ARTIFICIAL HAIR, WIG USING THE SAME, AND METHOD OF MAKING ARTIFICIAL HAIR

Technical Field

[0001] This invention relates to artificial hair having feeling and physical properties similar to those of natural hair, a wig using the same attached thereto, and a method of making the artificial hair.

Background Art

[0002] Natural hair in general has a diameter of about 80 to 100 μm, and is curled naturally or by a permanent wave treatment, but has a characteristic property that the curl is deformed and stretched when wetted by exposure to the rain or washing. Also, it is known that such as moist and tactile feelings, or such physical properties as bending rigidity are changed by the change of humidity. Therefore, natural hair obtained from humans and animals has long been prepared and used fondly as a material so as to have the characteristics as much as possible similar to that of human hair. However, for the reason of restricted supply of natural hair material or others, synthetic fibers have recently been often manufactured as a hair material for a wig. For example, polyacrylic, polyester, or polyamide synthetic fibers are used in many cases as a material of artificial hair.

[0003] The artificial hair of an acrylic fiber has low melting point and poor heat stability, so that it has such weak points as poor shape preservation after permanent wave setting, resulting in deformation of setting, for example, such as curl on fibers and the like when exposed to warm water. It also differs from natural hair in moist and tactile feelings and since it lacks toughness, uncomfortable feeling is neither denied.

[0004] On the other hand, polyester fibers excel in strength and heat stability, but have extremely low moisture absorbency compared with natural hair, and they show appearance, tactile feeling, and physical properties different from those of natural hair under high humidity,

resulting in uncomfortable feeling when used as hair for a wig. When natural hair gets wet in the rain or exposed to moisture upon hair washing, curl is deformed and stretched, whereas polyester fibers have extremely weak moisture absorbency and retention, so that show the feature of rich curl retention, resulting in almost no stretching. Therefore, if artificial hair is made of polyester fibers, and is curling-treated, the given curl does not tend to be deformed under high humidity, resulting in remarkably unnatural feeling different from the behavior of natural hair. Thus, polyester fibers can not show the behavior like natural hair that such as moist and tactile feelings and such physical properties as curl retention change with humidity change.

[0005] In addition, the polyester fiber of same diameter as that of natural hair of about 80 to 100 μm has too high bending rigidity compared with natural hair. The bending rigidity is the property relating to such feeling as tactile and texture of fibers, the required force for bending, and is widely recognized in fiber and textile industries as such that capable of numerical expression by KAWABATA method of measurement (See Non-Patent Reference 1.). Also, an apparatus has been developed which can measure the bending rigidity using a single strand of fiber or hair (See Non-Patent Reference 2.). Said bending rigidity is also called bending hardness, and is defined as the reciprocal number of curvature change generated when a unit bending moment is applied to artificial hair. The larger the bending rigidity of artificial hair, the less bendable, the more resistant to bending, that is, the harder and the less bendable is artificial hair. Conversely, the smaller the bending rigidity, the more bendable and the softer is artificial hair.

[0006] Since bending rigidity of the hair made of polyester having the same diameter as that of natural hair, about 80 to 100 μm, is extremely high compared with natural hair, if it is attached to a wig base, it stands upward too much. The hair of polyester feels rough, is high in tough feeling compared with natural hair, and moderate ductility can not be shown as with natural hair. For a so-called wearer's own hair-utilized wig which is worn by mixing the wearer's own hair and the wig hair, when polyester hair is used for a wig, the hair of polyester fiber does not adapt

to the wearer's own soft hair, and stands up fuzzy among the moderately lying wearer's own hairs. Such tendency of separation of the wearer's own hair and the hair of polyester becomes more remarkable with higher humidity.

[0007] On the other hand, polyamide fibers have appearance and physical properties similar to those of natural hair in many aspects, and excellent wigs have been provided, especially by the invention of the present applicant which removes unnatural gloss by surface treatment. (See Patent Reference 1.). Among polyamide fibers, aliphatic polyamide is especially preferable as artificial hair owing to its excellent processability. However, the fiber made of aliphatic polyamide has low bending rigidity compared with natural hair, so that its standing up is inferior when attached to a wig base, and it lies down along the wig base. Consequently, the artificial hair made of aliphatic polyamide is poor in tough feeling, and tends to be inferior in bulky feeling. As the result of the present applicant's strenuous study, with a double structure of sheath and core of an aliphatic and an aromatic polyamide resins, respectively, artificial hair was successfully manufactured which shows quite similar behavior to that of natural hair changing with the humidity change. (Japanese Patent Application. 2005-38415, February 15, 2005). By this art, the hair of polyamide fiber can attain bending rigidity similar to that of natural hair.

[0008] As other arts regarding artificial hair, such arts are proposed that preparing an artificial hair bundle by mixing polyester fibers and nylon fibers and attaching to a wig several strands pulled out of said artificial hair bundle so that a hair dryer or a curling iron can be used (Patent Reference 2) and maintaining moisture retention and approximating tint and gloss as a whole to natural hair by mixing natural hair to the artificial hair made of polyester fibers (Patent Reference 3).

[0009] Patent Reference 4 discloses a bristle material for brushes such as tooth brushes and face brushes having moderate toughness by mixing and melt-spinning polyethylene terephthalate to polybutylene terephthalate. Patent Reference 5 discloses short fibers made of a blend polymer containing polyethylene terephthalate and polybutylene terephthalate to

attain soft tactile feeling as a car seat surface material for transportation vehicles and a vehicular interior material such as a door interior material. Patent Reference 6 discloses a false-twist textured thread made by blending polyethylene terephthalate to polybutylene terephthalate to provide a soft textile excellent in stretchability. Patent Reference 7 discloses a non-woven textile made of polyethylene terephthalate and polybutylene terephthalate mixed in the pre-determined mass ratio.

[0010]

[Patent Reference 1] Japan Patent Laid Open S64-6114 A (1989)

[Patent Reference 2] Japan Patent Laid Open H9-324314 A (1997)

[Patent Reference 3] Japan Utility Model Registration 3021160

[Patent Reference 4] Japan Patent Laid Open 2004-166966 A

[Patent Reference 5] Japan Patent Laid Open 2004-84119 A

[Patent Reference 6] Japan Patent Laid Open 2000-273727 A

[Patent Reference 7] Japan Patent 345824

[Non-Patent Reference 1] Sen'ikikai Gakkaishi (Journal of Textile Machine Society, Textile Engineering), Sueo KAWABATA, 26, 10, pp.721 – 728, 1973

[Non-Patent Reference 2] KATOTECH LTD., Handling Manual of KES-SH Single Hair Bending Tester

Disclosure of the Invention

Problems to be Solved

[0011] As described above, artificial hair to be used for wigs is made variously so as to have feeling (appearance, tactile and texture) as close as possible to that of natural hair, and such physical properties as moisture absorbency, tensile strength, elasticity, and bending rigidity are required not inferior to, or preferably, superior to those of natural hair. Since the present applicant's artificial hair made of above-mentioned polyamide fiber has a diameter of about 80 to 100 μm which is about same as that of natural hair as mentioned above, and can provide feeling quite close to natural hair, it is a quite excellent material. However, when the artificial hairs made of polyamide fibers are attached to a wig base, they have a tendency to stick together to be bundled as a plurality of

strands as time elapses. Therefore, the bundled hairs have to be combed each time carefully so that they are disintegrated. Also, since the artificial hair of a polyamide fiber has moisture absorbency like natural hair, fibers tend to stick together to be bundled due to their property at high humidity. This tendency is more noticeable at higher humidity. Therefore, when artificial hairs of polyamide are bundled by absorbing moisture, for example upon wetting in the rain or hair-washing, a wig wearer has such a problem that combing, brushing and hair-styling of the bundled hairs would not be disintegrated each strand, and hence it takes time to set a desired hairstyle. This property is same for the artificial hair of a sheath/core double structure of the above-mentioned aliphatic and aromatic polyamide resins, and it is difficult to prevent bundling of the artificial hairs of polyamide fibers, and since artificial hairs are adhered tightly at higher humidity, it is also difficult to prevent them from bundling.

[0012] If the artificial hairs of mixed polyester fibers and nylon fibers are attached to a wig base, as described in Patent reference 2, bundling of nylon fibers can be prevented, but nylon fibers lie down on the wig base like natural hair, whereas the artificial hairs of polyester fibers stand up, and hence do not blend well with natural hair and nylon fibers, resulting in appearance of separation. This tendency is more noticeable at higher humidity, and nylon fibers lie down due to their moisture absorbency in high humidity to be stuck to a scalp like natural hair, whereas since polyester fibers have high bending rigidity and low moisture absorbency, they keep the state of standing up, and hence the wig wearing can not show natural appearance and is easily visible.

[0013] An object of the present invention is, in view of the above-mentioned problems, to provide an artificial hair having feeling and physical properties similar to those of natural hair, especially a part of the artificial hair attached to a wig base does not stand up in unnatural manner, excellent in hair shape retention, the same curling property as human hair can be realized, the artificial hairs are not bundled mutually under the influence of humidity giving flow feeling, and in addition, it has bending rigidity similar to that of natural hair, showing the behavior

similar to natural hair, a wig using the above-mentioned artificial fair and a method of making the same.

Means to Solve Problems

[0014] As the result of the present inventors' strenuous study, knowledge was obtained that, on the assumption of the state of polyamide artificial hair bundle being bundled due to the molecular structure of polyamide artificial hair, or due to the molecular bonding on the surfaces of polyamide artificial hair, so-called Van der Waals force, various experiments were performed to turn out that the state of bundling can be solved by not a single polyamide artificial hair but by mixing other synthetic fibers, more concretely, the artificial hair containing polyethylene terephthalate. Further, in order for polyamide artificial hair to have bending rigidity similar to that of natural hair, quite excellent property can be obtained by making the fiber having a double structure of a sheath and a core and by adjusting the sheath/core ratio and others. In case of polyethylene terephthalate artificial hair, the present invention was completed by obtaining the knowledge that it is attained by either controlling its diameter, or by melt-spinning with other synthetic resins.

[0015] In order to achieve the above-mentioned object, an artificial hair of the present invention is the fiber containing polyethylene terephthalate, having bending rigidity similar to that of natural hair. More concretely, said artificial hair is made of the fiber containing polyethylene terephthalate, having bending rigidity similar to that of natural hair by making the cross-sectional size similar to that of natural hair, for example, that perpendicular to the length direction of fiber in the range of 50 to 70 μm as an average diameter.

Said artificial hair is preferably the fiber containing polyethylene terephthalate and polybutylene terephthalate, having bending rigidity similar to that of natural hair. In this case, the cross-sectional size perpendicular to the length direction of fiber may be in the range of 50 to 100 μm as an average diameter

In the above-mentioned constitutions, bending rigidity of a fiber is preferably in the range of 6.5 to 7.8 X 10^{-3} gf$\cdot$cm^2/strand at humidity 40%.

On the surface of the fiber, fine pores are preferably formed in the length direction.

[0016] In the above-mentioned constitutions, the artificial hair of bending rigidity similar to that of natural hair can be provided by making the cross-sectional size of a fiber made of polyethylene terephthalate similar to that of natural hair. Since also bending rigidity can be spontaneously adjusted with polyethylene terephthalate of high bending rigidity and polybutylene terephthalate of low bending rigidity, resulting in the bending rigidity similar to that of natural hair, artificial hair similar to natural hair can be provided. Consequently, since these artificial hairs have bending rigidity similar to that of natural hair, natural artificial hair can be provided which has such feeling as appearance, tactile and texture feelings especially quite similar to those of natural hair. Since standing up of this artificial hair from a wig base shows the behavior similar to the standing up of natural hair from a scalp, natural feeling is realized, and wearing a wig is not visible. By forming fine pores in the length direction on the surface of artificial hair, the irradiated light is diffusely reflected to suppress gloss, giving the gloss similar to that of natural hair.

[0017] Artificial hair bundle of the present invention is characterized in that it is made up to a bundle by dispersing a first artificial hair made of a polyester resin in a second artificial hair made of a polyamide resin in the pre-determined ratio, further said polyester resin includes polyethylene terephthalate, and the first artificial hair has a cross-sectional size and bending rigidity similar to those of natural hair.

In said first artificial hair, polyester resin preferably includes polyethylene terephthalate and polybutylene terephthalate, and has bending rigidity similar to that of natural hair. The cross-sectional size perpendicular to the length direction of said first artificial hair is in the range of 50 to 70 μm as an average diameter. Said second artificial hair preferably has a sheath/core structure made of a core portion and a sheath portion covering said core portion, the core portion is made of a polyamide resin, and the sheath portion is made of a polyamide resin of bending rigidity lower than that of said core portion. The second artificial

hair preferably has a cross-sectional size and bending rigidity similar to those of natural hair, which is in the range of 6.5 to 7.8 X 10^{-3} gf・cm^2/strand at humidity 40%.

[0018] By properly mixing the first artificial hair made of polyester resin to said second artificial hair made of polyamide resin, and by attaching them to a wig base in a proper dispersing state, bundling of the second artificial hair itself can be suppressed. Since the first artificial hair has a material of polyethylene terephthalate and polybutylene terephthalate, it has bending rigidity similar to natural hair compared with the material of only polyethylene terephthalate, and natural artificial hair the feelings such as appearance, tactile and texture of which are quite close to those of natural hair can be provided.

[0019] A wig of a first constitution of the present invention comprises a wig base and artificial hair attached to said wig base, characterized in that a first artificial hair made of a polyester resin and a second artificial hair made of a polyamide resin are used as said artificial hair, said polyester resin includes polyethylene terephthalate, and said first artificial hair has bending rigidity similar to that of natural hair by having a cross-sectional size similar to that of natural hair.

A wig of a second constitution of the present invention comprises a wig base and artificial hair attached to said wig base, characterized in that a first artificial hair made of a polyester resin and a second artificial hair made of a polyamide resin are used as said artificial hair, said polyester resin includes polyethylene terephthalate and polybutylene terephthalate, and said first artificial hair has bending rigidity similar to that of natural hair. The second artificial hair preferably has a sheath/core structure comprising a core portion and a sheath portion covering the core portion, the core portion is made of a polyamide resin, and the sheath portion is made of a polyamide resin of bending rigidity lower than that of the core portion.

[0020] By using artificial hair of the above-mentioned constitution for a wig of the present invention, a wig can be provided which gives natural flow feeling, and shows behavior similar to that of natural hair. Therefore, since the first artificial hair made of a polyester resin is attached by

properly mixing with the second artificial hair made of a polyamide resin, bundling of the second artificial hair is suppressed, hair style setting causes no trouble regardless of high or low humidity, the wig-wearing is not visible owing to the appearance as if it were the wearer's own hair growing naturally from a scalp.

[0021] A first constitution of a method of making artificial hair is characterized in that, in order to obtain artificial hair having a cross-sectional size and bending rigidity similar to natural hair, said method is comprised of a first step to add a coloring material to the polyethylene terephthalate as a starting material, and to melt and discharge, a second step to solidify the discharged fiber-shaped melt, and a third step to stretch the solidified fiber-shaped material to the pre-determined diameter. A second constitution is characterized in that, in order to obtain artificial hair having bending rigidity similar to those of natural hair, said method is comprised of a first step to melt and discharge the polyethylene terephthalate and polybutylene terephthalate as starting materials and a coloring material in the pre-determined mass ratio, a second step to solidify the discharged fiber-shaped melt, and a third step to stretch the solidified fiber-shaped material to the pre-determined diameter. In said first and second constitutions, fine pores may be formed on the surface of artificial hair by an alkali denier reduction treatment in either of the second or third step.

[0022] In accordance with the above-mentioned constitutions, artificial hair made of a polyester resin can be provided which has properties similar to those of natural hair, and further, artificial hair can be provided which suppresses bundling of artificial hair made of a polyamide resin by mixing the artificial hair made of a polyester resin in artificial hair made of a polyamide resin.

Effect of the Invention

[0023] According to the present invention, the artificial hair of a polyester resin can be provided which has feeling (appearance, tactile and texture) and physical properties, especially bending rigidity similar to that of natural hair. Since said artificial hair suppresses bundling of the

artificial hairs of a polyamide resin, the artificial hairs of a polyamide resin are no longer bundled and disintegrated to each strand by using and mixing proper number of strands as hair in the wig having the artificial hairs of a polyamide resin attached thereto. Therefore, this artificial hair puts artificial hair of a polyamide resin into the smooth state, and can show the similar behavior to natural hair. Therefore, by the wig of the present invention, since the hair attached to the wig shows the similar behavior to the wig wearer's own hair, the wig wearing is hardly visible, and provides excellent appearance.

[0024] Since conventional artificial hair of a polyester resin has higher bending rigidity than that of natural hair, it stands up markedly from a wig base, and together with the low bending rigidity of artificial hair of a polyamide resin attached to the same wig base, the artificial hair of a polyester resin stands up and is markedly distinguished, the wig wearing is highly visible, and uniformity as a hair style can not be attained. On the other hand, if artificial hair of a polyester resin attached to a wig base has bending rigidity lower than that of natural hair, it is in the state as if lying down along the wig base. Therefore, the stand up of artificial hair of a polyamide resin of bending rigidity similar to that of natural hair is highly visible, and since the standing and the lying hairs are mixed, the wig wearing is easily visible, and uniformity as a hair style can not be attained. On the other hand, since said artificial hair of a polyester resin according to the present invention has bending rigidity similar to that of natural hair, it stands up similar to that of artificial hair of a polyamide resin attached to a wig base, and the wig wearing is hardly visible.

Brief Description of the Drawings

[0025] Fig. 1 is a view illustrating an embodiment of artificial hair in accordance with the present invention.

Fig. 2 is a cross-sectional view in the length direction illustrating another embodiment of artificial hair in accordance with the present invention.

Fig. 3 is a view illustrating an artificial hair bundle of the present invention.

Fig. 4 diagramatically illustrates a preferable make up of a second artificial hair shown in Fig. 3, in which (A) is a diagonal view, and (B) is a cross-sectional view in the length direction of the second artificial hair.

Fig. 5 is a cross-sectional view in the length direction diagrammatically illustrating a modified version of the second artificial hair.

Fig. 6 is a diagonal view diagrammatically illustrating a make up of the second artificial hair.

Fig. 7 is a view diagrammatically illustrating, respectively, (A) a wig of the present invention, and (B) a wig of a Comparative Example.

Fig. 8 is a diagrammatical view illustrating a series of apparatuses used for manufacturing artificial hair of the present invention.

Fig. 9 is a view diagrammatically illustrating an alkali denier reducing part.

Fig. 10 is a diagrammatical view illustrating a manufacturing apparatus used for manufacturing the second artificial hair making up the artificial hair bundle of the present invention.

Fig. 11 is a diagrammatical view illustrating a discharging part used for the manufacturing apparatus of Fig. 10.

Fig. 12 is a view showing a scanning electron microscopic image of the artificial hair manufactured in Example 1.

Fig. 13 is a graph showing the relationship of bending rigidity with regard to the cross-sectional diameter of artificial hair manufactured in Examples 1 to 5 and Comparative Examples 1 to 3.

Fig. 14 is a graph showing the bending rigidity with regard to the mixing ratio of polybutylene terephthalate mass.

Fig. 15 is a graph showing the bending rigidity before and after the alkali denier reducing process in case of 20% and 60% of the mixing ratio of polybutylene terephthalate.

Fig. 16 is a graph showing thermal shrinkage ratio with regard to bending rigidity of each artificial hair.

Explanation of Marks and Symbols

[0026]

1, 2: First artificial hair

2a: Fine pore

5, 6: Second artificial hair

5A: Sheath portion

5B: Core portion

5C: Concave and convex portion

10: Artificial hair bundle

20: Wig

21: Wig base

30, 50: Manufacturing apparatus

31, 51, 52: Feed material tank

31A, 51A, 52A: Melt liquid

32, 51D, 52D: Melt extruder

32A, 53C: Outlet

33, 54: Quenching bath

34, 36, 38, 40, 55, 57, 59, 62: stretching roll

35, 37, 39, 56, 58, 60: Dry stretching bath

41, 64: Rollup machine

45: Alkali denier reducing part

46: Liquid storage part

47: Rotating cylinder

47a: Jet nozzle

48: Shower part

51B, 52B: Gear pump

53: Discharging part

53A: Outer ring part

53B: Inner circle part

61: Oiling device for electrostatic prevention

62: Blast machine

100: Fiber

Best Modes for Carrying out the Invention

[0027] Hereinafter, the present invention is explained in details with reference to the embodiments illustrated in the figures.

Explanation is first made of an artificial hair. The artificial hair of the present invention is made of a polyester synthetic fiber, and has bending rigidity similar to that of natural hair. Here, polyethylene terephthalate is a polymer practically obtained by condensation polymerization of terephthalic acid and ethylene glycol. Bending rigidity similar to that of natural hair is optimally 6.5 to 7.8 X 10^{-3} gf · cm^2/strand at humidity 40%, and 3.9 to 5.8 X 10^{-3} gf · cm^2/strand at humidity 80%. When the artificial hair of polyester artificial fibers are dispersed in the artificial hair made of polyamide synthetic fibers and attached to a wig base in the pre-determined ratio, then bundling of the artificial hair made of polyamide synthetic fibers is suppressed, and since the artificial hair of polyester fibers has bending rigidity similar to those of the artificial hair of polyamide fibers and natural hair, it shows similar behavior to the natural hair growing from the wig wearer's scalp and the artificial hair of polyamide fibers attached to the wig base, for example, it has the similar growing state similar to that of the polyamide artificial hair attached to the wig base and the natural hair growing from the wig wearer's scalp, resulting in uniform appearance.

[0028] Hereinafter, explanation is made of each embodiment of artificial hair of the present invention.

A first embodiment of artificial hair of the present invention is the fiber with polyethylene terephthalate as the component containing coloring pigments whenever necessary, and has bending rigidity similar to that of natural hair by having a cross-sectional size similar to that of the artificial hair.

Fig. 1 is view illustrating an embodiment of the artificial hair with polyethylene terephthalate as the component of the present invention. Said artificial hair 1 may have the cross section of either an exact circle shown in Fig. 1, or an ellipsoid compressed in any direction or cocoon shape. The artificial hair 1 in accordance with the first embodiment of the present invention has the average cross-sectional

diameter of 50 to 70 μm. If the average diameter of the cross section of artificial hair 1 is less than 50 μm, then its bending rigidity is lower than that of natural hair, and it is undesirable that it lies along a wig base when attached thereto. On the other hand, if the average diameter exceeds 70 μm, then its bending rigidity is much higher than that of natural hair, and it is undesirable that its standing up is too much from a wig base when attached thereto.

[0029] A second embodiment of artificial hair of the present invention is the synthetic fiber of polyester, and, by containing polyethylene terephthalate and polybutylene terephthalate in the pre-determined ratio as the components of said synthetic fiber of polyester, it has bending rigidity similar to that of natural hair. Polybutylene terephthalate is a polymer practically obtained by condensation polymerization of terephthalic acid and 1,4-butane diol. The artificial hair of said second embodiment may have the cross section of either an exact circle as in Fig. 1, or an ellipsoid compressed in any direction or cocoon shape. Its cross-sectional size is preferably 50 to 100 μm. With said artificial hair, it is convenient that the diameter can be same 80 to 100 μm as natural hair.

[0030] Explanation is made of a third embodiment of artificial hair.

Fig. 2 is a cross-sectional view in the length direction illustrating artificial hair 2 in accordance with the third embodiment of the present invention. Unlike Fig. 1, fine concave and convex portion 2a is formed on the surface of said artificial hair 2. As for the artificial hair 2 having such a concave and convex portion 2a, since diffuse reflection is caused when light is irradiated, gloss due to the reflection by light irradiation is hardly caused on the surface of artificial hair 2, thereby so-called deglossing effect can be realized. The concave and convex portion 2a is preferably formed to be larger than the order of visible light wavelength so that light is reflected diffusively. Said concave and convex portion 2a can be formed by, for example, after spinning the artificial hair, soaking for weight reducing processing in sodium hydroxide solution or others, and water-washing and drying, but it may also be formed by conducting blast treatment. The components of artificial hair 2 may be composed with polyethylene terephthalate as in the first embodiment, or may be

polyethylene terephthalate and polybutylene terephthalate mixed in the pre-determined ratio as in the second embodiment. The artificial hair of the above-mentioned embodiments may contain pigments as components for the pre-determined coloring.

[0031] The fiber made of polyethylene terephthalate in general has strong bending rigidity, so that it has so far been not proper as a material of artificial hair, but with artificial hair 1, 2 of the present invention, if the fiber has a cross-sectional size similar to, or a little smaller than that of natural hair, bending rigidity is close to that of natural hair, and appearance and tactile and texture feelings can be attained similar to those of natural hair. Also with the fiber made of polyethylene terephthalate and polybutylene terephthalate, bending rigidity is close to that of natural hair with practically similar diameter to that of natural hair, and appearance and tactile and texture feelings can be attained similar to those of natural hair. By attaching to a wig base artificial hair of said first to third embodiments (hereinafter referred to as "first artificial hair") and a plurality of a second artificial hair made of polyamide fiber so that they are mixed, each strand of the first and the second artificial hairs is unbundled to make them smooth. Thereby bundling of the second artificial hair can be suppressed. When made to the desired hairstyle, unnaturalness by bundling can be prevented, and natural appearance can be provided to a wig.

[0032] Explanation is made hereafter of artificial hair bundle 10 of the present invention.

Fig. 3 is a view diagrammatically illustrating an artificial hair bundle 10 of the present invention. The artificial hair bundle 10 is so constituted that, as shown in Fig.3, the pre-determined number of strands of the first artificial hair 1 made of polyester synthetic fiber are dispersed and blended in a plurality of the second artificial hair 5 made of polyamide synthetic fiber to form a bundle, and said first and second artificial hairs are properly dispersed in a wig base to be randomly attached. The polyamide synthetic fiber as the second artificial hair 5 has a cross-sectional size and bending rigidity similar to those of natural hair.

[0033] For said artificial hair bundle 10, the thermal shrinkage ratio of

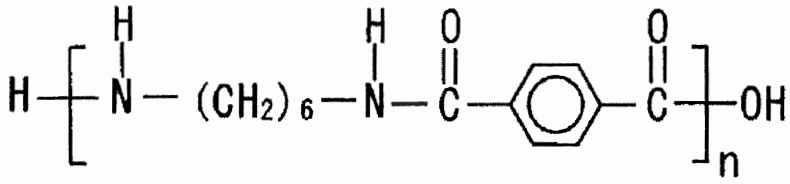
the second artificial hair 5 is preferably about same as or lower than that of the first artificial hair 1. Thereby, since the first artificial hair 1 and the second artificial hair 5 shrink to about same extent when curling treatment by heat is applied to the artificial hair bundle 10, wavy steps can be prevented from generating. The cause of wavy step generation is as described below. If the thermal shrinkage ratio of the second artificial hair 5 is higher than that of the first artificial hair 1, when curling treatment by heat is applied to the artificial hair bundle 10, the first artificial hair 1 neighboring the second artificial hair 5 tends to shrink as does the second artificial hair 5. However, the shrinkage of the second artificial hair 5 is larger than that of the first artificial hair 1, and hence the first artificial hair 1 of small shrinkage is pulled to cause kinks and slacks, and the pre-determined good curling can be no longer given, thereby wavy steps appear.

[0034] Fig. 4 is a view diagrammatically illustrating the preferred makeup of a second artificial hair 5 shown in Fig. 3, in which (A) is a diagonal view, and (B) is a vertical cross sectional view in the length direction of the second artificial hair 5. As is illustrated, the second artificial hair 5 has a sheath/core structure wherein its surface is a sheath portion 5A, and a core portion 5B is inside the sheath portion 5A, both portions made of a polyamide resin. In case of illustration here, the sheath/core structure is illustrated with an example of nearly concentric circular arrangement, but it also includes the cases where both core 5B and sheath 5A have different shapes other than nearly concentric circles, or the cross sectional shape of the second artificial hair 5 may be circular, elliptic, or cocoon-shaped.

[0035] As the polyamide resins for the material of said core portion 5B, semi-aromatic polyamide resins of high strength and bending rigidity can be properly used. As said semi-aromatic polyamide, such may be mentioned as the polymer consisting of an alternate copolymer of hexamethylenediamine and terephthalic acid (Nylon 6T, for example) expressed in Chemical Formula 1, or the polymer in which adipic acid and metaxylylenediamine are alternately bound by amide bond (Nylon MXD6, for example) expressed in Chemical Formula 2. The polymer material

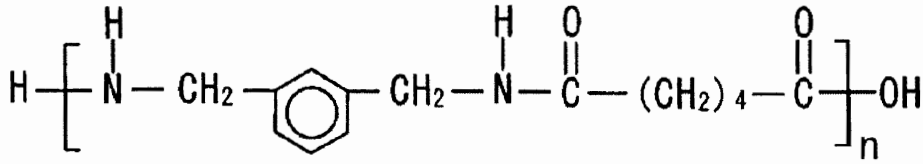
expressed in Chemical Formula 2 has a merit in easier hairset than that expressed in Chemical Formula 1.

[Chemical Formula 1]



(1)

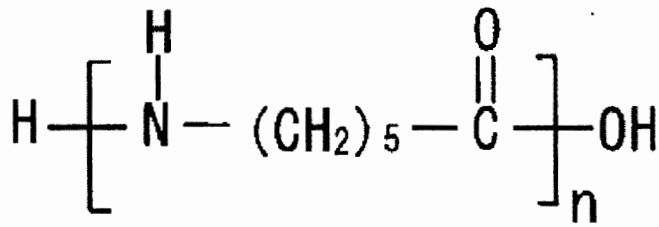
[Chemical Formula 2]



(2)

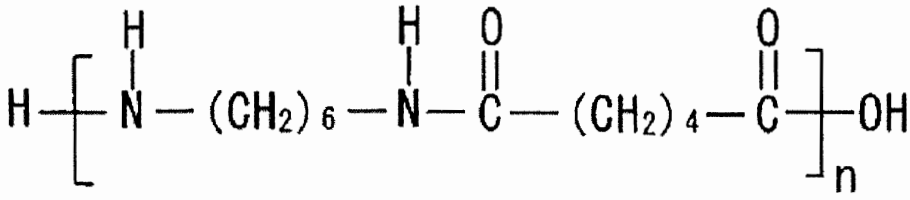
[0036] As the polyamide resins for the material of said sheath portion 5A, polyamide resins of lower bending rigidity than the core 5B may be used, and a linear saturated aliphatic polyamide, for example, can be properly used. As said linear saturated aliphatic polyamide, such may be mentioned as the polymer consisting of a ring-opening polymer of caprolactam, for example Nylon 6, expressed in Chemical Formula 3, or the polymer consisting of an alternate copolymer of hexamethylenediamine and adipic acid, for example Nylon 66, expressed in Chemical Formula 4.

[Chemical Formula 3]



(3)

[Chemical Formula 4]



(4)

[0037] The second artificial hair 5 has gloss, if the surface of the sheath 5A is smooth. In order to erase this unnatural gloss on the surface of the second artificial hair 5, so-called deglossing may be preferably applied. Fig. 5 is a cross sectional view in the length direction diagrammatically illustrating the makeup of a modified example of the second artificial hair 6. As is illustrated, on the surface of the sheath portion 5A of the second artificial hair 6, a fine concave and convex portion 5C is formed.

[0038] Here, the fine concave and convex portion 5C can be given by blast processing with fine powder such as sand, ice, dry-ice, and others either during spinning of the second artificial hair 6 or on to the fiber after spinning. In case during spinning of the second artificial hair 6, it may be by spherulite formation on the outermost surface of the second artificial hair 6. It may be the combined processes of spherulite formation and blast processing with fine powder such as said sand, ice, dry-ice, and others. The concave and convex portion formed by such spherulite formation and/or_blast processing may be formed to be the concave and convex portion 5C larger than the order of visible light wavelength so the light is diffuse reflected. The second artificial hair 5, 6 can be dyed in general depending upon the wearer's preference. Said dying may be by formulating pigment and/or dye during polymer kneading as the material for spinning, or by dying after spinning. By making a sheath/core structure with the polyamide of high bending rigidity used for the core 5B, and with the polyamide of the bending rigidity lower than the core 5B used for the sheath 5A, the second artificial hair 5, 6 can be obtained the rigidity of which is changed by temperature and humidity, and which shows behavior closer to the natural hair.

[0039] The mixing ratio of the first artificial hair 1, 2 and the second artificial hair 5, 6 in an artificial hair bundle 10 is preferably in the range of 10 to 60 weight %, and more preferably about 20 to 30 weight %. In this preferred range, polyamide fibers do not bundle. It is not preferable that, if the mixing ratio of the first artificial hair 1, 2, that is, a polyester fiber is lower than 10 weight %, then polyamide fibers bundle. On the other hand, if the mixing ratio of polyester fibers (the first artificial hair) exceeds 60 weight %, then, though the polyamide fibers do not bundle, the polyester fibers (the first artificial hair) are not preferably too much visible. Since polyester fibers have lower moisture absorbency than polyamide fibers, the artificial hair bundle 10 made of two kinds of fibers shows a different behavior by humidity change due to the difference in moisture absorbency.

[0040] Thus, the reason why bundling hardly occurs when a polyester artificial hair is mixed in a polyamide artificial hair is assumed that a polyester artificial hair of a different chemical structure is mixed in a polyamide artificial hair, and that a polyamide artificial hair tends to be electrically charged positively, while a polyester artificial hair tends to be charged negatively.

[0041] With the first artificial hair 1, 2 and the second artificial hair 5, 6 are mixed in a preferable weight ratio in an artificial hair bundle 10, the second artificial hair 5, 6 does not bundle, and the first artificial hair 1, 2 and the second artificial hair 5, 6 can have bending rigidity similar to that of natural hair.

[0042] Explanation is next made of a wig of the present invention.

Fig. 6 is a diagonal view diagrammatically illustrating the structure of a wig 20 of the present invention. A wig 20 using the artificial hair 1, 2 of the present invention is made by attaching the first artificial hair 1, 2 and the second artificial hair 5, 6 in the pre-determined ratio to a wig base 11. The first artificial hair 1, 2 is made of a polyester synthetic fiber as mentioned above, having bending rigidity similar to that of natural hair. The second artificial hair 5, 6 is made of a polyamide synthetic fiber, having a cross-sectional size and bending rigidity similar to those of natural hair, and preferably comprises, as mentioned above, a

core portion 5B of a high bending rigidity polyamide resin and a sheath portion 5A of a polyamide resin having lower bending rigidity than the core portion 5B.

[0043] The mixing ratio of the first artificial hair 1, 2 and the second artificial hair 5, 6 attached to a wig base 21 is preferably that the first artificial hair 1, 2 is about 20±5 weight % in an arbitrary region, because the second artificial hairs 5, 6 made of a polyamide fiber attached to the wig base 21 does not bundle in this preferred range. It is not preferable that, if the mixing ratio of the first artificial hair is less than 20±5 weight %, then polyamide fibers bundle. On the other hand, if the mixing ratio of polyester fibers (the first artificial hair) exceeds 20±5 weight %, then, though the polyamide fibers do not bundle, the polyester fibers (the first artificial hair) are not preferably too much visible.

[0044] The wig base 21 can be made of either a net-like base or an artificial skin base. In case of the figure, the wig base 21 is made of a net member, and the first artificial hair 1, 2 and the second artificial hair 5, 6 are tied to a mesh of the net member. The wig base 21 may be made by combination of a net-like base and an artificial skin base, and there is no special restriction so far as suitable to wig design or purpose of use.

[0045] The first artificial hair 1, 2 and the second artificial hair 5, 6 are preferably the artificial hair respectively having gloss similar to that of natural hair, with their surface specular glossiness suppressed. The colors of the first and the second artificial hair may be properly chosen according to the wearer's desire such as black, brown and blond. Natural appearance is increased if the artificial hair is chosen of the color fitting to the wearer's own hair around the lost hair portion. In case of a wig or hair extension for fashion, the artificial hair of the present invention may be made mesh-like by giving a color different from the wearer's own hair, or from a root portion to an end portion, gradation may be given such as, for example, dark and light tint or color is gradually changed.

[0046] Figs. 7(A) and (B) are views diagrammatically illustrating, respectively, a wig 20 of the present invention, and a wig 25 as a Comparative Example. As shown in Fig. 7(A), in the wig 20 of the present invention, since the first artificial hair 1, 2 is so made as to have bending

rigidity similar to that of the second artificial hair 5, 6 having bending rigidity similar to that of natural hair, the first artificial hair 1, 2 and the second artificial hair 5, 6 look similar, and are not distinguishable strictly when attached to a wig base 21. Further, an excellent wig can be provided wherein the polyamide fibers constituting the second artificial hair 5, 6 do not bundle. On the other hand, as shown in Fig. 7(B), in a conventional wig 20, wherein artificial hair 3 made only of polyethylene terephthalate the cross-sectional size of which is out of range of 50 to 70 μm as the average diameter is attached together with the second artificial hair 5, 6 to the wig base 21, the artificial hair 3 has bending rigidity different from that of the second artificial hair 5, 6, so that it stands up largely from the wig base 21, gives appearance separated from the second artificial hair 5, 6, and hence is not preferable.

[0047] Explanation is next made of a method of manufacturing artificial hair of the present invention. First, a series of apparatuses used for the method of manufacturing artificial hair of the present invention will be explained.

Fig. 8 is a diagrammatical view illustrating a series of apparatuses used for manufacturing artificial hair of the present invention. As shown in Fig. 8, the manufacturing apparatus 30 is constituted with a feed material tank 31 for storing polyethylene terephthalate resin pellets as a feed material and the polyethylene terephthalate resin pellets containing coloring materials, a melt extruder 32 to melt and knead the feed material, a quenching bath 33 to solidify the fibrous melt discharged from an outlet 32A formed from the molten liquid kneaded in the melt extruder 32, and thereafter, via the three step extension thermal treatment process each step of which comprising stretching rolls 34, 36, 38 and 40, and dry stretching baths 35, 37 and 39, a rollup machine 41 to roll up artificial hair 1, and an alkali denier reducing part (not shown) to further form fine pores 2a on the fiber surface.

[0048] The melt extruder 32 is provided with a heating device to melt polyethylene terephthalate resin pellets as a feed material and the polyethylene terephthalate resin pellets containing coloring materials, a

kneader to disperse and mix them to be uniform, and a gear pump to feed the molten liquid to an outlet 32A.

[0049] The outlet 32A of the discharge part 32 is provided with the pre-determined number of holes with the pre-determined diameter, and, as illustrated, the fiber from the outlet 32A of the discharge part 32, after passing sequentially the quenching bath 33, the first stretching roll 34, the first dry stretching bath 35, the second stretching roll 36, the second dry stretching bath 37, the third stretching roll 38, the third dry stretching bath 39, the fourth stretching roll 40, is rolled up by the rollup machine 41, and thereafter is alkali denier reducing treated with the alkali denier reducing part (not shown). Here, the first to the fourth stretching rolls 34 to 40 stretch-treat to the solidified fiber member. First, the first stretch-treating is conducted to the fiber member by increasing the roller speed of the second stretching roll 36 relative to the roller speed of the first stretching roll 34, the second stretch-treating is conducted to the fiber member by increasing the roller speed of the third stretching roll 38 relative to the roller speed of the second stretching roll 36, and thereafter the tension applied to the fiber is relaxed by decreasing the roller speed of the fourth stretching roll 40 relative to the roller speed of the third stretching roll 38 as the relaxing stretching treatment to stabilize a size. Here, an oiling device for electrostatic prevention (not shown) may be provided between the fourth stretching roll 40 and the rollup machine 41.

[0050] Fig. 9 is a view diagrammatically illustrating an alkali denier reducing part 45. The alkali denier reducing part 45 is constituted with a liquid storage part 46 to store the treating liquid containing alkali aqueous solution, a rotating cylinder 47 rotating with the fiber 100 hung down so as to soak a part of the fiber 100 in said liquid storage part 46, and a shower part 48 provided above said rotating cylinder 47 and emit the treating liquid to the fiber 100 hung down from the rotating cylinder 47. In the liquid storage part 46 is stored the treating liquid containing an alkali aqueous solution for etching polyester fiber and an accelerating agent to accelerate hydrolytic reaction, and the surface of fiber 100 is etched by soaking a part of fiber 100 in the treating liquid. The rotating

cylinder 47 is constituted so that its three tubing parts extend in the rotation axis direction, and have triangular cross-sectional shape, wherein each tubing part has a plurality of jet-emitting orifices 47a at the opposite side of the rotation axis to emit a jet of the treating liquid which flew into the tubing part to the outer direction of rotation. The shower part 48 is so constituted as to emit a jet of the treating liquid from nozzles.

[0051] With the thus constituted alkali denier reducing part 45, etching treatment can be applied to the fiber 100 stretched and relaxing-treated. That is, by soaking a part of the fiber 100 in the treating liquid, the fiber is uniformly etched to reduce the fiber diameter. Also by rotating the rotating cylinder 47 in the direction shown by a solid arrow in the figure, the fiber 100 rotates and moves in the direction shown by a solid line in the figure. In this case, the treating liquid emitted from each jet orifice 47a of the rotating cylinder 47 and from the shower part 48 is attached the outer surface of the fiber 100 hooked on the rotating cylinder 47. At the right hand side of the rotating cylinder 47, the moving direction of the fiber 100 (the direction of an arrow shown by a solid line) and the moving direction by the self weight of the treating liquid (the direction of an arrow shown by a broken line) agree, and etching treatment is applied along the moving direction of the fiber, that is, along the flow of the treating liquid. On the other hand, at the left hand side of the rotating cylinder 47, since the moving direction of the fiber 100 and the flowing direction of the treating liquid are opposite, etching is conducted in the reverse direction of the fiber movement. Thus, the treating liquid stained to the surface of the fiber 100 flows vertically downward by its own weight along the axis direction of the fiber on the surface that is, along the length direction, and etching treatment is applied along this flow direction. Thereby, the fiber 100 becomes thin by its alkali denier reducing treatment, and fine pores are formed along the axis direction on the fiber surface.

[0052] Explanation is made of a method of manufacturing artificial hair by a series of apparatuses 30 shown in Fig. 8. Explanation is first made of a method of manufacturing artificial hair made of a polyester synthetic

fiber with polyethylene terephthalate as its component and containing a coloring material.

In the apparatus 30 shown in Fig. 8, polyethylene terephthalate pellets and coloring resin pellets with polyethylene terephthalate as a base material and containing a coloring pigment are mixed in the pre-determined ratio and fed into a feed material tank 31. By changing the mixing ratio of coloring resin pellets, hair color of the artificial hair as the final product can be changed. The mixing ratio of the coloring resin pellets to polyethylene terephthalate pellets is the mass ratio 40:60 as maximum for polyethylene terephthalate pellets: the coloring resin pellets.

[0053] The pellets in the feed material tank 31 are fed into a melt extruder 32, the melt liquid 31A formed by kneading the pellets in the melt extruder 32 is discharged from an outlet 32A, and the fiber-like melt is solidified by a quenching bath 33. The temperature of the quenching bath 33 is preferably around 40 ℃ for high productivity. If the temperature of the quenching bath 33 is low, then the molecular structure difference is caused by crystallization proceeding in the inner resin while crystallization not proceeding in the outer portion by rapid cooling regarding the outer and the inner portions of fiber-like melt first contacted to the water upon contacting the quenching bath 33 after molten resin is discharged, resulting in undesired "fiber waving". If the temperature of the quenching bath 33 is too high, the resistance to stretching of fiber-like melt becomes weak due to too much proceeding of the fiber-like melt crystallization, resulting in low productivity because fiber cut-off occurs frequently upon stretching.

[0054] To the solidified fiber members, a first step of stretching treatment is applied by a first and a second stretching rolls 34 and 36, respectively, a second step of stretching treatment is applied by a second and a third stretching rolls 36 and 38, respectively, and relaxing treatment is applied by a third and a fourth stretching rolls 38 and 40, respectively. The overall ratio as the draw ratio is 6 by the first and the second stretching treatments.

[0055] Alkali denier reducing treatment is next applied to the fiber after

stretching treatment. More concretely, as shown in Fig. 9, the treating liquid of such alkali solution as sodium hydroxide aqueous solution with an accelerator mixed in for acceleration of hydrolysis is stored in a liquid storing part 46, a part of the fiber 100 hooked on to a rotating cylinder 47 is soaked, and at the same time, the treating liquid is emitted from a jet orifice of a rotating cylinder 47 and a shower part 48 to the unsoaked part of the fiber 100. Thus, the treating liquid stained to the surface of the fiber 100 flows vertically downward by its own weight along the axis direction of the fiber on the surface that is, along the length direction, and etching treatment is applied along this flow direction. Thereby, the fiber 100 becomes thin by its alkali denier reducing treatment, and fine pores are formed along the axis direction on the fiber surface. In this case, the treating liquid is preferably heated to the pre-determined temperature to accelerate hydrolysis. Then alkali stained to the fiber is neutralized, washing-treated, and artificial hair can be obtained.

[0056] As the polyester synthetic resin fiber of polyethylene terephthalate and coloring pigments as components obtain cross-sectional size and bending rigidity similar to those of natural hair by adjusting such spinning conditions as a nozzle diameter of an outlet 32A and the temperature of a quenching bath 33, speeds of the first to the fourth stretching rolls, such stretching conditions as temperature of the first to the third dry stretching baths, and further alkali denier reducing conditions, artificial hair of bending rigidity similar to that of natural hair can be obtained. For example, by spin rollup speed 27.9 m/min, and the final rollup speed 155 m/min, artificial hair of bending rigidity 6.5 X 10^{-3} gf · cm^2/strand can be obtained.

[0057] Explanation is next made of a method of manufacturing artificial hair with polyethylene terephthalate and polybutylene terephthalate as its components, and containing coloring pigments.

In the manufacturing apparatus 30 shown in Fig. 8, polyethylene terephthalate pellets, polybutylene terephthalate pellets, and coloring resin pellets with polyethylene terephthalate as a base material and containing a coloring pigment are mixed in the pre-determined ratio and fed into a feed material tank 31. The mixing ratio of the coloring resin

pellets to the total pellets of polyethylene terephthalate and polybutylene terephthalate is the mass ratio 40:60 as maximum for the total pellets of polyethylene terephthalate and polybutylene terephthalate: the coloring resin pellets. The temperature of a quenching bath is preferably around 40℃.

[0058] Like the method of manufacturing artificial hair of only polyethylene terephthalate and the coloring pigments as its components, the pellets in the feed material tank 31 are fed into a melt extruder 32, the melt liquid 31A formed by kneading the pellets in the melt extruder 32 is discharged from an outlet 32A, and the fiber-like melt is solidified by a quenching bath 33. To the solidified fiber members, like the above-mentioned case, a first step of stretching treatment, a second step of stretching treatment, and a relaxing treatment are applied, and alkali denier reducing treatment is applied thereafter. Then, alkali stained to the fiber is neutralized, washing-treated, and artificial hair can be obtained.

[0059] By adjusting the mixing ratio of polyethylene terephthalate pellets and polybutylene terephthalate pellets, artificial hair having bending rigidity similar to that of natural hair can be obtained. The mass ratio of polyethylene terephthalate and polybutylene terephthalate is preferably in the range of 15:85 to 25:75, and more preferably 20:80. If the mass ratio is lower than 15:85, bending rigidity is too high, and if the mass ratio exceeds 25:75, bending rigidity is too low. When the artificial hair out of the above-mentioned range is used for a wig, said artificial hair and the wig wearer's natural hair show undesirably different behavior. By adjusting such spinning conditions as a nozzle diameter of an outlet 32A and the temperature of a quenching bath 33, speeds of the first to the fourth stretching rolls, such stretching conditions as temperature of the first to the third dry stretching baths, and further alkali denier reducing conditions, artificial hair having optimal bending rigidity can be obtained.

[0060] Explanation is next made of a method of manufacturing the second artificial hair 5, 6 constituting an artificial hair bundle of the present invention.

Fig. 10 is a diagrammatical view illustrating a manufacturing apparatus 50 used for manufacturing the second artificial hair 5, 6, and Fig. 11 is a diagrammatical cross-sectional view illustrating a discharging part used for the manufacturing apparatus of Fig. 10. As shown in Fig. 10, a manufacturing apparatus 50 comprises a first feed material tank 51 of a polyamide resin for the sheath portion 5A, a second feed material tank 52 of a polyamide resin for the core portion 5B, melt extruders 51D, 52D to melt and knead the feed material supplied from said feed material tanks 51, 52, a quenching bath 54 to solidify the fiber-like melt discharged from an outlet 53C of the discharge part 53 with melt liquid 51A, 52A kneaded by melt extruders 51D, 52D, and to form a concave and convex portion on the surface, and thereafter via three step stretching thermal treatment processing parts with each step comprising stretching rolls 55, 57, and 59, and dry stretching baths 56, 58, and 60, a blast machine 63 for forming further the concave and convex portion 5C on the fiber surface, and a rollup machine 64 to roll up the artificial hair deglossed to the desired extent with the blast machine 63.

[0061] The melt extruders 51D, 52D are provided with a heating device to melt polyamide resin pellets, a kneader to disperse and mix to uniformity, and gear pumps 51B, 52B to supply the melts 51A, 52A to the discharge part 53.

[0062] The fiber from the outlet 53C of the discharge part 53 goes, as shown in the figure, via a quenching bath, stretching, and dry stretching mechanisms, through an oiling device 61 for electrostatic prevention, a stretching roll 62 to relax the tension applied on the artificial hair to stabilize dimension, a blast machine 63 for surface processing, and to a rollup machine 64.

[0063] As shown in Fig. 11, the discharge part 53 is provided with a concentric circular double outlet from the inner circle part 53B of which is discharged semi-aromatic polyamide resin melt 52A, and from the outer ring part 53A surrounding said inner circle part 53B is discharged linear saturated aliphatic polyamide resin melt 51A, respectively.

[0064] Explanation is next made of a method of manufacturing the second artificial hair 5, 6 with said manufacturing apparatus 50.

Using said manufacturing apparatus 50, artificial hair 5, 6 can be manufactured by melting each polyamide at appropriate temperature in melt extruders 51D, 52D, feeding the melts to the discharge part 53, and by discharging from an outlet 53C semi-aromatic polyamide resin melt 52A from the inner circle part 53B of the outlet and linear saturated aliphatic polyamide resin melt 51A from the outer ring part 53A to make fiber of sheath/core structure.

[0065] In this case, the ratio of the volume of the linear saturated aliphatic polyamide resin melt 51A fed for a certain time with the gear pump 51B and the volume of semi-aromatic polyamide resin melt 52A fed with the gear pump 52B is defined as sheath/core volume ratio in the present invention. In order to approximate the bending rigidity of the artificial hair 5 to that of natural hair, the weight ratio of sheath and core, the sheath/core weight ratio, is preferably in the range of 10/90 – 35/65. As the manufacturing condition to obtain said weight ratio of sheath and core, the sheath/core volume ratio is preferably 1/2 – 1/7, and this range is preferred for such properties as bending rigidity of artificial hair 5, 6. If said sheath/core volume ratio is higher than 1/2, that is, the ratio of the sheath portion 5A is large, the core portion 5B of artificial hair 5, 6 has small effect to contribute the increase of bending rigidity. On the other hand, if said sheath/core volume ratio is lower than 1/7, that is, the ratio of the core portion 5B is large, it is not preferred, for the bending rigidity becomes too high to be close to that of natural hair.

[0066] The stretching ratio may be 5 – 6 times upon spinning of the artificial hair 5, 6. Said stretching ratio is about twice as high as that for the conventional artificial hair of nylon 6 only. For the second artificial hair 5, 6, such as stretching ratio upon spinning, fiber diameter, and bending rigidity can be properly determined in accordance with the desired design. In this case, the shape of sheath/core of artificial hair 5, 6 can be made nearly concentric circular by properly controlling spinning conditions.

[0067] In the spinning for the artificial hair, the artificial hair 6 can be manufactured by generating and growing spherulite for the concave and convex portion 5C on the surface of linear saturated aliphatic polyamide

resin as the sheath portion 5A by passing the fiber drawn from the outlet 53C through the water at 80℃ or higher in the quenching bath 54, thereby giving appearance similar to the natural hair, and deglossing to erase unnatural gloss.

[0068] As methods to form the fine concave and convex portion 5C on the fiber surface, any one of the methods of blasting with such fine particles as sand, ice, and dry-ice to the fiber surface after spinning, or of chemical treatment of the fiber surface, or proper combination of them may be adopted, in addition to the above-mentioned spherulite formation and growth.

[0069] In order to give the proper color and appearance as the artificial hair 5, 6, a pigment and/or dye may be formulated during spinning, or the artificial hair 5, 6 itself may be dyed after spinning.

[0070] As described above, since the second artificial hair 5, 6 has the sheath/core structure with polyamide resins of different bending rigidities, the artificial hair 5, 6 of the bending rigidity higher than that of the conventional artificial hair of linear saturated aliphatic polyamide resin only can be manufactured with good reproducibility. Also, by forming the fine concave and convex portion 5C on the surface of the artificial hair 5, the natural gloss similar to natural hair can be given, thereby so can the natural appearance as hair.

Examples

[Example 1]

[0071] Explanation is next made in detail of examples of the present invention.

Using the spinning machine 30 shown in Fig. 8, artificial hair with polyethylene terephthalate as its component was manufactured. As the feed material for artificial hair, polyethylene terephthalate pellets (TOYOBO, LTD., density 1.40 g/cm^3, melting point 255℃) and coloring resin pellets with polyethylene terephthalate resin as a base material and pigment weight % of black, yellow, orange, and red are 6%, 6%, 5% and 5%, respectively, were used.

[0072] The spinning conditions are such that melting temperature of

pellets is 270℃ as discharging temperature from the outlet, and a nozzle with 15 holes of diameter 0.7 mm was provided to the outlet. Temperature of the quenching bath 33 was set at 40℃.

[0073] For spinning conditions, the cross-sectional average diameter of artificial hair after alkali denier reducing treatment was made 65 μm by adjusting the speeds of the first to the fourth stretching rolls 34 to 40, respectively. That is, the speed of the second stretching roll 36 was set as 4.6 times that of the first stretching roll 34, the speed of the third stretching roll 38 was set as 1.3 times that of the second stretching roll 36, and the speed of the fourth stretching roll 40 was set as 0.93 times that of the third stretching roll 38. Also, temperature of the first dry stretching bath 35 was set at 130 ℃ as the first stretching temperature, temperature of the second dry stretching bath 37 was set at 180℃ as the second stretching temperature, and temperature of the third dry stretching bath 39 was set at 180 ℃ as the relaxing stretching temperature.

[0074] As the alkali denier reducing condition, an alkali aqueous solution was used wherein cathiosol (Takamatsu Oil and Fat, Ltd.) was added to 0.5 weight % as a hydrolysis accelerator to 5 weight % sodium hydroxide aqueous solution. Also, the bath ratio was set as the mass ratio of the treated matter : treating solution = 1:30, the treating temperature about 100℃, and the treating time was set as 60 minutes so as to attain alkali denier reducing ratio as 10 to 20 %.

[0075] Table 1 shows physical properties of artificial hair with and without alkali denier reducing treatment.

[Table 1]

Alkali Weight Reducing Treatment	Fiber Dia. (μm)	Strength (kgf/mm^2)	Stretch (%)
before	75.1	84.7	19.6
after	66.1	63.4	12.2

[0076] As is seen from Table 1, the diameter of artificial hair was reduced from 75.1 μm to 66.1 μm by alkali denier reducing treatment. The strength was decreased from 84.7 kgf/mm^2 to 63.4 kgf/mm^2. The elongation ratio was decreased from 19.6 % to 12.2 %.

[0077] Fig. 12 is a view showing a scanning electron microscopic image of

the artificial hair manufactured in Example 1. The acceleration voltage of electrons is 15 kV, and the magnification is 800. As is seen from Fig. 12, fine pores were seen to be formed in the direction perpendicular to the length direction of artificial hair on its surface, that is, long in the axis direction of a fiber. Said fine pores can cause the light to attain deglossing effect. The cross-sectional size of artificial hair turned out to be about 65 μm as the average diameter.

[Example 2]

[0078] Artificial hair of the cross-sectional size 50 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[Example 3]

[0079] Artificial hair of the cross-sectional size 55 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[Example 4]

[0080] Artificial hair of the cross-sectional size 60 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[Example 5]

[0081] Artificial hair of the cross-sectional size 70 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[0082] Comparative Examples 1 to 3 are shown next in contrast to Examples 1 to 5.

(Comparative Example 1)

Artificial hair of the cross-sectional size 45 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[0083]

(Comparative Example 2)

Artificial hair of the cross-sectional size 75 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[0084]

(Comparative Example 3)

Artificial hair of the cross-sectional size 80 μm as the average diameter was manufactured as in Example 1 but with the stretching condition changed.

[0085] The results of bending rigidities of artificial hairs manufactured in Examples 1 to 5 and Comparative Examples 1 to 3 are shown next. The measurement of bending rigidities was performed in the environment of temperature 20℃ and humidity 40 %.

As the measurement of bending rigidity of a fiber, KAWABATA method of measurement and its principle are widely known for textile, and its improved version Single Hair Bending Tester (KATOTECH, LTD., Model KES-FB2-SH) was used to measure bending rigidity of artificial hair. As the method of measurement for any case of artificial and natural hair as a sample in Examples and Comparative Examples of the present invention, each one strand of 1 cm was bent at equal speed in an arc shape to a certain curvature, the small bend moment accompanying it was detected, and the relationship of the bend moment and the curvature was measured. Bending rigidity was obtained therefrom by bend moment/curvature change. Typical measurement conditions are shown below.

(Measurement Conditions)

Distance between Chucks: 1 cm

Torque Detector: Detection of Torque of Tortion Wire (Steel Wire)

Torque Sensitivity: 1.0 gf·cm (at Full Scale 10V)

Curvature: $\pm 2.5\ cm^{-1}$

Rate of Bend Deviation: $0.5\ cm^{-1}/sec$

Measurement Cycle: 1 Round Trip.

Here, a chuck is a mechanism for clipping said each hair of 1 cm.

[0086] Table 2 shows measurement results of bending rigidities of

artificial hairs manufactured in Examples 1 to 5 and Comparative Examples 1 to 3. Fig. 13 is a graph showing the relationship of bending rigidity with regard to the cross-sectional diameter of artificial hair manufactured in Examples 1 to 5 and Comparative Examples 1 to 3. The ordinate axis of the figure represents bending rigidity (gf·cm²/strand), and the abscissa axis represents the cross-sectional diameter of artificial hair (μm).

[Table 2]

	Cross-sectional Average Diameter (μm)	Bending Rigidity $\times 10^{-3}$ (gf·cm²/strand)
Example 1	65	7.44
Example 2	50	6.7
Example 3	55	6.86
Example 4	60	7.12
Example 5	70	7.67
Comp.Ex.1	45	6.37
Comp.Ex.2	75	8.06
Comp.Ex.3	80	8.35

[0087] As is seen from Table 2 and Fig. 13, bending rigidity increased linearly for the artificial hair of polyethylene terephthalate as its main component as its cross-sectional size increases. That is, as the average diameter increased as 45, 50, 55, 60, 65, 70, 75 and 80 μm, bending rigidity increased, respectively, 6.37 X 10^{-3}, 6.70 X 10^{-3}, 6.86 X 10^{-3}, 7.12 X 10^{-3}, 7.44 X 10^{-3}, 7.67 X 10^{-3}, 8.06 X 10^{-3} and 8.35 X 10^{-3} gf·cm². Since bend rigidities of natural hairs have wide personal deviation, hairs were collected from 25 males and 38 females of respective ages between 20 and 50 years old, bending rigidities of the samples of 80 μm diameter were measured in the same measurement environment, that is, in the environment of temperature 20℃ and humidity 40 %. Their maximum value was 7.4 X 10^{-3} gf·cm²/strand, their minimum value was 6.6 X 10^{-3} gf·cm²/strand, and their average was 7.1 X 10^{-3} gf·cm²/strand. From this result, it is similar to that of natural hair within the range of about 6.5 X $10^{-3}$to 7.8 X 10^{-3} gf·cm²/strand in the environment of temperature 20℃ and humidity 40 %. Judging from these results, the artificial hairs

manufactured in Examples 1 to 5 have bending rigidities similar to that of natural hair, but those manufactured in Comparative Examples 1 to 3 have bending rigidities out of the range of natural hair. From the above, it is seen that, in order for artificial hair of polyethylene terephthalate as its component to have bending rigidity similar to that of natural hair, its size may be 50 to 70 μ m. Also, it was confirmed by a scanning electron microscopic images that fine pores were formed, as in Example 1, to artificial hair manufactured in Examples 2 to 5 and Comparative Examples 1 to 3.

[Example 6]

[0088] Polyester artificial hair 2 was manufactured using a manufacturing apparatus 30 shown in Fig. 8. As the material of artificial hair, polyethylene terephthalate pellets (TOYOBO, LTD., density 1.40 g/cm^3, melting point255 ℃), polybutylene terephthalate pellets (Mitsubishi Engineering Plastics, LTD., density 1.31 g/cm^3, melting point 224℃), and coloring resin pellets of black, yellow, orange, and red pigment weight % being 6:6:5:5, respectively and with polyethylene terephthalate resin base were used. The mixing ratio of polybutylene terephthalate pellets to polyethylene terephthalate pellets was varied as 0 to 75 % by mass ratio, and seven kinds of artificial hair were manufactured. The conditions such as spinning, stretching, and alkali denier reducing treatment are same as in Example 1.

[0089] Table 3 shows bending rigidity of artificial hair manufactured in Example 4, and shows the values before and after alkali denier reducing treatment with polybutylene terephthalate mixing ratio as a parameter. Fig. 14 is a graph converted from Table 3, showing bending rigidity with regard to the mixing ratio of polybutylene terephthalate mass. The ordinate axis represents bending rigidity (gf・cm^2/strand), and the abscissa axis represents the mixing ratio of polybutylene terephthalate to the whole pellets by mass, PBT/(PET + PBT) (%). Of the plots, ◆(diamond) is values before, and ■(square) is values after alkali denier reducing treatment. The measurement conditions were temperature 22℃ and humidity 40 %.

[Table 3]

PBT Mixing Ratio %	Bending Rigidity $\times 10^{-3}$ gf·cm^2/strand	
	before Alkali Weight Reducing treatment	after Alkali Weight Reducing treatment
0	19. 79	11. 66
10	18. 07	9. 70
20	16. 35	8. 32
30	14. 64	7. 68
50	11. 10	6. 40
60	9. 88	5. 75
75	6. 79	4. 78

[0090] As is seen from Table 3 and Fig. 14, when the ratio of polybutylene terephthalate was increased as the artificial hair component, bending rigidity decreased both before and after alkali denier reducing. Before alkali denier reducing treatment, bending rigidity was about 1.6 X 10^{-2} gfcm^2/strand for mixing ratio 20 %, whereas it decreases monotonously to about 6.7 X 10^{-3} gf·cm^2/strand when mixing ratio was increased to 75 %. Also, after alkali denier reducing treatment, bending rigidity was about 1.2 X 10^{-2} gf·cm^2/strand for mixing ratio 0 %, whereas it decreases monotonously to about 8.3 X 10^{-3} gf·cm^2/strand when mixing ratio was increased to 20 %, and about 5.7 X 10^{-3} gf·cm^2/strand for mixing ratio 60 %.

[0091] The cross-sectional diameter of seven kinds of artificial hair of different mixing ratio of polybutylene terephthalate was 81.3 μm as an average before alkali denier reducing treatment, and 71.1 μm as an average after alkali denier reducing treatment.

[0092] From the results above, bending rigidity of artificial hair can be lowered by increasing mixing ratio of polybutylene terephthalate, and artificial hair of bending rigidity similar to that of natural hair (6.5 to 7.8 X 10^{-3} gf·cm^2/strand) can be obtained. For example, in case without alkali denier reducing treatment, mixing ratio of polybutylene terephthalate may be about 70 to 80 %, and in case with alkali denier reducing

treatment, mixing ratio of polybutylene terephthalate may be about 20 to 60 %.

[0093] Fig. 15 is a graph showing the bending rigidity before and after the alkali denier reducing treatment in case of 20% and 60% of the mixing ratio of polybutylene terephthalate. The ordinate axis represents bending rigidity (gf·cm^2/strand), and the abscissa axis represents mixing ratio of polybutylene terephthalate. As is seen from Fig. 15, bending rigidity was about 1.6 X 10^{-2} gf·cm^2/strand for mixing ratio 20 %, and was decreased to about 8.3 X 10^{-3} gf·cm^2/strand by alkali denier reducing treatment. The cross-sectional diameter of artificial hairs of mixing ratio 20 % and 60 % of polybutylene terephthalate was 80.4 μm as an average before alkali denier reducing treatment, and 71.1 μm as an average after alkali denier reducing treatment.

[0094] It is seen from the above that alkali denier reducing treatment is effective in a method of manufacturing artificial hair made of polyester synthetic resins for reducing the cross-sectional diameter of artificial hair, or for reducing bending rigidity similar to natural hair.

[Example 7]

[0095] As in Example 1, thermal treatment was applied to artificial hair made of polyester fiber after alkali denier reducing treatment having bending rigidity about 6.5 X 10^{-3} gf·cm^2/strand and the diameter about 66 μm. Said thermal treatment is a mock test of curling process, and was conducted as holding artificial hair rolled on a pipe of a diameter 30 mm in the environment of 180℃ for 2 hours. The shrinkage ratio of artificial hair after thermal treatment was measured as 0.77 %.

[Example 8]

[0096] As in Example 1, the same thermal treatment as in example 7 was applied to artificial hair made of polyester fiber without alkali denier reducing treatment unlike Example 7 having bending rigidity about 1.2 X 10^{-2} gfcm^2/strand and the diameter about 75 μm. The shrinkage ratio of artificial hair after thermal treatment was measured as 1.55 %.

[0097] Comparison of Examples 7 and 8 revealed that thermal shrinkage

ratio by thermal treatment was lowered to half by alkali denier reducing treatment.

[Example 9]

[0098] Next, thermal treatment was preliminarily applied to the second artificial hair of an artificial hair bundle, and the influence was confirmed with and without preliminary treatment on the second artificial hair as a mock test of curling process by mixing with the first artificial hair.

[0099] A first thermal treatment was applied to artificial hair having a sheath/core structure and bending rigidity 3.9 to 7,8 X 10^{-3} gfcm^2/strand, and a second thermal treatment was applied thereafter. A core portion of artificial hair was made of nylon MXD6 (Mitsubishi Gas Chemical Co., Ltd., Trade name MX nylon) as a polyamide resin, and a sheath was made of a copolymer of nylon 6 and nylon 66 (NY6/NY66) and nylon 6 (NY6) containing coloring materials. The first thermal treatment corresponds to a pre-treatment, as holding artificial hair in the stretched state without rolling on a pipe in the environment of 160℃ for 30 minutes. The second thermal treatment was a curling process corresponding to a main treatment, like thermal treatment in Examples 3 and 4, as holding artificial hair rolled on a pipe of a diameter 30 mm in the environment of 180℃ for 2 hours.

[0100]

(Comparative Example 4)

Comparative Example 4 is shown next in contrast to Example 9. In Comparative Example 4, the first thermal treatment was not applied but the second thermal treatment to the same artificial hair as in Example 9 was applied.

[0101] Explanation will be made of the results of Example 9 and Comparative Example 4. Table 4 shows the results of Example 9 and Comparative Example 4, showing thermal shrinkage ratio of respective artificial hair, the values after the first thermal treatment and the values after the first and the second thermal treatments as the result of Example 9, and the values after the second thermal treatment only as the result of Comparative Example 4. Fig. 16 is a graph of Table 4, showing thermal

shrinkage ratio with regard to bending rigidity of each artificial hair. The ordinate axis represents thermal shrinkage ratio (%), and the abscissa represents bending rigidity (gf·cm²/strand). Here, the plot ◆(diamond) represents bending rigidity after the first thermal treatment, the plot ■ (square) represents bending rigidity after the first and the second thermal treatments, and the plot ▲(triangle) represents bending rigidity after the second thermal treatment only as the result of Comparative Example 4.

[Table 4]

Bending Rigidity $\times 10^{-3}$ (gf·cm²/strand)	Thermal Contraction Ratio (%)		
	Example 9		Comp. Ex. 4
	after First Thermal Treatment	after Second Thermal Treatment	Second Thermal Treaatment Only
3. 90	3. 11	0. 17	1. 12
5. 20	3. 54	0. 53	1. 03
6. 50	3. 63	0. 08	1. 12
7. 80	4. 58	0. 18	1. 38

[0102] As is seen from Table 4 and Fig. 16, artificial hair shrinks thermally by the first, or the second, or both thermal treatment. As a result of Example 9, that is, the higher the bending rigidity, the higher is the thermal shrinkage ratio by the first thermal treatment, and it is about 3 % for the artificial hair of bending rigidity about 3.9 X 10^{-3} gf·cm²/strand, but about 4.6 % for the artificial hair of bending rigidity about 7.8 X 10^{-3} gf·cm²/strand. The thermal shrinkage ratio by the first and the second thermal treatment is less than 1 % regardless of the value of bending rigidity, and in the range of 0.53 to 0.08 %. On the other hand, as a result of Comparative Example 4, that is, if only the second thermal treatment is applied, the thermal shrinkage ratio does not depend upon the value of bending rigidity, and is about 1 to 1.4 %.

[0103] Comparison is made between Examples 7 and 9 and Comparative Example 4. Since, according to the result of Example 7, the thermal shrinkage ratio of polyester artificial hair as the first artificial hair is 0.77 %, and according to the result of Comparative Example 4, the thermal shrinkage ratio of polyamide artificial hair as the second artificial hair is higher than 1 %, the second artificial hair shrinks more

than the first artificial hair. Thus, if this treatment is applied by mixing polyester artificial hair used in Example 7 and polyamide artificial hair used in Comparative Example 4, the polyester artificial hair neighboring the polyamide artificial hair tends to shrink similarly to the polyamide artificial hair. However, if the pre-treatment is not applied to the polyamide artificial hair and this treatment is applied by mixing polyester artificial hair, then the polyester artificial hair of lower shrinkage than the polyamide artificial hair can not shrink similarly to the polyamide artificial hair. As a result, undesired wavy steps are caused to an artificial hair bundle.

[0104] On the other hand, according to the result of Example 9, the thermal shrinkage ratio of polyamide artificial hair as the second artificial hair is less than 0.5 %, and according to the result of Example 7, the thermal shrinkage ratio of polyester artificial hair as the first artificial hair is 0.77 %, and hence the difference of both is small. Thus, by pre-treatment to the polyamide artificial hair as the second artificial hair to cause thermal shrinkage, curling treatment by mixing with the polyester artificial hair as the first artificial hair causes similar shrinkage to the first and the second artificial hairs, and hence wavy steps do not occur.

[0105] From the above, in case of making up an artificial hair bundle of the present invention, wavy steps can be prevented from occurring in the first artificial hair upon curling treatment to the artificial hair bundle by applying in advance thermal treatment to the polyamide fiber as the second artificial hair to make it similar to or lower than the first artificial hair.

[0106] As described above, according to the present invention, artificial hair having similar feeling to that of natural hair can be provided by melt-spinning with polyethylene terephthalate as a main component, applying stretching and alkali denier reducing treatments so as to have similar cross-sectional size to that of natural hair, and making artificial hair by melt-spinning with polyethylene terephthalate and polybutylene terephthalate in the pre-determined mass ratio so as to have similar size and bending rigidity to those of natural hair. The artificial hair made of

polyester fiber does not bundle by itself, can prevent bundling of the artificial hair made of polyamide fiber, thereby can attain similar bending rigidity to that of natural hair. Further, by making the artificial hair made of polyester fiber the first artificial hair, and by mixing it into the second artificial hair made of polyamide fiber and having similar size and bending rigidity to those of natural hair in the pre-determined ratio, bundling of the second artificial hair can be suppressed. Therefore, in a wig with these artificial hairs attached to the wig base, when set to the hairstyle according to the wig wearer's preference, the second artificial hair does not bundle, and the bending rigidities of the first and the second artificial hairs can be approximated to that of natural hair, thereby it behaves similarly to natural hair having natural feeling.

[0107] The best mode for carrying out the present invention explained above may be variously modified within the appropriate range of the claimed invention.

CLAIMS

1. An artificial hair bundle, characterized in that:

it is made up to a bundle by dispersing a first artificial hair made of a polyester resin in a second artificial hair made of a polyamide resin in the pre-determined ratio,

said polyester resin includes polyethylene terephthalate, and

said second artificial hair has a sheath/core structure comprising a core portion and a sheath portion covering said core portion, said core portion is made of a semi-aromatic polyamide resin, said sheath portion is made of a linear saturated aliphatic polyamide resin, and a sheath/core weight ratio is in a range of 10/90 – 35/65.

2. An artificial hair bundle, characterized in that:

it is made up to a bundle by dispersing a first artificial hair made of a polyester resin in a second artificial hair made of a polyamide resin in the pre-determined ratio,

said polyester resin includes polyethylene terephthalate and polybutylene terephthalate, and

said second artificial hair has a sheath/core structure comprising a core portion and a sheath portion covering said core portion, said core portion is made of a semi-aromatic polyamide resin, said sheath portion is made of a linear saturated aliphatic polyamide resin, and a sheath/core weight ratio is in a range of 10/90 – 35/65.

3. The artificial hair bundle as set forth in Claim 1 or 2, characterized in that:

said second artificial hair has a cross-sectional size and bending rigidity similar to those of natural hair.

4. The artificial hair bundle as set forth in Claim 1 or 2, characterized in that:

said first artificial hair and said second artificial hair have a bending rigidity which is in a range of 6.5 to 7.8 X 10^{-3} gfcm^2/strand at 40% humidity.

5. The artificial hair bundle as set forth in Claim 1 or 2, characterized in that:

the cross-sectional size perpendicular to the length direction of said first artificial hair is in a range of 50 to 70 μm as an average diameter.

6. The artificial hair bundle as set forth in claim 1 or claim 2, characterized in that:

said semi-aromatic polyamide resin is either Nylon 6T or Nylon MXD6.

7. The artificial hair bundle as set forth in claim 1 or claim 2, characterized in that:

said linear saturated aliphatic polyamide resin is either Nylon 6 or Nylon 66.

8. A wig comprising a wig base and artificial hair attached to said wig base, characterized in that:

a first artificial hair made of a polyester resin and a second artificial hair made of a polyamide resin are used as said artificial hair, said polyester resin includes polyethylene terephthalate,

said second artificial hair has a sheath/core structure comprising a core portion and a sheath portion covering said core portion, said core portion is made of a semi-aromatic polyamide resin, said sheath portion is made of a linear saturated aliphatic polyamide resin, and a sheath/core weight ratio is in a range of 10/90 – 35/65, and

said first artificial hair and said second artificial hair have a bending rigidity similar to that of natural hair.

9. A wig comprising a wig base and artificial hair attached to said wig base, characterized in that:

a first artificial hair made of a polyester resin and a second artificial hair made of a polyamide resin are used as said artificial hair,

said polyester resin includes polyethylene terephthalate and polybutylene terephthalate,

said second artificial hair has a sheath/core structure comprising a core portion and a sheath portion covering said core portion, said core portion is made of a semi-aromatic polyamide resin, said sheath portion is made of a linear saturated aliphatic polyamide resin, and a sheath/core weight ratio is in a range of 10/90 – 35/65, and

said first artificial hair and said second artificial hair have a bending rigidity similar to that of natural hair.

10. The wig as set forth in Claim 8 or Claim 9, characterized in that:

said semi-aromatic polyamide resin is either Nylon 6T or Nylon MXD6.

11. The wig as set forth in Claim 8 or Claim 9, characterized in that:

said linear saturated aliphatic polyamide resin is either Nylon 6 or Nylon 66.