other than the inner protruding portion and the outer protruding portion is Y , a ratio of X_{MAX} to Y can be from 0.90 to 2.50, is preferably from 1.00 to 2.50, and is more preferably from 1.05 to 2.50. The ratio of X_{MAX} to Y is, for example, 0.90, 0.95, 1.00, 1.05, 1.10, 1.20, 1.30, 1.40, 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.10, 2.20, 2.30, 2.40, or 2.50, and may be within a range between any two of the numerical values exemplified here.

[0067]

The central thickness X of the inner protruding portion 16 and the outer protruding portion 17 can be the thickness when traversing a center of the protruding portion in a direction of protrusion. When the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction has a plurality of protruding portions, X_{MAX} can be the maximum value of the plurality of X 's. A thick central portion means that an area of the joint surface 14 is large.

The thickness Y of the thinnest portion at a location other than the inner

protruding portion 16 and the outer protruding portion 17 can be the shortest distance between an outer surface 11 and an inner surface 12 at a location other than the inner protruding portion 16 and the outer protruding portion 17. The thickness Y of the thin portion can be the thickness of a portion farthest from any joint portion. When there is one joint portion 13, the thickness Y of the thin portion can be the thickness of a portion opposite to the joint portion. When there are two or more joint portions 13, the thickness Y of the thin portion can be the thickness of a position intermediate between adjacent joint portions. By setting the ratio of X_{MAX} to Y to be equal to or greater than the above lower limit, sufficient strength can be imparted to the joint portion 13.

In one embodiment of the present invention, when the fiber for artificial hair has a plurality of protruding portions in one cross-section, it is more preferable that a ratio of X to Y, calculated from the central thickness X of each protruding portion, is within the above numerical range.

[0068]

X can be from 5 to 70 μm . X is, for example, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, or 70 μm , and may be within a range between any two of the numerical values exemplified here.

Y can be from 5 to 40 μm . Y is, for example, 5, 10, 15, 20, 25, 30, 35, or 40 μm , and may be within a range between any two of the numerical values exemplified here. Further, in the fiber for artificial hair according to one embodiment of the present invention, the thickness of the thinnest portion can be 5 μm or more. The thickness of the thinnest portion is, for example, 5, 10, 15, 20, 25, 30, 35, or 40 μm , and may be within a range between any two of the numerical values exemplified here. In conventional fibers for artificial hair, a thin portion could become a starting point for separation or collapse of the structure, but according to the fiber for artificial hair of one embodiment of the present invention, by having the thicknesses X and Y in the above numerical ranges and/or the thickness of the thinnest portion being equal to or greater than the above lower limit, the separation and collapse of the structure can be further suppressed.

[0069]

The cross-sectional shape of the fiber for artificial hair can be controlled by a composition of a resin composition for a fiber for artificial hair constituting the fiber for artificial hair, conditions of melt extrusion, and a shape of a nozzle used for the melt extrusion.

[0070]

2.1.2 Composition

A composition of the fiber for artificial hair according to the second aspect can be the same as in the first aspect.

[0071]

2.2 Bundle of Fibers for Artificial Hair

An aspect of a composition of a bundle of fibers for artificial hair according to the second aspect can be the same as in the first aspect.

[0072]

2.3 Method for Producing Fiber for Artificial Hair

A method for producing the fiber for artificial hair according to the second aspect is not particularly limited, and can be any production method as long as a structure can be obtained such that the fiber for artificial hair comprises a hollow portion, and a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one of an inner protruding portion and an outer protruding portion. As one example, the fiber for artificial hair according to the second aspect can be obtained by the same method as in the first aspect, and a nozzle similar to the nozzle described in the first aspect can be used as the nozzle for melt extrusion.

[0073]

2.4 Hair Decoration Product

A hair decoration product according to the second aspect can be the same as in the first aspect.

EXAMPLES

[0074]

Hereinafter, the present invention will be described in more detail based on examples, but the present invention is not to be construed as being limited thereto.

[0075]

(Example 1)

<Resin Composition Preparation Step for Fiber for Artificial Hair>

70 parts by mass of a polyvinyl chloride-based resin (manufactured by Taiyo Vinyl Corporation, product name: TH1000), 30 parts by mass of a vinyl-based copolymer resin (in-house product, GR-AT-6S) comprising 68% by mass of a styrene monomer unit and 32% by mass of an acrylonitrile monomer unit, a total of 5 parts by mass of additives such as a plasticizer, a stabilizer, and a lubricant (specifically, 3 parts by mass of a

stabilizer composition, 1 part by mass of an epoxidized soybean oil, 0.4 parts by mass of a phosphorus-based chelating agent, and 0.6 parts by mass of a polyethylene wax), and 0.5 parts by mass of a carbon black were mixed with a blender. The blended material was kneaded using a single-screw extruder with a diameter of 40 mm to obtain a resin composition 1 for a fiber for artificial hair in a pellet form for spinning.

The stabilizer composition used to obtain the resin composition has the following components and composition.

- Hydrotalcite compound ($\text{Mg}_4\text{Al}_2(\text{OH})_{12}\text{CO}_3 \cdot 3\text{H}_2\text{O}$) 72.6 parts by mass
- Zinc stearate 13.1 parts by mass
- Silica ("Carplex (registered trademark) #80" manufactured by DSL. Japan Co., Ltd.) 2.2 parts by mass
- Dibenzoylmethane 2.3 parts by mass
- Dipentaerythritol 0.9 parts by mass
- Vinyl chloride resin (manufactured by Taiyo Vinyl Corporation, product name: TH1000) 8.9 parts by mass

Other additives used to obtain the resin composition are as follows.

- Epoxidized soybean oil: "ADK CIZER (registered trademark) O-130P" manufactured by ADEKA CORPORATION
- Phosphorus-based chelating agent: "ADEKA STAB (registered trademark) 1030" manufactured by ADEKA CORPORATION
- Polyethylene wax: manufactured by Mitsui Chemicals, Inc.

[0076]

<Spinning Step>

The obtained pellet-shaped resin composition for a fiber for artificial hair was spun using a 40 mm diameter single-screw melt spinning machine with a nozzle 1. Note that the nozzle 1 is a nozzle having two C-shaped nozzle holes of the same shape with a nozzle hole inner protruding portion, as shown in the schematic diagram of FIG. 13C. Each nozzle hole of the nozzle 1 had a ratio of B to A (B/A) of 3, where A is a minor axis length of the nozzle hole on an opening surface of the nozzle, and B is a length of a line connecting points equidistant from an inner surface and an outer surface on the opening surface of the nozzle. Further, on the opening surface of the nozzle 1, a ratio of C to A (C/A) was 1.0, where A is the minor axis length of each nozzle hole, and C is a separation distance between the two nozzle holes. The molten resin discharged from the nozzle was used to prepare an undrawn yarn by adjusting a discharge rate and a winding speed. Note that a cylinder temperature and a nozzle temperature of the spinning machine were set to 140 to 180°C.

[0077]

<Drawing Step and Heat Treatment Step>

The obtained undrawn yarn was drawn at 100°C, and then annealed at 100°C to 200°C to obtain a fiber for artificial hair 1. A draw ratio was 3 times, and a relaxation rate during annealing was 0.5 to 3%. The relaxation rate during annealing is a value calculated as a ratio of a rotational speed of a take-up roller during annealing to a rotational speed of a feed roller during annealing.

(a rotational speed of a take-up roller during annealing)/(a rotational speed of a feed roller during annealing)

[0078]

(Examples 2 to 12, Comparative Examples 1 to 2)

Fibers for artificial hair 2 to 13 were obtained in the same manner as in Example 1, except that nozzles 2 to 13 were used as the nozzle used in the spinning step. Note that nozzles 2, 3, and 6 to 11 have two C-shaped nozzle holes of the same shape with a nozzle hole inner protruding portion, as shown in the schematic diagram of FIG. 13C, and the ratio of B to A and the ratio of C to A are as shown in Table 1, respectively. Further, nozzle 4 has three rod-shaped nozzle holes of the same shape with a nozzle hole inner protruding portion, as shown in the schematic diagram of FIG. 16B, and the ratio of B to A and the ratio of C to A are as shown in Table 1, respectively. Nozzle 5 has three C-shaped nozzle holes of the same shape with a nozzle hole inner protruding portion, as shown in the schematic diagram of FIG. 14A, and the ratio of B to A and the ratio of C to A are as shown in Table 1, respectively. Nozzle 12 has two C-shaped nozzle holes of the same shape with a nozzle hole outer protruding portion, as shown in FIG. 13B, and the ratio of B to A and the ratio of C to A are as shown in Table 1. Nozzle 13 has three C-shaped nozzle holes of the same shape, as shown in the schematic diagram of FIG. 14A, and the ratio of B to A and the ratio of C to A are as shown in Table 1, respectively. Nozzle 14 has four C-shaped nozzle holes of the same shape, as shown in the schematic diagram of FIG. 15, and the ratio of B to A and the ratio of C to A are as shown in Table 1, respectively.

[0079]

[Table 1]

Table 1			Examples												Comparative Examples	
			1	2	3	4	5	6	7	8	9	10	11	12	1	2
Nozzle	Nozzle No.		1	2	3	4	5	6	7	8	9	10	11	12	12	13
	Schematic Diagram of Nozzle Hole		FIG. 13C	FIG. 13C	FIG. 13C	FIG. 16B	FIG. 14B	FIG. 13C	FIG. 13C	FIG. 13C	FIG. 13C	FIG. 13C	FIG. 13C	FIG. 13B	FIG. 14A	FIG. 15
	Number of Nozzle Holes		2	2	2	3	3	2	2	2	2	2	2	2	3	4
	Shape of Nozzle Hole		C	C	C	Rod	C	C	C	C	C	C	C	C	C	C
	Presence/Absence of Nozzle Hole Protruding Portion		Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Absent	Absent
	B/A		3.0	12.0	21.0	6.0	6.0	5.0	16.0	12.0	12.0	12.0	12.0	12.0	6.0	4.0
	C/A		1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	1.6	1.0	1.0	1.0	1.0	1.0
Fiber for Artificial Hair	Cross-sectional Shape	Presence/Absence of Protruding Portion	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Absent	Absent
		X_{MAX}/Y	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1	2.6	1.3	0.8	0.8
	Area Ratio of Hollow Portion (%)		5	30	50	30	30	10	40	30	30	30	30	30	30	30
	Volume (cc/g)		9	11	13	10	10	10	12	11	11	11	11	11	10	10
	Cross-sectional Structure Retention Rate		99	97	95	98	98	98	96	99	94	94	99	95	80	82
	Tactile Feeling		4	4	3	2	4	4	3	4	4	4	2	3	4	4

[0080]

(Evaluation Method of Fiber for Artificial Hair)

The obtained fiber for artificial hair was evaluated by the following methods. In cross-section observation, a yarn bundle of the fiber for artificial hair cut to an appropriate length was wrapped with a vinyl tape, and the yarn bundle was cut with a utility knife so as to be perpendicular to the longitudinal direction to prepare a cross-section.

[0081]

<Cross-section Observation>

Using a laser microscope, a cross-sectional photograph of the fiber was taken at a magnification of 400 times, and the presence or absence of a protruding portion was confirmed. In addition, a thickness X of a thick portion at a center of the inner protruding portion and the outer protruding portion, and a thickness Y of a thinnest portion at a location other than the inner protruding portion and the outer protruding portion were measured, and a ratio of X_{MAX} to Y (X_{MAX}/Y) was calculated.

[0082]

<Area Ratio of Hollow Portion>

Using a laser microscope, a cross-sectional photograph of the fiber was taken at a magnification of 400 times, and an area ratio of the hollow portion in the cross-section was calculated with $N=30$.

Area ratio of hollow portion in cross-section = Area enclosed by inner surface/Area enclosed by outer surface

[0083]

<Structure Retention Rate>

Using a laser microscope, a cross-section of the fiber was photographed at a magnification of 400 times. Thereafter, with $N=300$, the structure retention rate was calculated based on the following formula.

$$\text{Structure retention rate} = (300 - i - j)/300$$

i : number of fibers having one or more separated joint portions

j : number of fibers in which the hollow portion has collapsed and the inner surfaces are in contact

[0084]

<Volume>

Using the fiber for artificial hair cut to 120 cm, a 120 g fiber bundle was prepared, and the fiber was folded back to a length of 60 cm and placed in a partition with a width

of 39.5 mm. Thereafter, a height of the sample was measured, and a specific volume was calculated based on the following formula.

$$\begin{aligned} & (\text{Width of partition plate}) \times (\text{length of sample}) \times (\text{height of sample}) / (\text{fiber mass}) \\ & = \text{specific volume (cc/g)} \end{aligned}$$

[0085]

<Tactile Feeling>

For tactile feeling, the fibers for artificial hair of Examples and Comparative Examples were bundled to a length of 250 mm and a mass of 20 g, and evaluated by the judgment of 10 technicians of fiber for artificial hair treatment (with 5 years or more of practical experience) by touch, according to the following evaluation criteria.

4: 9 or more technicians evaluated the tactile feeling as good.

3: 6 to 8 technicians evaluated the tactile feeling as good.

2: 3 to 5 technicians evaluated the tactile feeling as good.

1: 2 or fewer technicians evaluated the tactile feeling as good.

[0086]

An observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Example 2 is shown in FIG. 18, an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Example 5 is shown in FIG. 19, an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Comparative Example 1 is shown in FIG. 21A, and an observation photograph by a laser microscope of a cross-section of the fiber for artificial hair according to Comparative Example 2 is shown in FIG. 21B. From the observation results, it was confirmed that the cross-section of the fiber for artificial hair according to the Examples have a strength-enhancing structure (a protruding portion) for improving joint strength at the joint portion, and that a protruding portion height Z is 1 μm or more. Further, in the cross-section of the fiber for artificial hair according to the Comparative Example, a thickness of the joint portion was thinner than the thickness of portions other than the joint portion, and no protruding portion was observed.

REFERENCE SIGNS LIST

[0087]

100: Cross-section of fiber for artificial hair, 11: Outer surface, 12: Inner surface, 13: Joint portion, 14: Joint surface, 15: Hollow portion, 16: Inner protruding portion, 17: Outer protruding portion, 18: Major axis, 19: Joint strength-enhancing structure, X: Central thickness of the thickest protruding portion, Y: Thickness of thin portion, Z: Protruding portion height, 200: Nozzle hole, 21: Nozzle hole outer surface, 22: Nozzle hole inner surface, 23: Separation portion, 24: Nozzle hole inner protruding portion, 25:

Nozzle hole outer protruding portion, A: Minor axis length, B: Length of a line connecting points equidistant from inner surface and outer surface, C: Separation distance

Claims

[Claim 1]

A fiber for artificial hair, wherein:

the fiber for artificial hair comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair;

a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one joint portion; and

the joint portion comprises a strength-enhancing structure for improving joint strength.

[Claim 2]

The fiber for artificial hair of Claim 1, wherein the strength-enhancing structure improves the joint strength by being thicker than other portions.

[Claim 3]

The fiber for artificial hair of Claim 1, wherein the strength-enhancing structure comprises at least one of an inner protruding portion protruding toward the hollow portion and an outer protruding portion protruding toward an outside of the fiber for artificial hair.

[Claim 4]

A fiber for artificial hair, wherein:

the fiber for artificial hair comprises a hollow portion extending in a longitudinal direction of the fiber for artificial hair; and

a cross-section of the fiber for artificial hair perpendicular to the longitudinal direction comprises at least one of an inner protruding portion protruding toward the hollow portion and an outer protruding portion protruding toward an outside of the fiber for artificial hair.

[Claim 5]

The fiber for artificial hair of Claim 1 or Claim 4, wherein the hollow portion occupies an area of 5% to 50% in the cross-section of the fiber for artificial hair perpendicular to the longitudinal direction.

[Claim 6]

The fiber for artificial hair of Claim 3 or Claim 4, wherein, when a maximum value of a central thickness of the inner protruding portion and the outer protruding portion is X_{MAX} , and a thickness of a thinnest portion at a location other than the inner

protruding portion and the outer protruding portion is Y, a ratio of X_{MAX} to Y is from 0.90 to 2.50.

[Claim 7]

The fiber for artificial hair of Claim 1 or Claim 4, comprising a vinyl chloride-based resin.

[Claim 8]

A hair decoration product comprising the fiber for artificial hair of Claim 1 or Claim 4.

[Claim 9]

A nozzle for melt extrusion the fiber for artificial hair of Claim 1 or Claim 4, the nozzle comprising one or more C-shaped nozzle holes or two or more rod-shaped nozzle holes.

[Claim 10]

The nozzle of Claim 9, wherein, on an opening surface of the nozzle, when a minor axis length of the nozzle hole is A, and a length of a line connecting points equidistant from an inner surface and an outer surface of the nozzle hole is B, a ratio of B to A is from 3 to 20.

[Claim 11]

The nozzle of Claim 9, wherein, on an opening surface of the nozzle, when a minor axis length of the nozzle hole is A, and a separation distance between the nozzle holes is C, a ratio of C to A is from 0.5 to 1.5.