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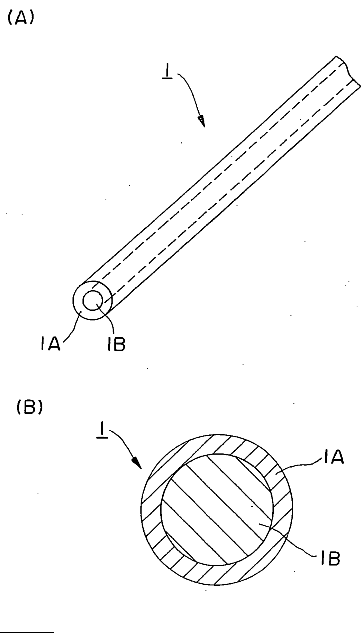
(54) ARTIFICIAL HAIR AND WIG USING THE SAME

(57) An artificial hair and a wig using the same are provided which have such feeling as appearance, tactile and texture and preferable physical properties similar to natural hair, wherein an artificial hair 1 has a sheath and core structure comprising a core portion 1B and a sheath portion 1A covering said core portion 1B, and by making the core portion 1B of a polyamide resin, especially a semi-aromatic polyamide resin, and the sheath portion 1A of a polyamide resin having a rigidity for bending lower than the core portion 1B, especially a linear saturated aliphatic polyamide resin, the rigidity for bending, for example, can be made to have a value close to that of natural hair, and further its variation behavior depending upon humidity can be controlled quite similar to natural hair, thereby the wig made of it as a material has natural feeling, so that the wig having an excellent appearance can be offered.

FIG. 1



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Description

Technical Field

[0001] This invention relates to artificial hair having physical properties and feeling similar to natural hair and a wig using the same.

Background Art

[0002] Wigs have been manufactured and used since ancient age with natural hair as the material, but recently such problems as the supply limitation of natural hair material and others caused the manufacture to increase using synthetic fibers as hair material for wigs. In this case, the synthetic fiber to be used is selected with the primary target that it is basically close to natural hair in terms of feeling and physical properties.

[0003] The artificial hair materials to be used are synthetic fibers of acrylic, polyester, and polyamide in many cases, but acrylic fibers in general have low melting point and poor heat stability, so that they have such weak points as poor shape preservation after permanent wave setting, resulting in distortion of setting, for example, such as curl and the like when soaked in warm water. Polyester fibers excel in strength and heat stability, but have too high rigidity for bending, in addition to extremely low moisture absorbency compared with natural hair, resulting in appearance, feeling, or physical properties different from natural hair, for example, in the environment of high humidity, and they give markedly uncomfortable feeling when used for wigs.

[0004] Here, the rigidity for bending is the property relating to such feeling as tactile and texture of fibers, 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 rigidity for bending using a single strand of fiber or hair (See Non-Patent Reference 2.). Hereinafter rigidity for bending may be called "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 rigidity for bending of artificial hair, the less bendable, the more resistant to bending, that is, the harder and the less bendable is artificial hair. On the other hand, the smaller the rigidity for bending, the more bendable and the softer is artificial hair.

[0005] Since polyamide fibers can offer appearance and physical properties similar to natural hair in many aspects, they have so far been in practical use as the hair for wigs, and especially, the invention by the present applicant of the method of manufacture which can remove unnatural gloss by surface processing provides excellent wigs (See Patent Reference 1.).

[0006] Polyamide fibers include linear saturated aliphatic polyamides in which only methylene chains are connected with amide bonds as a main chain, for example, such as nylon 6 and nylon 66, and semi-aromatic polyamides in which phenylene units are included in the main chain, for example, such as nylon 6T of TOYOBO, LTD. and MXD6 of MITSUBISHI GAS CHEMICAL COMPANY, INC.. Patent Reference 1 discloses surface-processed artificial hair of nylon 6 fiber as the material, but only nylon 6 fiber has the rigidity for bending lower than natural hair as the property relating to such feeling as tactile and texture, and hence it is difficult to manufacture the artificial hair of the same property as natural hair.

[0007] On the other hand, the artificial hair using nylon 6T has the rigidity for bending higher than the natural hair, and hence it is difficult to manufacture the hair of the same property as natural hair. Therefore, it might be considered to manufacture the fiber having the rigidity for bending close to natural hair by melt-spinning of nylon 6 and nylon 6T, but these two resins have too different melting points, and if melting temperature is determined fitting to nylon 6T of higher melting point, then there is too serious a problem in the manufacturing process that nylon 6 having low melting point and relatively poor heat stability is deteriorated by thermal oxidation during melting. Consequently, nylon 6T has not so far been in practical use as an artificial hair material.

[0008] The fiber of sheath/core structure is known as a method to utilize both properties of two kinds of resins. Said fiber comprises as one strand of fiber a core fiber and a sheath fiber surrounding it, and can be a generic fiber, or artificial hair material for wigs, by utilizing respective properties of different two kinds of resins. For example, Patent Reference 2 discloses the fiber of sheath/core structure made of vinylidene chloride, polypropylene, and others, and Patent Reference 3 discloses a polyamide, but modified fiber by blending protein bridged gel into the core part.

[0009] Further, in order to prevent the transparency of ordinary synthetic fibers to cause unnatural gloss when used as artificial hair, various attempts have been tried to give the appearance and feeling close to natural hair by making uneven surface to cause opacity. The above-mentioned Patent Reference 1 discloses the method of making uneven surface by causing spherocrystal to be generated and grow, and Patent Reference 4 by treating the fiber surface with chemical reagents. In addition, also known is the method of blast-treating of the artificial hair surface with fine powders such as sand, ice, and dry-ice.

[0010]

[Patent Reference 1] JP S64-6114 A (1989)
[Patent Reference 2] JP 2002-129432 A (2002)
[Patent Reference 3] JP 2005-9049 A (2005)
[Patent Reference 4] JP 2002-161423 A (2002)
[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] Artificial hair to be used for wigs is required primarily to have feeling (appearance, tactile and texture) and physical properties close to natural hair, and in addition, ideally speaking, the physical properties superior to natural hair. As mentioned above, various synthetic fiber materials have their own merits and weak points, respectively, and among them, specific polyamide fibers, especially nylon 6 and nylon 66, are in practical use because of their superior properties, but they still have a problem of having rigidity for bending lower than natural hair.

[0012] An object of the present invention is, in view of the above-mentioned problems, to provide an artificial hair having feeling (appearance, tactile and texture) and physical properties close to natural hair, and a wig using it.

Means to Solve Problems

[0013] The present inventors have completed the present invention, as the result of strenuous study, by utilizing the characteristics of polyamide fibers to make a core portion with a polyamide fiber of high rigidity for bending, and a sheath portion with a polyamide fiber of the rigidity for bending lower than the core portion, and by attaining the knowledge that the sheath/core structure, that is, the structure comprising a core fiber and the sheath fiber surrounding it, can utilize the characteristics of both resins to be optimal as an artificial hair of the feeling (appearance, tactile and texture) and physical properties quite close to natural hair.

[0014] In order to achieve the above-mentioned object, an artificial hair of the present invention is characterized to have a sheath/core structure comprising a core portion and a sheath portion covering the core portion, wherein the core is made of a polyamide resin, and the sheath is made of the polyamide resin of the rigidity for bending lower than the core portion.

In said structure, the surface of the artificial hair is preferably deglossed by having fine concave and convex portions. Fine concave and convex portions may be made by forming spherocrystal and/or a blast processing. The core portion is preferably made of a semi-aromatic polyamide resin, and the sheath portion is made of a linear saturated aliphatic polyamide. A semi-aromatic polyamide resin is preferably an alternating copolymer of hexamethylenediamine and terephthalic acid, or an alternating copolymer of metaxylylenediamine and adipic acid, and a linear saturated aliphatic polyamide is a caprolactam ring-opening polymer, and/or an alternating copolymer of hexamethylenediamine and adipic acid. The sheath/core weight ratio is preferably 10/90 - 35/65. The artificial hair may contain pigment and/or dye.

[0015] The artificial hair of the present invention has a double structure of a core portion and a sheath portion surrounding it, and since they are made of polyamide resins of different rigidities for bending, the artificial hair can be provided which has rigidity for bending quite close to that of natural hair with respect to humidity change. Therefore, since said artificial hair has the rigidity for bending close to that of natural hair, natural aritificial hair can be provided which has such feeling as appearance, tactile and texture quite close to natural hair, thereby its rigidity for bending changes especially by temperature and humidity resulting in the behavior close to human hair.

[0016] A wig of the present invention is characterized in that it comprises a wig base and artificial hair attached or tied to the wig base, such artificial hair as has a sheath/core structure made of a core portion and a sheath portion covering the core, the core portion is made of a polyamide resin, and the sheath portion is made of a polyamide resin of the rigidity for bending lower than the core portion.

By using the artificial hair of the above-mentioned structure for a wig of the present invention, a wig can be provided which shows the behavior quite close to that by the rigidity for bending of natural hair to humidity change. Therefore, since the artificial hair has good hair standing, and its rigidity for bending is close to that of natural hair, a wig of natural appearance, and quite excellent in such feeling as appearance, tactile and texture can be obtained. Consequently, with the artificial hair of the rigidity for bending changing in accordance with temperature and humidity, and showing the behavior closer to human hair than the conventional hair, such appearance is given that of the wearer's own hair naturally growing on the head, and the wearer would not expose the wig wearing.

Effect of the Invention

[0017] According to the present invention, the artificial hair can be provided which has a sheath/core structure, and has feeling (appearance, tactile and texture), various physical properties, especially rigidity for bending and its changing behavior by humidity close to those of natural hair. Further, the wig using the artificial hair having said sheath/core structure can provide natural feeling to the wearer and the surrounding observers more than the conventional wig using artificial hair made of a single synthetic fiber material.

Especially, by making artificial hair of a sheath/core structure with a sheath portion of a polyamide resin with rigidity for bending lower than a core portion, the rigidity for bending changes depending upon temperature and humidity, resulting in the artificial hair showing the behavior closer to human hair, and by said artificial hair of the present invention, even when curl is set, the extension of curl upon wetting with water and recovery of curl upon removing moisture under natural standing can show the behavior similar to natural hair.

Therefore, with the wig of the present invention, when worn in the rain, or under the environment of high humidity, the artificial hair softens, hangs down, and its bulkiness disappears, by the change characteristics of rigidity for bending by moisture absorption of artificial hair, that is, lowering of rigidity for bending with humidity rise, and when the absorbed water is released by natural standing or drying, artificial hair stands up gradually to return to the original state. As a result, since a wig can be obtained which shows the same behavior as if natural hair is growing on a scalp, it can be a wig of excellent appearance, hard to recognize as a wig.

Brief Description of the Drawings

[0018]

Fig. 1 diagrammatically illustrates a structure of an artificial hair in accordance with a first embodiment of the invention, and (A) is a diagonal view, and (B) is a vertical cross sectional view in the length direction of the artificial hair.

Fig. 2 is a cross sectional view in the length direction diagrammatically illustrating the structure of a modified example of the artificial hair of the present invention.

Fig. 3 is a diagrammatical drawing of a spinning machine used for manufacturing the artificial hair of the present invention.

Fig. 4 is a diagrammatical cross sectional view illustrating an outlet used for a spinning machine.

Fig. 5 is a diagonal view diagrammatically illustrating the structure of a wig using artificial hair in accordance with a second embodiment of the invention.

Fig. 6 is an enlarged view diagrammatically illustrating the behavior of the wig of Fig. 5 with respect to humidity change, and (A) shows an ordinary humidity state, and (B) shows a high humidity state.

Fig. 7 is a graph showing the stretching ratio dependency of rigidity for bending of the artificial hair of Example 3.

Fig. 8 is an image of the cross section of artificial hair of Example 2 by an electron microscope.

Fig. 9 is an image of the surface of artificial hair of Example 2 by an electron microscope.

Fig. 10 is an image of the cross section of artificial hair of Example 3 by an electron microscope.

Fig. 11 is a cross sectional image of artificial hair having a sheath/core structure of Comparative Example 3 by an electron microscope.

Fig. 12 is a graph showing the humidity dependency of rigidity for bending of the artificial hairs of Examples 1-5 and Comparative Examples 1 and 2.

Fig. 13 is a graph showing the humidity dependency of rigidity for bending of the artificial hairs of Examples 6 - 10 and Comparative Examples 1, 4, and 5.

Fig. 14 shows photographs of the initial states of curls of (A) the artificial hair of Example of the present invention, (B) the natural hair, and (C) the conventional artificial hair made of polyester.

Fig. 15 shows photographs of the water-soaked states of (A) the artificial hair of Example of the present invention, (B) the natural hair, and (C) the conventional artificial hair made of polyester.

Fig. 16 shows photographs of the dried states after water-soaking of (A) the artificial hair of Example of the present invention, (B) the natural hair, and (C) the conventional artificial hair made of polyester.

[0019]

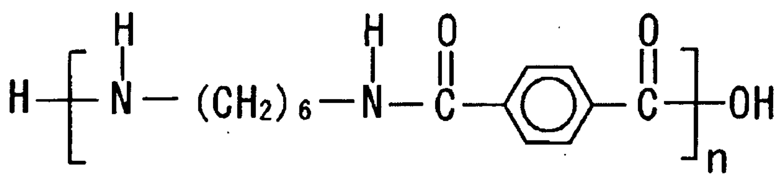
1:	Artificial Hair
1A:	Sheath Portion
1B:	Core Portion
1C:	Fine Concave and Convex Portion
10:	Artificial Hair Having Fine Concave and Convex Portions on Its Surface

21: First Cylinder
22: Second Cylinder
21A, 22A: Resin Melt Composition
21B, 22B: Gear Pump
23: Discharge Part
23A: Outer Ring Outlet
23B: Inner Circle Outlet
23C: Outlet
24: Quenching Bath
25: First Stretching Roll
26: First Dry Stretching Bath
27: Second Stretching Roll
28: Second Dry Stretching Bath
29: Third Stretching Roll
30: Third Dry Stretching Bath
31: Oiling Device
32: Fourth Stretching Roll
33: Blast Machine
34: Rollup Machine
40: Wig Using Artificial Hair
41: Wig Base

Best Modes for Carrying out the Invention

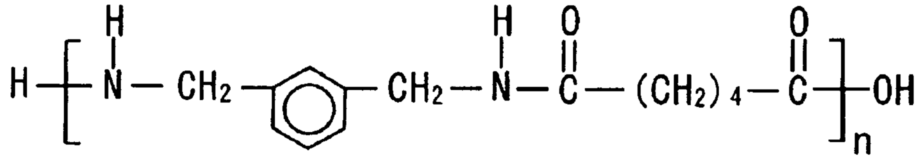
[0020] Hereinafter, the present invention will be explained in details with reference to the embodiments illustrated in the figures.
Explanation is first made of an artificial hair in accordance with the first embodiment of the invention.
Fig. 1 diagrammatically illustrates the structure of an artificial hair in accordance with a first embodiment of the invention, and (A) is a diagonal view, and (B) is a vertical cross sectional view in the length direction of artificial hair. As is illustrated, the artificial hair 1 of the present invention has a sheath/core structure wherein its surface is a sheath portion 1A, and a core portion 1B is inside the sheath portion 1A.
In this 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 1B and sheath 1A have different shapes other than nearly concentric circles, for example, the core is eccentric with regard to the sheath, not being perfectly concentric circles.
It may also be such a sheath/core shape as that the core is nearly a perfect circle while the sheath has varied thickness.
Also, the cross sectional shape of artificial hair 1 may be circular, elliptic, or cocoon-shaped.
[0021] As the polyamide resins for the material of said core portion 1B, semi-aromatic polyamide resins of high strength and rigidity for bending can be properly used. As said semi-aromatic polyamide, such may be mentioned as the polymer consisting of an alternating 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 bonded, Nylon MXD6 for example, expressed in Chemical Formula 2.

[Chemical Formula 1]



(1)

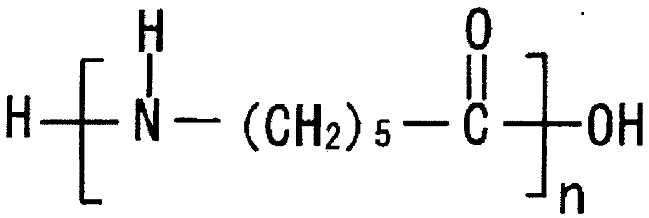
[Chemical Formula 2]



(2)

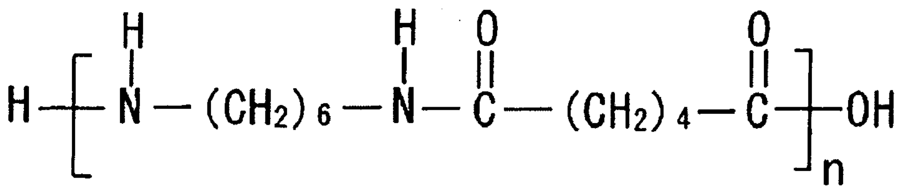
[0022] As the polyamide resins for the material of said sheath portion 1A, polyamide resins of lower rigidity for bending than the core 1B may be used, and a linear saturated aliphatic polyamide, for example, can be properly used. As said linear saturated aliphatic polyamide, such may be mentioned as the polymer consisting of a ring-opening polymer of caprolactam, Nylon 6 for example, expressed in Chemical Formula 3, or the polymer consisting of an alternating copolymer of hexamethylenediamine and adipic acid, Nylon 66 for example, expressed in Chemical Formula 4.

[Chemical Formula 3]



(3)

[Chemical Formula 4]



(4)

[0023] The artificial hair of the present invention 1 has gloss, if the surface of the sheath 1A is smooth. In order to erase this unnatural gloss on the surface of artificial hair 1, so-called deglossing may be applied.

[0024] Fig. 2 is a cross sectional view in the length direction diagrammatically illustrating the structure of a modified example of artificial hair of the present invention. As is illustrated, on the surface of the sheath portion 1A of artificial hair 10, a fine concave and convex portion 1C is formed. In the case that such a fine concave and convex portion 1C is formed, diffuse reflection occurs upon light irradiation to artificial hair 10. Therefore, the gloss no longer occurs due to the reflection from light irradiation on the surface of artificial hair, bringing about so-called deglossing effect.

Here, the fine concave and convex portion 1C can be given by blast processing with fine powder such as sand, ice, dry-ice, and others either during spinning of the artificial hair 1 or on to the fiber after spinning. In the case during spinning of the artificial hair 1, it may be by spherocrystal forming on the outermost surface of artificial hair 1. In this case, it may be the combined processes of spherocrystal forming and blast processing with fine powder such as said sand, ice, dry-ice, and others. The concave and convex portion formed by combination of such spherocrystal formation and blast processing may be formed to be the concave and convex portion 1C larger than the order of visible light wavelength so the light is diffuse reflected.

[0025] The artificial hair 1, 10 of the present invention can be dyed 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 artificial hair after spinning.

[0026] According to the artificial hair 1, 10 of the present invention, by making a sheath/core structure with the polyamide of high rigidity for bending used for the core 1B, and with the polyamide of the rigidity for bending lower than the core 1B used for the sheath 1A, artificial hair can be obtained the rigidity for bending of which is changed by temperature and humidity, and which shows behavior closer to the human hair than the conventional artificial hair. Also, with the artificial hair 10 having the fine concave and convex portion 1C on the surface of the sheath portion 1A, the deglossing effect is attained, and its properties and feeling are more approximated to those of artificial hair.

[0027] Explanation is next made of a method of manufacturing artificial hair in accordance with the present invention. Fig. 3 is a diagrammatical drawing of a spinning machine used for manufacturing the artificial hair of the present invention, and Fig. 4 is a diagrammatical cross sectional view illustrating a discharge part used for a spinning machine. As shown in Fig. 3, a spinning machine 20 comprises a first cylinder 21 of a polyamide resin for the sheath portion 1A, a second cylinder 22 of a polyamide resin for the core portion 1B, a discharge part 23 to discharge the melts 21A, 22A supplied from said cylinders 21, 22, a quenching bath 24 to solidify the melt thread discharged from an outlet 23C of the discharge part 23 and to form a concave and convex portion on the surface, and thereafter via three steps stretching thermal treatment processing parts with each step comprising stretching rolls 25, 27, and 29, and dry stretching baths 26, 28, and 30, a blast machine 33 for forming further the concave and convex portion 1C on the thread surface, and a rollup machine 34 to roll up the artificial hair deglossed to the desired extent with the blast machine 33.

[0028] The cylinders 21, 22 are provided with a heating device to melt polyamide resin pellets, screws for supplying to a kneader and the discharge part 23, and gear pumps 21B, 22B to supply the melts 21A, 22A to the discharge part 23.

[0029] The fiber from the outlet 23C of the discharge part 23 goes, as shown in the figure, via a quenching bath, and stretching and dry stretching mechanisms, through an oiling device 31 for electrostatic prevention, a stretching roll 32 to relax the tension applied on the artificial hair to stabilize dimension, a blast machine 33 for surface processing, and to a rollup machine 34.

[0030] As shown in Fig. 4, the discharge part 23 is provided with a concentric circular double outlet from the inner circle part 23B of which is discharged semi-aromatic polyamide resin melt 22A, and from the outer ring part 23A surrounding said inner circle part 23B is discharged linear saturated aliphatic polyamide resin melt 21A, respectively.

[0031] Explanation is next made of a method of manufacturing the artificial hair with said spinning machine 20. Using said spinning machine 20, artificial hair 1, 10 can be manufactured by melting each polyamide at appropriate temperature in cylinders 21, 22, feeding the melts to the discharge part 23, and by discharging semi-aromatic polyamide resin melt 22A form the inner circle part 23B of the outlet and linear saturated aliphatic polyamide resin melt 21A from the outer ring part 23A to make the thread of sheath/core structure.

[0032] In this case, the ratio of the volume of the linear saturated aliphatic polyamide resin melt 21A fed for a certain time with the gear pump 21B and the volume of semi-aromatic polyamide resin melt 22A fed with the gear pump 22B is defined as sheath/core volume ratio in the present invention. As described below, in order to approximate the rigidity for bending of the artificial hair 10 to that of the 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 rigidity for bending of artificial hair 1, 10 as mentioned below. If said sheath/core volume ratio is higher than 1/2, that is, the ratio of the sheath portion 1A is large, the core portion 1B of artificial hair 1, 10 has small effect to contribute the increase of rigidity for bending. On the other hand, if said sheath/core volume ratio is lower than 1/7, that is, the ratio of the core portion 1B is large, it is not preferred, for the rigidity for bending becomes too high to be close to the natural hair.

[0033] The stretching ratio may be 5 - 6 times upon spinning of the artificial hair 1, 10. Said stretching ratio is about twice as high as that for the conventional artificial hair of nylon 6 only. For the artificial hair 1, 10 of the present invention, such as stretching ratio upon spinning, thread diameter, and rigidity for bending can be properly determined in accordance with the desired design. In this case, the shape of sheath/core of artificial hair 1, 10 can be made nearly concentric circular by properly controlling spinning conditions.

[0034] In the spinning for the artificial hair in accordance with the present invention, the artificial hair 10 can be manufactured by forming spherocrystal for the concave and convex portion 1C on the surface of linear saturated aliphatic polyamide resin as the sheath portion 1A by passing the thread drawn form the outlet 23C through the water at 80°C or higher in the quenching bath 24, thereby giving appearance similar to the natural hair to the thread, and deglossing to erase an unnatural gloss.

[0035] As methods to form the fine concave and convex portion 1C on the thread surface, any one of the methods of blasting with such fine particles as sand, ice, and dry-ice to the thread surface after spinning, or of chemical treatment of the thread surface, or proper combination of them may be adopted, in addition to the above-mentioned spherocrystal formation and growth.

[0036] In order to give the proper color and appearance as the artificial hair 1, 10, the pigment and/or dye may be formulated during spinning, or the artificial hair 1, 10 itself may be dyed after spinning.

[0037] As described above, since the artificial hair 1, 10 of the present invention has the sheath/core structure with polyamide resins of different rigidities for bending, the artificial hair 1, 10 of the rigidity for bending 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 1C on the surface of the artificial hair 1, the natural gloss similar to the natural hair can be given, thereby so can the natural appearance as hair.

[0038] Explanation is next made of a wig using the artificial hair in accordance with a second embodiment of the present invention.

Fig. 5 is a diagonal view diagrammatically illustrating the structure of a wig using the artificial hair in accordance with a second embodiment of the invention. A wig 40 using the artificial hair 1, 10 of the present invention is that made by tying the artificial hair 1 or 10 to a wig base 41. The wig base 41 can be made of either a net base or an artificial skin base. In the case of the figure, the wig base 41 is shown to be attached or tied to a mesh of a net member. The wig base 41 may be made by combination of a net base and an artificial skin base, and there is no special restriction so far as suitable to wig design or purpose of use.

[0039] The diameter of the artificial hair 1, 10 may be about 0.05 - 0.1 mm. Also, the artificial hair 10 can be properly used of which the relative-specular glossiness is suppressed, and which has gloss similar to natural hair. The color of the artificial hair 1, 10 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 part falling out hair. In case of a wig or attached hair 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.

[0040] Fig. 6 is an enlarged view diagrammatically illustrating the behavior of the wig of Fig. 5 with respect to humidity change, and (A) shows an ordinary humidity state, and (B) shows a high humidity state. In the figure, the case is shown where artificial hair is straight.

As shown in Fig. 6(A), the artificial hair 1, 10 attached or tied to the wig 40 of the present invention has rigidity for bending close to that of the natural hair. Therefore, under the ordinary environment where the humidity is about 40 - 60 %, the artificial hair 1, 10 has good standing, and gives bulkiness to the wig 40.

On the other hand, when the wig 40 of the present invention gets wet in the rain, or is worn in the environment of high humidity, the artificial hair becomes soft, and, as shown in Fig. 6(B), hangs and loses bulkiness, due to the property of changing rigidity for bending by moisture absorption of the artificial hair attached or tied to the wig, that is, rigidity for bending is lowered with humidity increase. Further, when the absorbed water is released by natural standing or drying, the artificial hair 1, 10 gradually stands up, and returns to the original state.

Also, if a curl is given to the artificial hair 1, 10, the curl extends like the natural hair, and, as in the case of straight hair, it returns to the original state when the absorbed water is released naturally or by drying.

[0041] With the wig 40 of the present invention, since the polyamide of high rigidity for bending is used for the core portion 1B, and a polyamide of the rigidity for bending lower than the core portion 1B for the sheath portion 1A to make the artificial hair 1, 10 of a sheath/core structure, and it is attached or tied to a wig base, the rigidity for bending is changed by temperature and humidity, and the wig with good appearance can be obtained which has feeling or behavior closer to natural hair. Further if the fine concave and convex portion 1C is formed on its surface as the artificial hair, it gives appearance closer to natural hair by deglossing effect.

Also if the wig 40 of the present invention gets wet in the rain, or gets moisture with the wearer's sweat, the artificial hair 1, 10 uses the polyamide resin of good water absorption, thereby absorbs water, hangs down due to its weight increase, and shows the behavior similar to natural hair. On the other hand, in the case of a wig using conventional artificial hair, for example, of polyester, since the rigidity for bending is higher than natural hair, the wearer's own hair hangs down to a scalp side, whereas the artificial hair of polyester remains standing upon water absorption when the wig is worn, and the blended wearer's own hair and the artificial hair of the wig are combed, thereby separation of the wearer's own hair and the wig hair of polyester is caused, and unnatural appearance is given. However, in accordance with the present invention, since the wig hair hangs down practically as does the wearer's own hair upon water absorption, no hair separation is caused, thereby the state can be maintained where the wearer's own hair and artificial hair are well blended.

<u>Examples</u>

[Example 1]

[0042] Explanation is next made in detail of examples of the present invention.

Using the spinning machine 20 shown in Fig. 3, the artificial hair 10 of Example 1 was manufactured. As a polyamide resin for the core portion 1B, nylon 6T (TOYOBO, LTD.) was used, and as a polyamide resin for the sheath portion 1A, nylon 6 (TOYOBO, LTD.) was used. For the quenching bath 24, hot water of 80 °C was used. By setting the sheath/core volume ratio as 1/7, and the outlet temperature at 310°C, the artificial hair 10 was manufactured. The sheath/core weight ratio was 12/88 for the artificial hair 10 of Example 1.

As a coloring agent, resin chips were used which were made by blending a polyamide resin used either for said sheath 1A or for core 1B and a pigment in pre-determined ratio, heating and melting, and cooling after kneading. These resin chips used as a coloring agent were defined as the master batch. As the master batch used in Example, the resin chips containing 3 weight % black inorganic pigment, the resin chips containing 3 weight % yellow organic pigment, and the resin chips containing 4 weight % red organic pigment were used.

[0043] As the concrete details, nylon 6 chips as the material for the sheath 1A 84 g, a black master batch 5 g, yellow 10 g, red 1 g, total 100 g of melt resin 21A was first fed into the first cylinder 21 and nylon 6T chips as the material for the core 1B 84 g, a black master batch 5 g, yellow 10 g, red 1 g, total 100 g of melt resin 22A was fed into the second cylinder 22.

Nylon 6T was fed with the gear pump 22B to the inner outlet 23B of the discharge part 23, and nylon 6 was fed with the gear pump 21B to the outer outlet 23A, respectively, and extrusion volume ratio was made 1/7 as sheath/core ratio by adjusting rotations of gear pumps 21B and 22B. The spinning machine was that spun 15 strands of fibers through the outlet of 15 holes.

The fiber of the sheath/core structure coming out of the outlet 23C was passed through the quenching bath 24 of 1.5 m length and was filled with 80°C warm water to form spherocrystal on the surface.

Thereafter, it was drawn by passing through the first stretching roll 25 and the first dry stretching bath 26 at 180°C, and did heat-set by passing through the second stretching roll 27 and the second dry stretching bath 28 at 180°C, then annealed for thread diameter size stabilization by passing through the third stretching roll 29 and the third dry stretching bath 30 at 185°C, and was passed through the oiling device 31 for electrostatic prevention.

As a final step, the fiber surface was made coarse by blasting fine alumina powder onto the surface through the fourth stretching roll 32 and the blast machine 33, and rolled up to the rollup machine 34. The speeds of the first to the fourth stretching rolls 25, 27, 29, 32 were adjusted so to make stretching ratio 5.5, and rollup rate 150 m/min in this process.

All the diameters of thus manufactured artificial hairs 10 were 40 - 80 μm. The stretching ratio was 5.5 in Example 1, but, as shown in Example 3 described later, the rigidity for bending of artificial hair 10 could be adjusted by stretching ratio.

[Example 2]

[0044] The artificial hair 10 of the sheath/core structure was manufactured by the same condition as Example 1, except that the sheath/core volume ratio was made 1/5 by adjusting respective gear pumps 21B and 22B. The sheath/core weight ratio of the artificial hair 10 of Example 2 was 16.1/83.9.

[Example 3]

[0045] The artificial hair 10 of the sheath/core structure was manufactured by the same condition as Example 1, except that the sheath/core volume ratio was made 1/3 by adjusting respective gear pumps 21B and 22B. The sheath/core weight ratio of the artificial hair 10 of Example 3 was 24.2/75.8, and its diameter was 80 μm.

Fig. 7 is a graph showing the stretching ratio dependency of rigidity for bending of the artificial hair 10 of Example 3. In the figure, an abscissa axis shows a stretching ratio, and an ordinate axis shows rigidity for bending: 10^{-5} gfcm^2/strand. The measurement condition was temperature 22°C and humidity 40 %. As is obvious from Fig. 7, the rigidities for bending for stretching ratios 3 and 5.5 were 430 X 10^{-5} gfcm^2/strand and 720 X 10^{-5} gfcm^2/strand, showing that rigidity for bending increased linearly with the increase of stretching ratio.

[Example 4]

[0046] The artificial hair 10 of the sheath/core structure was manufactured by the same condition as Example 1, except that the sheath/core volume ratio was made 1/2 by adjusting respective gear pumps 21B and 22B. The sheath/core weight ratio of the artificial hair 10 of Example 4 was 32.3/67.7.

[Example 5]

[0047] The artificial hair 10 of Example 5 was manufactured by the same condition as Example 1, except that nylon 66 (MITSUBISHI ENGINEERING PLASTICS, LTD.) was used as a polyamide resin for the sheath 1A, and temperature was 92°C for the quenching bath 24, and 320°C for the outlet. The sheath/core weight ratio of the artificial hair 10 of Example 5 was 16.2/83.8.

The manufacturing conditions of artificial hair of the above-described Examples 1-5 are shown in Table 1, where all the diameters of artificial hairs 10 were 40- 80 μm.

[Table 1]

Example		1	2	3	4	5
Resin	Core	Nylon 6T	Nylon 6T	Nylon 6T	Nylon 6T	Nylon
	Sheath	Nylon 6	Nylon 6	Nylon 6	Nylon 6	Nylon 66
Sheath/Core Volume Ratio		1/7	1/5	1/3	1/2	1/5
Outlet Temp. (°C)		310	310	310	310	320
Pigment Ratio	Black	0.15%	0.15%	0.15%	0.15%	0.30%
	Yellow	0.30%	0.30%	0.30%	0.30%	0.30%
	Red	0.04%	0.04%	0.04%	0.04%	0.04%
Cooling Water Temp. (°C)		80	80	80	80	92
Sheath/Core Weight Ratio of Artificial Hair		12:88	16.1:83.9	24.2:75.8	32.3:67.7	16.2:83.8

[Example 6]

[0048] The artificial hair 10 of Example 6 was manufactured by the same condition as Example 1, except that nylon MXD6 (MITSUBISHI GAS CHEMICAL COMPANY, INC.) was used as a polyamide resin for the core 1B, nylon 6 (MITSUBISHI ENGINEERING PLASTICS, LTD.) was used as a polyamide resin for the sheath 1A, the temperature for the outlet was 270°C, and the sheath/core volume ratio was made 1/7. The sheath/core weight ratio of the artificial hair 10 of Example 6 was 11.8/88.2. For the artificial hair 10 of Example 6, nylon MXD6 was used instead of nylon 6T used for the core 1B of Examples 1 - 5. Here, it was drawn using a hot water stretching bath of 95°C instead of a first dry stretching bath 26 of Example 1, and did heat-set in the second dry stretching bath 28 of 150°C, annealed for thread diameter size stabilization by passing through the third stretching roll 29 and the third dry stretching bath 30 at 185°C, and was passed through the oiling device 31 for electrostatic prevention. The final step to make the fiber surface of artificial hair coarse was conducted as in Example 1. The speeds of the first to the fourth stretching rolls 25, 27, 29, 32 were adjusted so to make stretching ratio 5.6, and rollup rate 150 m/min in this process. All the diameters of thus manufactured artificial hairs 10 were in the range between 40 and 80 μm.

[Example 7]

[0049] The artificial hair 10 of Example 7 was manufactured by the same condition as Example 6, except that the sheath/core volume ratio was made 1/5. The sheath/core weight ratio of the artificial hair 10 of Example 7 was 15.8/84.2.

[Example 8]

[0050] The artificial hair 10 of Example 8 was manufactured by the same condition as Example 6, except that the sheath/core volume ratio was made 1/4. The sheath/core weight ratio of the artificial hair 10 of Example 8 was 18.9/81.1.

[Example 9]

[0051] The artificial hair 10 of Example 9 was manufactured by the same condition as Example 6, except that the sheath/core volume ratio was made 1/3. The sheath/core weight ratio of the artificial hair 10 of Example 9 was 23.8/76.2.

[Example 10]

[0052] The artificial hair 10 of Example 10 was manufactured by the same condition as Example 6, except that the sheath/core volume ratio was made 1/2. The sheath/core weight ratio of the artificial hair 10 of Example 10 was 31.8/68.2. The manufacturing conditions of the above-described Examples 6 - 10 are shown in Table 2, where all the diameters of the artificial hairs 10 were in the range between 40 and 80 μm.

[Table 2]

Example		6	7	8	9	10
Resin	Core	Nylon MXD6	Nylon MXD6	Nylon MXD6	Nylon MXD6	Nylon MXD6
	Sheath	Nylon 6	Nylon 6	Nylon 6	Nylon 6	Nylon 6
Sheath/Core Volume Ratio		1/7	1/5	1/4	1/3	1/2
Outlet Temp. (°C)		270	270	270	270	270
Pigment Ratio	Black	0.18%	0.18%	0.18%	0.18%	0.18%
	Yellow	0.45%	0.45%	0.45%	0.45%	0.45%
	Red	0.04%	0.04%	0.04%	0.04%	0.04%
Cooling Water Temp. (°C)		80	80	80	80	80
Sheath/Core Weight Ratio of Artificial Hair		11.8:88.2	15.8:84.2	18.9:81.1	23.8:76.2	31.8:68.2

[0053] Explanation is next made of artificial hairs of Comparative Examples.

(Comparative Example 1)

[0054] The thread of diameter 80 μm and stretching ratio 3.3 without sheath structure was manufactured with nylon 6, using the same spinning machine as Example 1, at the outlet temperature 270°C, and without using the first cylinder 21.

(Comparative Example 2)

[0055] The thread of diameter 80 μm and stretching ratio 5.5 without sheath structure was manufactured with nylon 6T, using the same spinning machine as Example 1, at the outlet temperature 310°C, and without using the first cylinder 21.

(Comparative Example 3)

[0056] The thread of a sheath/core volume ratio 1/1, thread diameter 80 μm and ratio 5.5 was manufactured with polyester (TORAY, LTD.) for the core portion 1B, and nylon 6 for the sheath portion 1A, using the same spinning machine as Example 1, at the outlet temperature 290°C.

(Comparative Example 4)

[0057] The thread of diameter 80 μm and stretching ratio 5.6 without sheath structure was manufactured with nylon MXD6 by the same condition and method as Example 6, using the same spinning machine as Example 1, at the outlet temperature 270°C, and without using a first cylinder 21.

(Comparative Example 5)

[0058] The thread of diameter 80 μm and stretching ratio 5.6 without sheath structure was manufactured with the mixed polyamides of nylon MXD6 and nylon 6 by the same condition and method as Example 6, using the same spinning machine as Example 1 at the outlet temperature 270°C, and without using the first cylinder 21. The weight ratio of nylon MXD6 and Nylon 6 was 90:10. The pigment formulation ratio was same in all Comparative Examples 1 - 5, and that of black, yellow, and red was 0.15%, 0.30%, and 0.04%, respectively. The manufacturing conditions are shown in Table 3.

[Table 3]

Comparative Example		1	2	3	4	5
Resin	Core	Nylon 6	Nylon 6T	Polyester	Nylon MXD6	Mixed Polyamide
	Sheath	-----	-----	Nylon 6	-----	-----
Sheath/Core Volume Ratio		-----	-----	1/1	-----	-----

(continued)

Comparative Example		1	2	3	4	5
Outlet Temp. (°C)		270	310	290	270	270
Pigment Ratio	Black	0.15%	0.15%	0.15%	0.15%	0.15%
	Yellow	0.30%	0.30%	0.30%	0.30%	0.30%
	Red	0.04%	0.04%	0.04%	0.04%	0.04%
Cooling Water Temp. (°C)		80	80	80	80	80

[0059] Explanation is next made of the reason why nylon 6T or MXD6 is used for the core 1B of the artificial hair 10, and nylon 6 for the sheath 1A in Example 1.

Table 4 shows the humidity dependency of rigidity for bending, which hereinafter may call "bending rigidity", at 22°C of the artificial hairs manufactured by using a single polyamide of nylon 6 in Comparative Example 1, nylon 6T in Comparative Example 2, and nylon MXD6 in Comparative Example 4. The rigidity for bending was measured using a single hair bending tester (KATOTECH, LTD.) as will be described below.

As is seen in Table 4, the rigidities for bending of artificial hair of nylon 6 in Comparative Example 1 were 510 X 10^{-5} gfcm^2/strand, 340 X 10^{-5} gfcm^2/strand, and 250 X 10^{-5} gfcm^2/strand, respectively, at humidity 40, 60, and 80 %. Though not shown in the table, the rigidity for bending and its humidity dependency of artificial hair using nylon 66 were about the same as those of nylon 6.

The rigidities for bending of artificial hair of nylon 6T in Comparative Example 2 were 980 X 10^{-5} gfcm^2/strand, 920 X 10^{-5} gfcm^2/strand, and 860 X 10^{-5} gfcm^2/strand, respectively, at humidity 40, 60, and 80 %.

The rigidities for bending of the artificial hair of nylon MXD6 in Comparative Example 4 were 940 X 10^{-5} gfcm^2/strand, 870 X 10^{-5} gfcm^2/strand, and 780 X 10^{-5} gfcm^2/strand, respectively, at humidity 40, 60, and 80 %. It is seen from these results that the artificial hairs using nylon 6T and nylon MXD6 showed higher rigidity for bending than those using nylon 6 or nylon 66.

Therefore, it became clear that the artificial hairs of Examples 1 - 10 has the core portion 1B made of a polyamide resin consisting of nylon 6T or nylon MXD6 of high rigidity for bending, and the sheath portion 1A made of a polyamide resin consisting of nylon 6 or nylon 66 of lower rigidity for bending than the core portion 1B.

[Table 4]

Comparative Example		1	2	4
Resin		Nylon 6	Nylon 6T	Nylon MXD6
Rigidity for bending at 22°C at Each Humidity (X 10^{-5} gfcm^2)	40 %	510	980	940
	60 %	340	920	870
	80 %	250	860	780

[0060] Explanation is next made of various properties of the artificial hairs manufactured in the above-mentioned Examples 1-10 and Comparative Examples 1-5.

Fig. 8 is an image of the cross section of artificial hair of Example 2 by an electron microscope. The electron accelerating voltage was 15 kV, and magnification was 800. The sheath/core volume ratio of this artificial hair 10 was 1/5, its diameter 80 μm, and the stretching ratio was 5.5. As is obvious from the figure, the sheath/core structure was formed with the semi-aromatic polyamide (nylon 6T) as the core portion 1B and the linear saturated aliphatic polyamide (nylon 6) as the sheath portion 1A around it.

[0061] Fig. 9 is an image of the surface of artificial hair of Example 2 by an electron microscope. The electron accelerating voltage was 15 kV, and magnification was 700. As is obvious from the figure, spherocrystals were formed and grew on the linear saturated aliphatic polyamide, nylon 6, of the surface to give fine concave and convex portion 1C to the surface.

[0062] Fig. 10 is an image of the cross section of artificial hair of Example 3 by an electron microscope. The electron accelerating voltage was 15 kV, and magnification was 900. The sheath/core volume ratio of this artificial hair 10 was 1/3, its diameter 80 μm, and stretching ratio 5.5. As is seen from the figure, the sheath/core structure was formed with the semi-aromatic polyamide, nylon 6T, as the core portion 1B and the linear saturated aliphatic polyamide, nylon 6, as the sheath portion 1A around it.

[0063] Fig. 11 is a cross sectional image of artificial hair having the sheath/core structure of Comparative Example 3

by an electron microscope. The electron accelerating voltage was 15 kV, and magnification was 300.
The artificial hair of Comparative Example 3 had the sheath/core structure consisting of the core portion 1B of polyester and the sheath portion 1A of linear saturated aliphatic polyamide, nylon 6. The sheath/core volume ratio was 1/1, the thread diameter 80 μm, and stretching ratio 5.5. As is seen from the figure, peeling off was detected at the interface of the core 1B and a sheath 1A, the fiber was white-brownish, and the dyed color was changed, so that it turned out that such a sheath/core structure is not suitable to the artificial hair.

[0064] Explanation is next made of the measurement results of rigidities for bending of the artificial hairs of Examples and Comparative Examples.

[0065] The rigidity for bending is the physical property applied in general to fiber and others, and is recognized recently, also for hair, as the property relating to such feeling as appearance, tactile and texture etc. As the measurement of the rigidity for bending of fiber, KAWABATA method and its principle has been well known for textile, and the rigidity for bending of the artificial hair was measured using the single hair-bending tester (KATOTECH, LTD., Model KES-FB2-SH), which applies the method. The measurement methods in cases of Examples and Comparative Examples of the present invention for both artificial and natural hairs are such that bending the whole hair of each one strand of 1cm as a circular arc at an equal rate to a certain curvature, detecting a minute bending moment accompanying it, thereby measuring the relationship of the bending moment and the curvature. Thus the rigidity for bending was obtained by bending moment / curvature change. The representative measurement conditions are shown below.

(Measurement Conditions)

[0066] 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: ± 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.

[0067] Fig. 12 is a graph showing the humidity dependency of rigidity for bending of the artificial hairs of Examples 1 - 5 and Comparative Examples 1 and 2. In the figure, the abscissa axis shows humidity (%), and the ordinate axis shows rigidity for bending (10^{-5} gfcm^2/strand). The measurement temperature was 22°C. In Fig. 12, the humidity dependency of rigidity for bending of the artificial hair of Examples and Comparative Examples is shown together with that of natural hair. Since natural hairs have wide personal deviation, hairs were collected from 25 males and 38 females of respective ages between 20 and 50 years old, rigidities for bending of the samples of 80 μm diameter were measured, and their average was defined as a standard value. Their maximum and minimum values were also shown in the figure. It is seen that the average value of the rigidity for bending of natural hair was 720 X 10^{-5} gfcm^2/strand and 510 X 10^{-5} gfcm^2/strand for humidity 40 and 80 %, respectively, and decreases monotonously with humidity increase.
On the other hand, the maximum value of rigidity for bending of natural hair was 740 X 10^{-5} gfcm^2/strand and 600 X 10^{-5} gfcm^2/strand for humidity 40 and 80 %, respectively, and its minimum value was 660 X 10^{-5} gfcm^2/strand and 420 X 10^{-5} gfcm^2/strand for humidity 40 and 80 % respectively, and thus the rigidity for bending of natural hair has wide deviation.

[0068] The artificial hair 10 of Example 1 had a thread diameter of 80 μm, and the sheath/core volume ratio of 1/7. Its rigidity for bending was 740 X 10^{-5} gfcm^2/strand for humidity 40 %, equal to the maximum value of natural hair, and it gradually decreases with humidity increase, lowering to about 700 X 10^{-5} gfcm^2/strand for humidity 60 %, and to about 650 X 10^{-5} gfcm^2/strand for humidity 80 %.
From this result, in the case of the artificial hair 10 of Example 1, it showed higher rigidity for bending than natural hair, but, compared with the artificial hair of nylon 6 of Comparative Example 1 and the artificial hair of nylon 6T of Comparative Example 2 mentioned below, it showed the rigidity for bending and humidity dependency similar to natural hair.

[0069] The artificial hair 10 of Example 2 had a thread diameter of 80 μm, and the sheath/core volume ratio of 1/5. Its rigidity for bending was 720 X 10^{-5} gfcm^2/strand for humidity 40 %, equal to that of natural hair, and it gradually decreases to about 650 X 10^{-5} gfcm^2/strand till humidity 45 %. Then it stayed constant at about 650 X 10^{-5} gfcm^2/strand for humidity between 45 and 60 %. In the range of humidity 60 - 80 %, rigidity for bending gradually decreased to about 600 X 10^{-5} gfcm^2/strand for humidity 80 %.
From this result, in the case of the artificial hair 10 of Example 2, it turned out that the rigidity for bending was equal to that of natural hair for humidity 40 %, and decreased with humidity increase, thus showing rigidity for bending and humidity dependency similar to natural hair.

[0070] The difference of artificial hair 10 of Example 3 from Example 1 is that its sheath/core volume ratio was 1/3. Its rigidity for bending was 720 X 10^{-5} gfcm^2/strand for humidity 40 %, equal to natural hair, decreased in the humidity range 40 - 60 % to about 520 X 10^{-5} gfcm^2/strand for humidity 60 %. In the humidity range 60 - 80 %, it gradually decreased to about 480 X 10^{-5} gfcm^2/strand for humidity 80 %.

From this result, in the case of the artificial hair 10 of Example 3, it turned out that the rigidity for bending was equal to that of natural hair for humidity 40 %, and decreased with humidity increase, thus showing the rigidity for bending quite close to that of natural hair for humidity 80 %.

[0071] The difference of artificial hair 10 of Example 4 from Example 1 was that its sheath/core volume ratio was 1/2. Its rigidity for bending was 720 X 10^{-5} gfcm^2/strand for humidity 40 %, equal to natural hair, decreased in the humidity range 40- 60 % to about 510 X 10^{-5} gfcm^2/strand for humidity 60 %. In the humidity range 60 - 80 %, it gradually decreased to about 390 X 10^{-5} gfcm^2/strand for humidity 80 %.

From this result, in the case of the artificial hair 10 of Example 4, it turned out that the rigidity for bending was equal to that of natural hair for humidity 40 %, and decreased with humidity increase, thus showing the rigidity for bending close to the minimum value of natural hair for humidity 80 %.

The reason why rigidity for bending of artificial hair 10 of Examples 2-4 was lower than that of Example 1 for humidity 40 % or higher was that the volume of a sheath portion 1A was higher than that of Example 1, in another word, the core portion 1B had lower volume. Therefore, for the artificial hair of the present invention, the humidity dependency of rigidity for bending can be changed by changing the sheath/core volume ratio. Thereby, in the case of artificial hair 10 of Examples 2-4, the rigidity for bending was equal to that of natural hair for humidity 40 %, decreased with humidity increase, and showed humidity dependency similar to natural hair.

[0072] The difference of artificial hair 10 of Example 5 from Example 1 is that its sheath portion was made of nylon 66, and all others were the same. In Example 5, rigidity for bending was 780 X 10^{-5} gfcm^2/strand for humidity 40 %, higher than natural hair, and decreases about linearly in humidity range 40 - 50 % to about 650 X 10^{-5} gfcm^2/strand for humidity 50 %. In humidity range 50 - 80 %, it decreased to about 600 X 10^{-5} gfcm^2/strand with the slope about equal to Example 1.

From this result, in the case of the artificial hair 10 of Example 5, it turned out that the rigidity for bending was higher than that of the natural hair for humidity 40 %, and decreased with humidity increase. In the case of the artificial hair 10 of Example 5, the rigidity for bending was higher than Examples 1 - 4 in humidity range 40 - 50 %.

Thereby, in the case of the artificial hair 10 of Example 5 also, the rigidity for bending was close to that of the natural hair, decreased with humidity increase, and showed the rigidity for bending and its humidity dependency similar to the natural hair.

[0073] The artificial hair of Comparative Example 1 was made of nylon 6, its thread diameter was 80 μm, and stretching ratio was 3.3. In the case of this artificial hair, the rigidity for bending was about 510 X 10^{-5} gfcm^2/strand for humidity 40 %, which was about 70 % of natural hair. It decreased about monotonously with humidity increase to about 250 X 10^{-5} gfcm^2/strand for humidity 80 %. This value was about 50 % of natural hair. It turned out that the rigidity for bending of Comparative Example 1 was considerably lower than natural hair or artificial hair of Examples 1 - 5 over the whole measured humidity range.

[0074] The artificial hair of Comparative Example 2 was made of nylon 6T, its thread diameter was 80 μm, and stretching ratio was 5.5. In the case of this artificial hair, rigidity for bending was about 980 X 10^{-5} gfcm^2/strand for humidity 40 %, about 136 % of natural hair. It decreased about monotonously with humidity increase to about 860 X 10^{-5} gfcm^2/strand for humidity 80 %. This value was about 170 % of natural hair. It turned out that rigidity for bending of Comparative Example 2 was considerably higher than the natural hair or the artificial hair of Examples 1-5 over the whole measured humidity range.

In the case of Comparative Example 3, the peeling off was caused between the sheath 1A and the core 1B, as mentioned above, and since it could not be used as the artificial hair, its rigidity for bending was not measured.

[0075] Explanation is next made of humidity dependency of the rigidity for bending of artificial hairs of Examples 6 - 10. Fig. 13 is a graph showing the humidity dependency of the rigidity for bending of the artificial hairs of Examples 6-10 and Comparative Examples 1, 4, and 5. In the figure, the abscissa axis shows humidity (%), and the ordinate axis shows rigidity for bending (10^{-5} gfcm^2/strand). The measurement temperature was 22°C. In Fig. 13, as in Fig. 12, rigidities for bending of the natural hair were shown as average, maximum, and minimum values. The difference of the artificial hair 10 of Example 6 from Example 1 was that its core portion 1B was made of nylon MXD6, its thread diameter was 80 μm, and the sheath/core volume ratio was 1/7.

As is seen from Fig. 13, in the case of the artificial hair 10 of Example 6, the rigidity for bending was 730 X 10^{-5} gfcm^2/strand for humidity 40 %, about equal to the average value of natural hair, and gradually decreased with humidity increase. It lowered to about 660 X 10^{-5} gfcm^2/strand for humidity 60 %, and about 600 X 10^{-5} gfcm^2/strand for humidity 80 %.

From this result, in the case of artificial hair 10 of Example 6, it turned out that the rigidity for bending was about equal to that of the natural hair for humidity 40 %, decreased with humidity increase, and shows the behavior similar to natural hair. That was, the artificial hair 10 of Example 6 showed the rigidity for bending and its humidity dependency similar to the natural hair.

[0076] The difference of artificial hair 10 of Example 7 from Example 6 was that its sheath/core volume ratio was 1/5, and all others were the same.

As is seen from Fig. 13, in the case of the artificial hair 10 of Example 7, the rigidity for bending was 730 X 10^{-5} gfcm^2/strand for humidity 40 %, about equal to the average value of natural hair, and decreased as humidity increased to around 50 % to 620 X 10^{-5} gfcm^2/strand. Then it gradually lowered till humidity 60 % to about 610 X 10^{-5} gfcm^2/strand for humidity 60 %. It further gradually decreased in humidity range 60 - 80 % to 560 X 10^{-5} gfcm^2/strand for humidity 80 %. From this result, in the case of the artificial hair 10 of Example 7, it turned out that the rigidity for bending was about equal to that of natural hair for humidity 40 %, decreased with humidity increase, and shows the behavior similar to the natural hair. That was, the artificial hair 10 of Example 7 showed the rigidity for bending and its humidity dependency similar to the natural hair.

[0077] The difference of the artificial hair 10 of Example 8 from Example 6 was that its sheath/core volume ratio was 1/4, and all others were the same.

As is seen from Fig. 13, in the case of artificial hair 10 of Example 8, the rigidity for bending was 730 X 10^{-5} gfcm^2/strand for humidity 40 %, about equal to the average value of the natural hair, and decreased as humidity increased in humidity range 40 - 60 %, and 560 X 10^{-5} gfcm^2/strand for humidity 60 %. Then it gradually lowered in humidity range 60 - 80 % to 490 X 10^{-5} gfcm^2/strand for humidity 80 %.

From this result, in the case of the artificial hair 10 of Example 8, it turned out that the rigidity for bending was about equal to that of the natural hair for humidity 40 %, decreased with humidity increase, and shows the behavior similar to the natural hair.

[0078] The difference of the artificial hair 10 of Example 9 from Example 6 was that its sheath/core volume ratio was 1/3, and all others were the same.

As is seen from Fig. 13, in the case of the artificial hair 10 of Example 9, the rigidity for bending was 730 X 10^{-5} gfcm^2/strand for humidity 40 %, about equal to the average value of natural hair, and decreased as the humidity increased in humidity range 40 - 60 % to 530 X 10^{-5} gfcm^2/strand for humidity 60 %. Then it gradually lowered in humidity range 60 - 80 % to 440 X 10^{-5} gfcm^2/strand for humidity 80 %.

From this result, in the case of the artificial hair 10 of Example 9, it turned out that the rigidity for bending was about equal to that of the natural hair for humidity 40 %, decreased with humidity increase, and showed the behavior similar to the natural hair.

[0079] The difference of the artificial hair 10 of Example 10 from Example 6 was that its sheath/core volume ratio was 1/2, and all others were the same.

As is seen from Fig. 13, in the case of the artificial hair 10 of Example 10, rigidity for bending was 730 X 10^{-5} gfcm^2/strand for humidity 40 %, about equal to the average value of the natural hair, and decreased as the humidity increased in humidity range 40 - 60 % to 490 X 10^{-5} gfcm^2/strand for humidity 60 %. Then it gradually lowered in humidity range 60 - 80 % to 380 X 10^{-5} gfcm^2/strand.

From this result, in the case of the artificial hair 10 of Example 10, it turned out that rigidity for bending was about equal to that of the natural hair for humidity 40 %, and decreased with humidity increase. When the humidity exceeded about 60 %, the rigidity for bending of artificial hair 10 was lower than that of the natural hair, but, compared with the artificial hair of nylon 6 of said Comparative Example 1, or that of nylon MXD6 of Comparative Example 4 mentioned below, it shows the behavior similar to the natural hair.

[0080] The artificial hair of Comparative Example 4 was made of nylon MXD6, its thread diameter was 80 μm, its rigidity for bending was 940 X 10^{-5} gfcm^2/strand for humidity 40 %, and decreased in humidity range 40 - 60 % to 870 X 10^{-5} gfcm^2/strand for humidity 60 %. It further gradually decreased till humidity range 60 - 80 % to 780 X 10^{-5} gfcm^2/strand for humidity 80 %. It turned out that the rigidity for bending of Comparative Example 4 was considerably higher than the natural hair or the artificial hairs of Examples 6-10 over the whole measured humidity range.

[0081] The artificial hair of Comparative Example 5 was made of nylon MXD6 with 10 % nylon 6 blended in, and its thread diameter was 80 μm. Its rigidity for bending was 870 X 10^{-5} gfcm^2/strand for humidity 40 %, and decreased till humidity about 60 % to 720 X 10^{-5} gfcm^2/strand for humidity 60 %. It further gradually decreased till humidity range 60 - 80 % to 610 X 10^{-5} gfcm^2/strand for humidity 80 %. It turned out that the rigidity for bending of Comparative Example 5 was considerably higher than the natural hair or the artificial hairs of Examples 6 - 10 over the whole measured humidity range.

Here, as in Fig. 12, the rigidity for bending of the artificial hair of Comparative Example 1 is shown together, and it turned out that it was considerably lower than the natural hair or the artificial hairs of Examples 6 - 10 over the whole measured humidity range.

[0082] As shown in Fig. 12 or 13, the rigidities for bending of natural hairs tended to have individual deviation, unlike artificially manufactured hairs, and the humidity dependency of their rigidities for bending had broad range. The rigidities for bending of natural hairs by humidity change were in the range of 660 X 10^{-5} gfcm^2/strand as its minimum value and 740 X 10^{-5} gfcm^2/strand as its maximum value for humidity 40 %, and the width of this deviation was 80 X 10^{-5} gfcm^2/strand. For humidity 60 %, the minimum value was 520 X 10^{-5} gfcm^2/strand, the maximum value was 660 X 10^{-5} gfcm^2/strand, and the width of deviation was 140 X 10^{-5} gfcm^2/strand which was wider than for humidity 40 %. Further for humidity 80 %, the deviation was wider, as wide as with the minimum value 420 X 10^{-5} gfcm^2/strand and the maximum value 600 X 10^{-5} $gfcm^2$/strand.

[0083] According to the artificial hair 10 of Examples 1 - 10, by making the sheath with nylon 6 or nylon 66, the core with nylon 6T or nylon MXD6, and by varying the sheath/core volume ratio, the artificial hair 10 were obtained which had the rigidity for bending and its humidity dependency similar to natural hair. As shown in Figs. 12 and 13, the rigidity for bending of the artificial hair 10 manufactured using nylon 6T or nylon MXD6 for the core portion 1B with the sheath/core volume ratio about 1/2 was close to the minimum value of that of the natural hair, and that of the artificial hair 10 manufactured with the sheath/core volume ratio about 1/7 was close to the maximum value of that of the natural hair.

[0084] With the artificial hair 10 of the sheath/core structure with the core 1B of the semi-aromatic polyamide resin, and the sheath 1A of the aliphatic polyamide resin, when the sheath/core volume ratio was within the range of 1/2 - 1/7, the artificial hair was obtained the rigidity for bending of which shows behavior similar to the natural hair. As shown in Tables 1 and 2, the sheath/core weight ratio of the artificial hair 10 manufactured by the sheath/core volume ratio within the range of 1/2-1/7 was in the range of 10/90 - 35/65.

Especially, in the case of the artificial hair 10 of Examples 6-10 with the sheath of nylon 6 and the core of nylon MXD6, its rigidity for bending was between the maximum and the minimum values of the natural hair for humidity 40 - 50 % at 22°C, and showed the behavior similar to its average value. Further in the humidity range over 50 %, the rigidity for bending of artificial hair 10 of Examples 6 and 7 showed a characteristic behavior similar to the maximum value of the natural hair, that of the artificial hair 10 of Example 8 showed a characteristic behavior similar to the average value of the natural hair, and that of artificial hair 10 of Examples 9 and 10 showed a characteristic behavior similar to the minimum value of the natural hair.

[0085] Explanation is next made of the change of the artificial hair of Examples by moisture absorption.

Figs. 14 - 16 are figures showing (A) the artificial hair of Example of the present invention, (B) the natural hair, and (C) the conventional artificial hair made of polyester in the initial states of curls, the water-soaked states, and the dried states after water-soaking, respectively. Each hair was bound at its upper portion, and drying was by natural drying.

As shown in Fig. 14, all hairs had the same lengths, and were in the state of curling with the same curl diameters. It is seen that, when water-soaked, artificial hairs 1, 10 of Examples stretch by water absorption, and the change of their lengths was close to that of the natural hair (See Figs. 15(A) and (B).). On the other hand, in the case of the artificial hair using polyester, since it does not stretch due to low moisture absorbency, it is seen that curl was not distorted unlike the behavior of natural hair (See Fig. 15(C).).

In the dried state after water-soaking, the artificial hairs 1, 10 of Examples recovered to the initial state of curl, and it is seen that it showed a change close to the natural hair (See Figs. 16(A) and (B).). Though not shown in figures, in the case of the artificial hairs made of materials other than polyester, it was known that their curls stretch upon wetting with water, for example, and did not recover easily to the original curl even if the moisture was removed under natural standing. Therefore, according to the artificial hairs 1, 10 of the present invention, it is seen that, when they were curled, their behavior was close to natural hair in the stretch of curl upon wetting with water, and the recovery of curl when the moisture was removed under natural standing.

[0086] According to the artificial hair 10 of the above-mentioned Examples 1 - 10, it was seen that the rigidity for bending for humidity 40 % at 22°C either coincided with the average value of natural hair 720 X 10^{-5} $gfcm^2$/strand, or showed a quite close value. It is further seen that the behavior of the rigidity for bending decreased accompanying humidity increase up to humidity 80 % was also quite close to natural hair. Still further, it was seen that, for the artificial hair 10 upon actually wetting with water, the stretch of a curl and its recovery when the moisture was removed under natural standing are similar behavior to the natural hair.

[Example 11]

[0087] Like the artificial hair 10 shown in Examples 1 - 10, various artificial hairs 10 with different diameters were made, and a wig was manufactured therefrom as shown in Fig. 5. It was such a wig that artificial hairs with different diameters were properly arranged, having appearance similar to the natural hair by the design of a curl to a part of hair, thereby the hairline and the hems of the wig did not have unnatural appearance. According to the evaluation by the wearer and observers around, feelings, such as appearance, tactile and texture, was quite natural, and, in the state of wetting with the rain or shower, the lying state of hair, the uncurling state, and such feelings as appearance, tactile and texture did not differ from the wearer's own natural hair, as shown in Fig. 6 and Figs. 14 - 16, hair separation was not caused, thereby it could be worn quite comfortably.

[0088] According to the above-mentioned Examples, it is seen that the artificial hair manufactured in accordance with the present invention had the rigidity for bending for humidity 40 % at 22°C either coinciding with the average value of natural hair 720 X 10^{-5} $gfcm^2$/strand, or showed a quite close value, and the behavior of the rigidity for bending decreased accompanying the humidity increase was also quite close to the natural hair.

Therefore, it is seen that, since the wig 40 manufactured using the artificial hair 1 or 10 of the present invention has feelings, such as appearance, tactile and texture, similar to natural hair, and these characteristics change like natural hair under high humidity, or when wet with water, it can be worn with natural feeling.

[0089] The present invention is by no way limited to the above-mentioned Examples, and needless to say that various modifications are possible within the range of invention as set forth in the claims, which is also included within the range of the present invention. For example, polyamide resins may be properly chosen so that the desired rigidity for bending and others may be attained.

Claims

1. An artificial hair having a sheath and core structure comprising a core portion and a sheath portion covering said core portion, **characterized in that**:

   said core portion is made of a polyamide resin, and said sheath portion is made of a polyamide resin having lower rigidity for bending than said core portion.

2. The artificial hair as set forth in Claim 1, **characterized in that** the surface of said artificial hair is deglossed by having a fine concave and convex portion.

3. The artificial hair as set forth in Claim 2, **characterized in that** said fine concave and convex portion is formed by spherocrystal and/or blast processing.

4. The artificial hair as set forth in Claim 1, **characterized in that** said core portion is made of a semi-aromatic polyamide resin, and said sheath portion is made of a linear saturated aliphatic polyamide resin.

5. The artificial hair as set forth in Claim 4, **characterized in that** said semi-aromatic polyamide resin is an alternating copolymer of hexamethylenediamine and terephthalic acid, or an alternating copolymer of metaxylylene diamine and adipic acid.

6. The artificial hair as set forth in Claim 4, **characterized in that** said linear saturated aliphatic polyamide resin is a caprolactam ring-opening polymer, and/or an alternating copolymer of hexamethylene-diamine and adipic acid.

7. The artificial hair as set forth in Claim 1, **characterized in that** the sheath and core weight ratio of said sheath and said core portions is 10/90 - 35/65.

8. The artificial hair as set forth in Claim 1, **characterized in that** said artificial hair contains pigment and/or dye.

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

   said artificial hair has a sheath and core structure comprising a core portion and a sheath portion covering said core portion,
   said core portion is made of a polyamide resin, and said sheath portion is made of a polyamide resin having lower rigidity for bending than said core portion.

10. The wig as set forth in Claim 9, **characterized in that** the surface of said artificial hair is deglossed by having a fine concave and convex portion.

11. The wig as set forth in Claim 10, **characterized in that** said fine concave and convex portion is formed by spherocrystal and/or blast processing.

12. The wig as set forth in Claim 9, **characterized in that** said core portion is made of a semi-aromatic polyamide resin, and said sheath portion is made of a linear saturated aliphatic polyamide resin.

13. The wig as set forth in Claim 12, **characterized in that** said semi-aromatic polyamide resin is an alternating copolymer of hexamethylenediamine and terephthalic acid, or an alternating copolymer of metaxylylene diamine and adipic acid.

14. The wig as set forth in Claim 12, **characterized in that** said linear saturated aliphatic polyamide resin is a caprolactam ring-opening polymer, and/or an alternating copolymer of hexamethylene-diamine and adipic acid.

15. The wig as set forth in Claim 9, **characterized in that** the sheath and core weight ratio of said sheath and said core portions is 10/90 - 35/65.

16. The wig as set forth in Claim 9, **characterized in that** said artificial hair contains pigment and/or dye.

FIG. 1

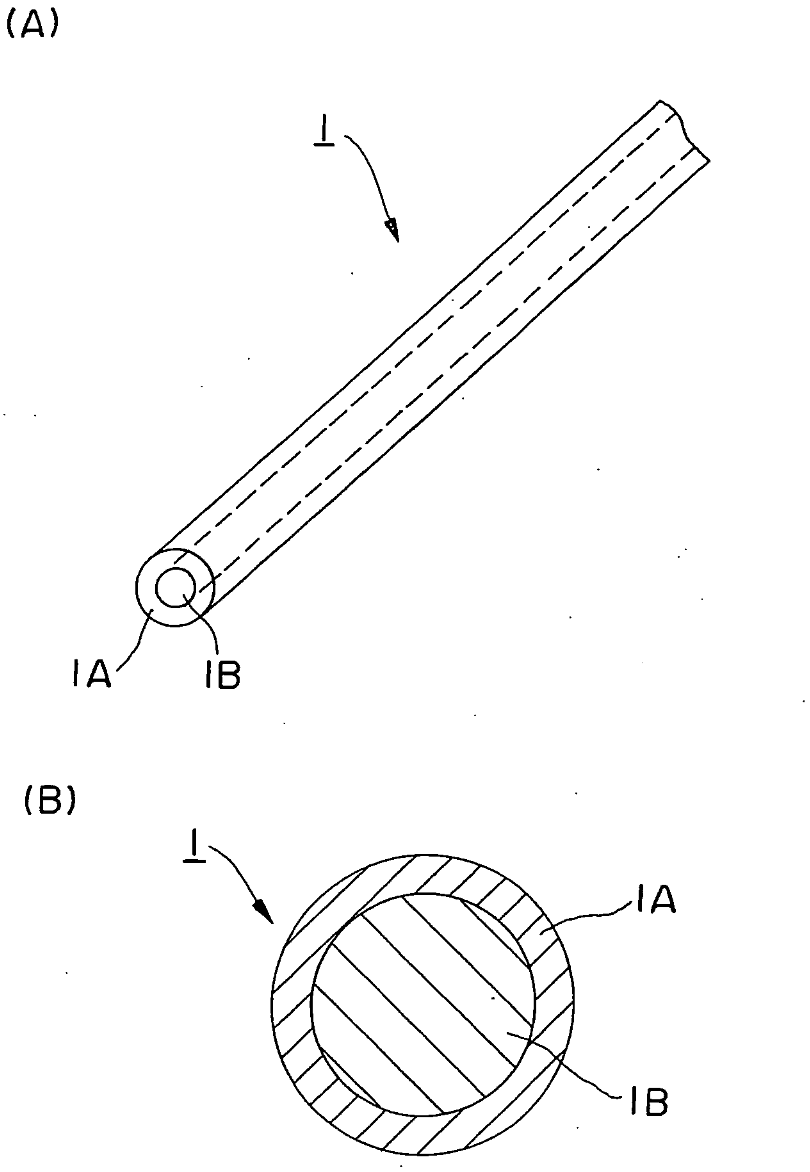


FIG. 2

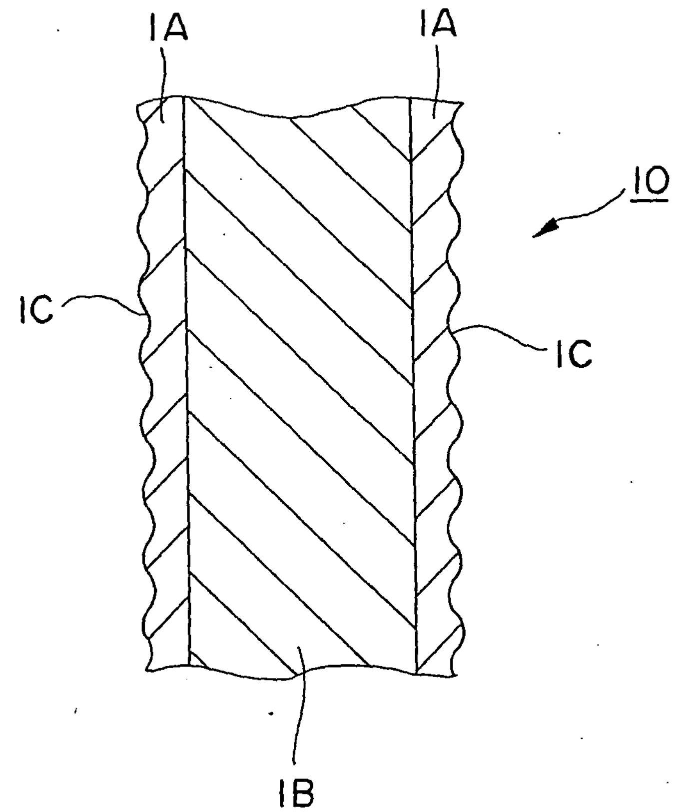


FIG. 3

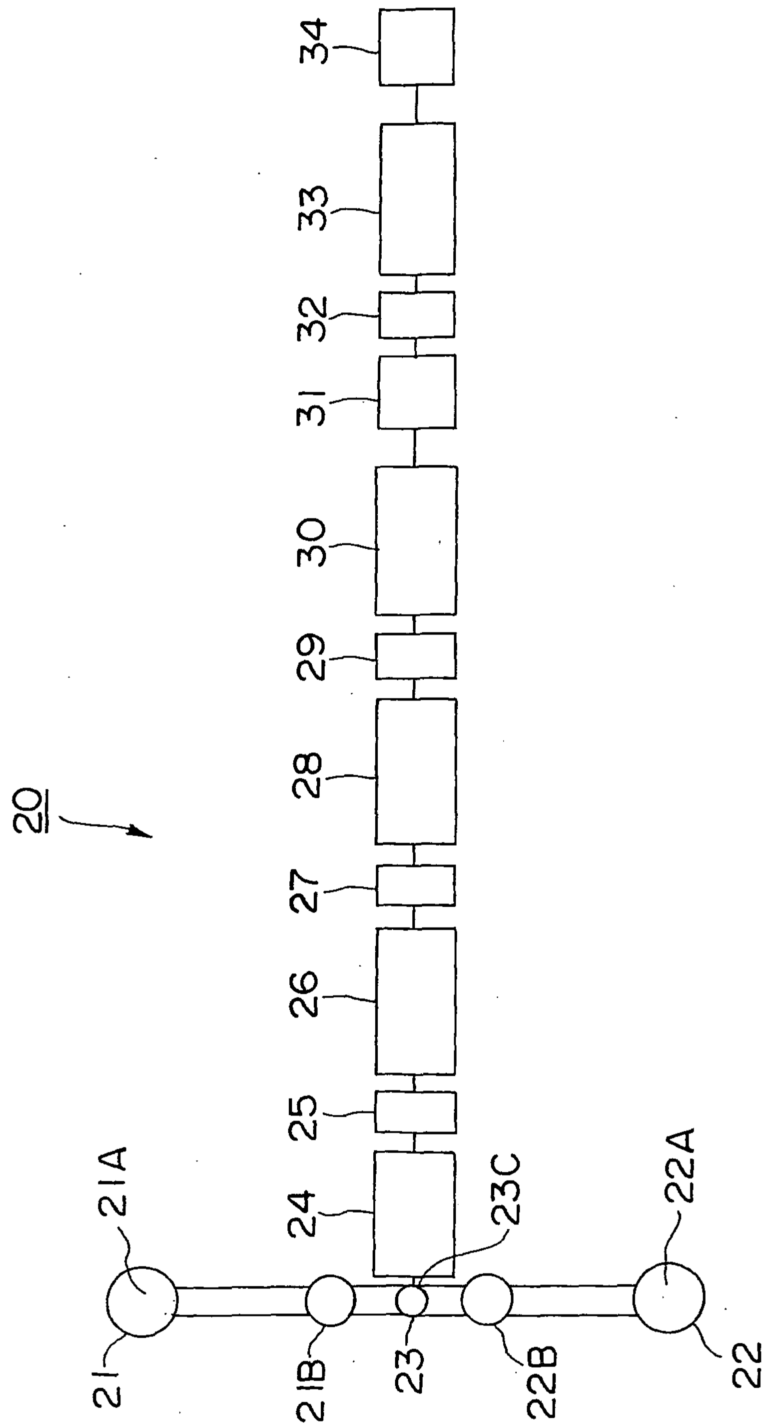


FIG. 4

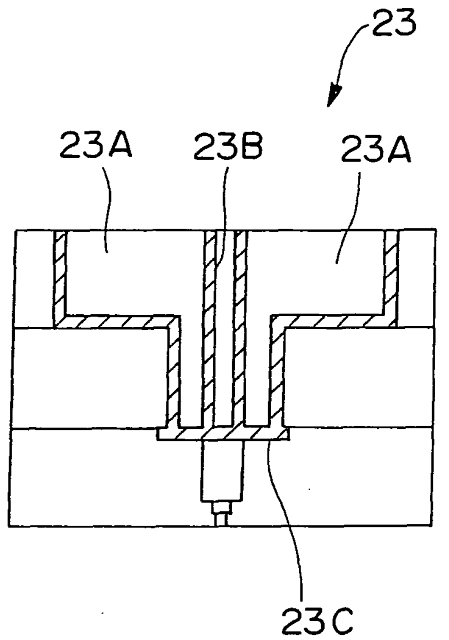


FIG. 5

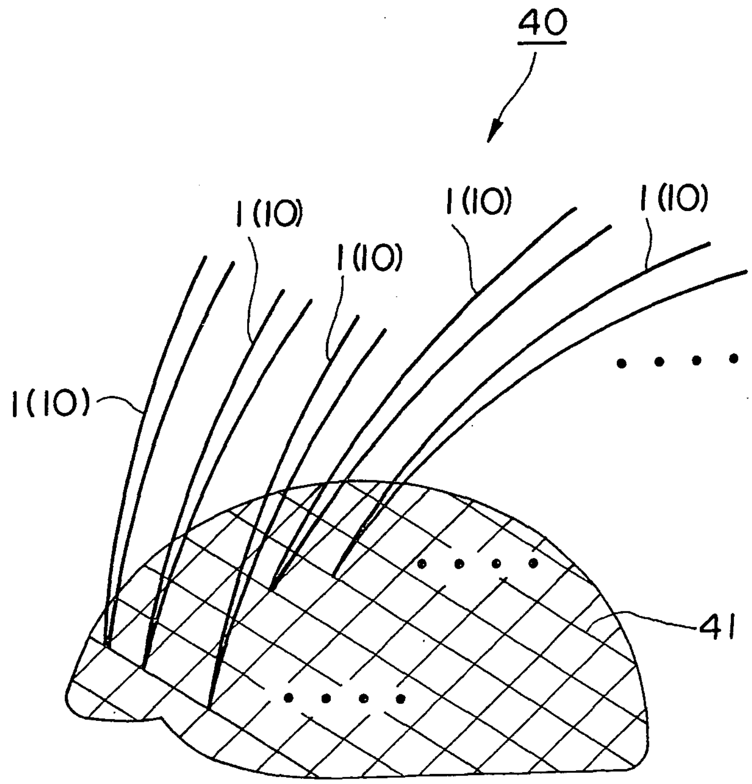
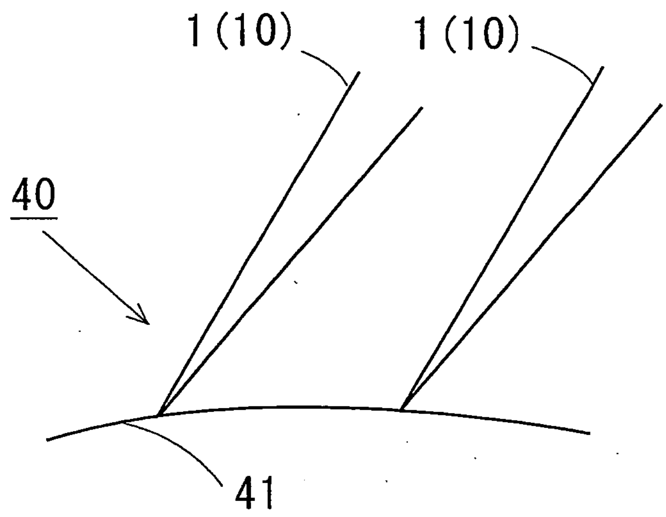


FIG. 6

(A)



(B)

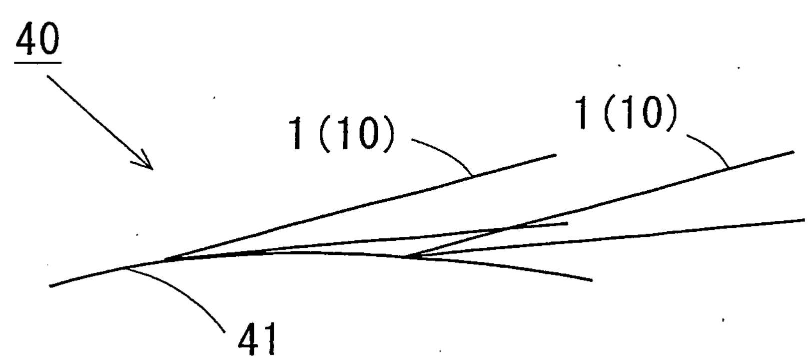


FIG. 7

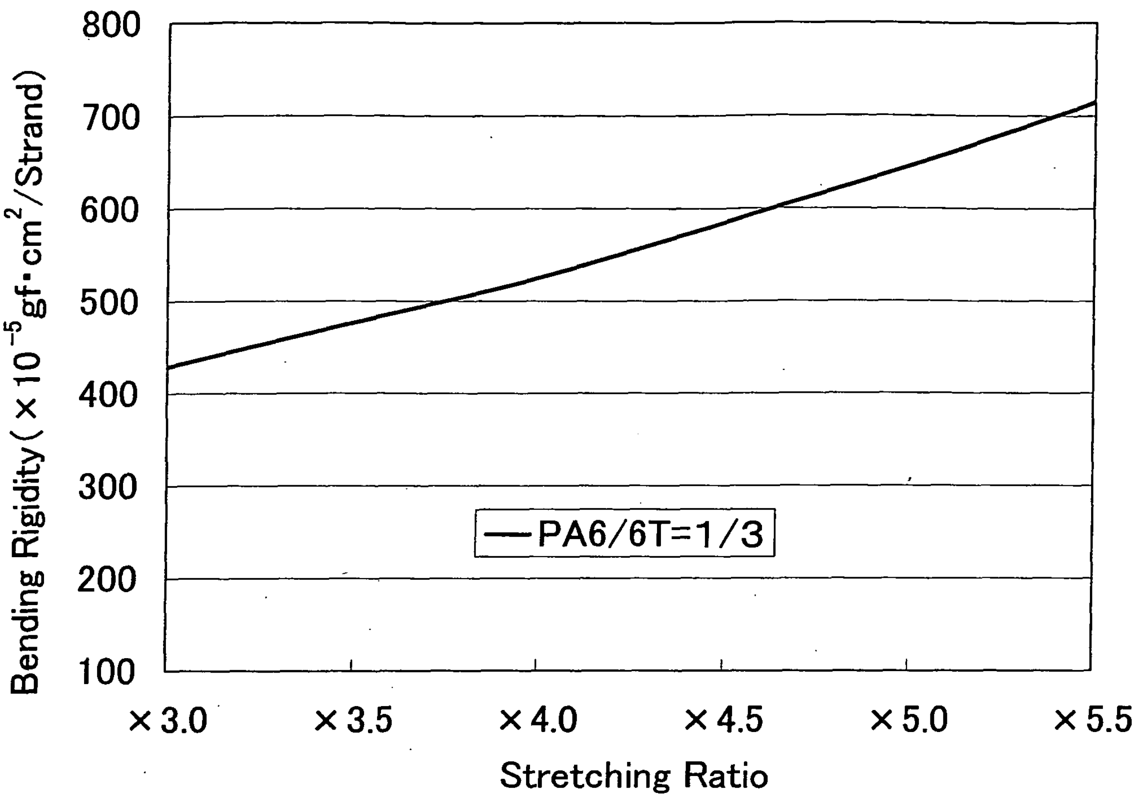

800
700
600
500
400
300
200
100
Bending Rigidity(×10⁻⁵gf·cm²/Strand)
—PA6/6T=1/3
×3.0
×3.5
×4.0
×4.5
×5.0
×5.5
Stretching Ratio

FIG. 8

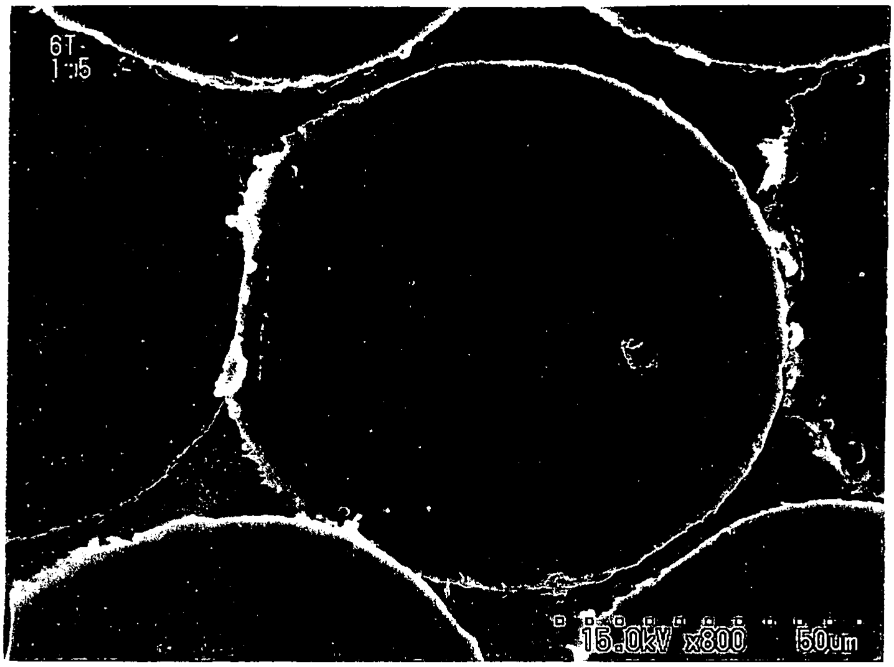


FIG. 9

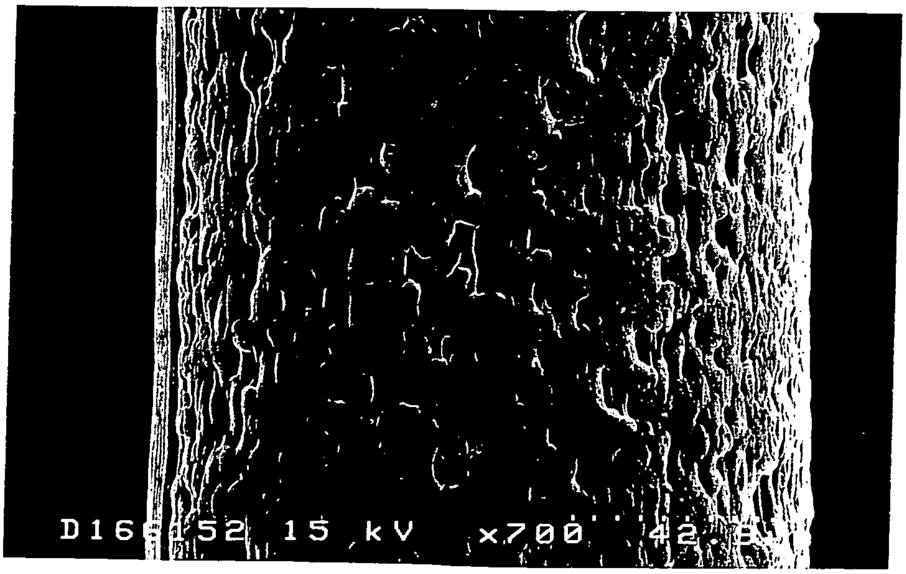


FIG. 10

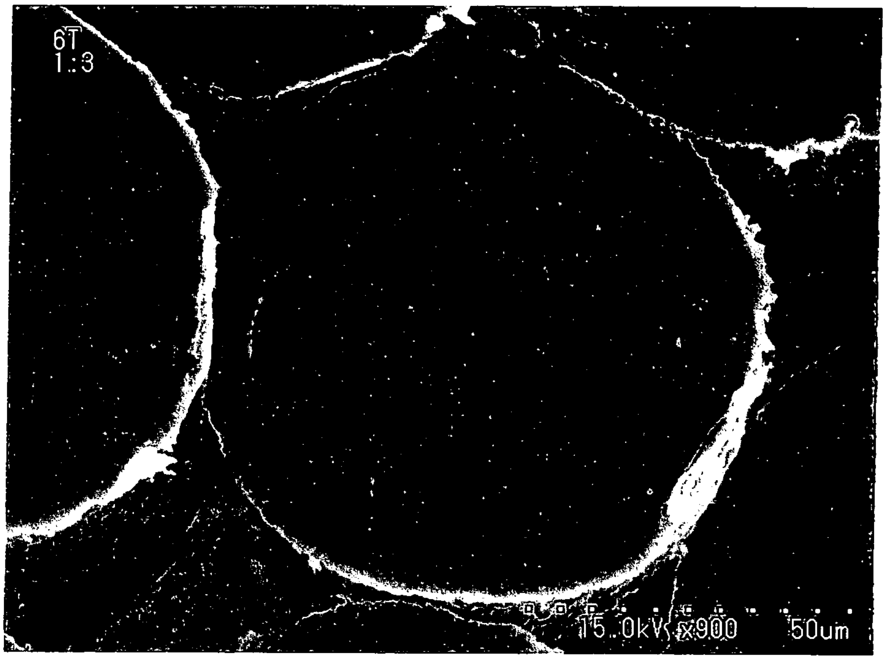


FIG. 11

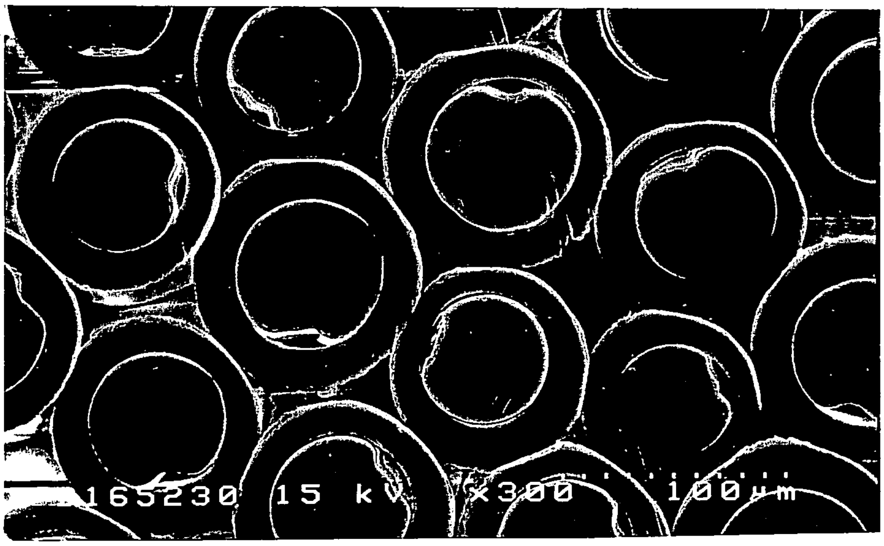
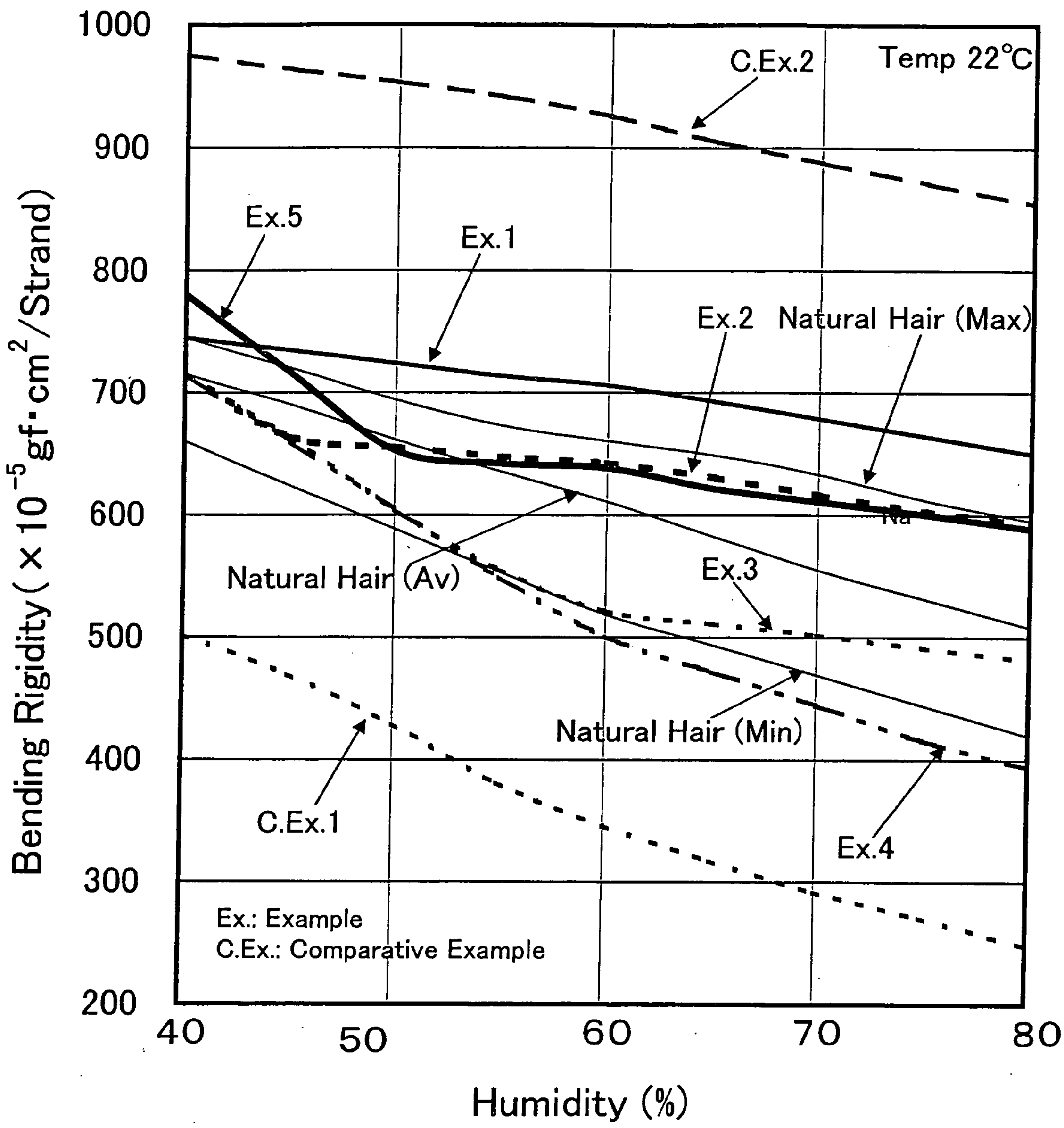


FIG. 12



Temp 22℃
C.Ex.2
Ex.5
Ex.1
Ex.2
Natural Hair (Max)
Natural Hair (Av)
Ex.3
Natural Hair (Min)
C.Ex.1
Ex.4
Ex.: Example
C.Ex.: Comparative Example
Bending Rigidity(×10^-5gf·cm^2/Strand)
1000
900
800
700
600
500
400
300
200
40
50
60
70
80
Humidity (%)

FIG. 13

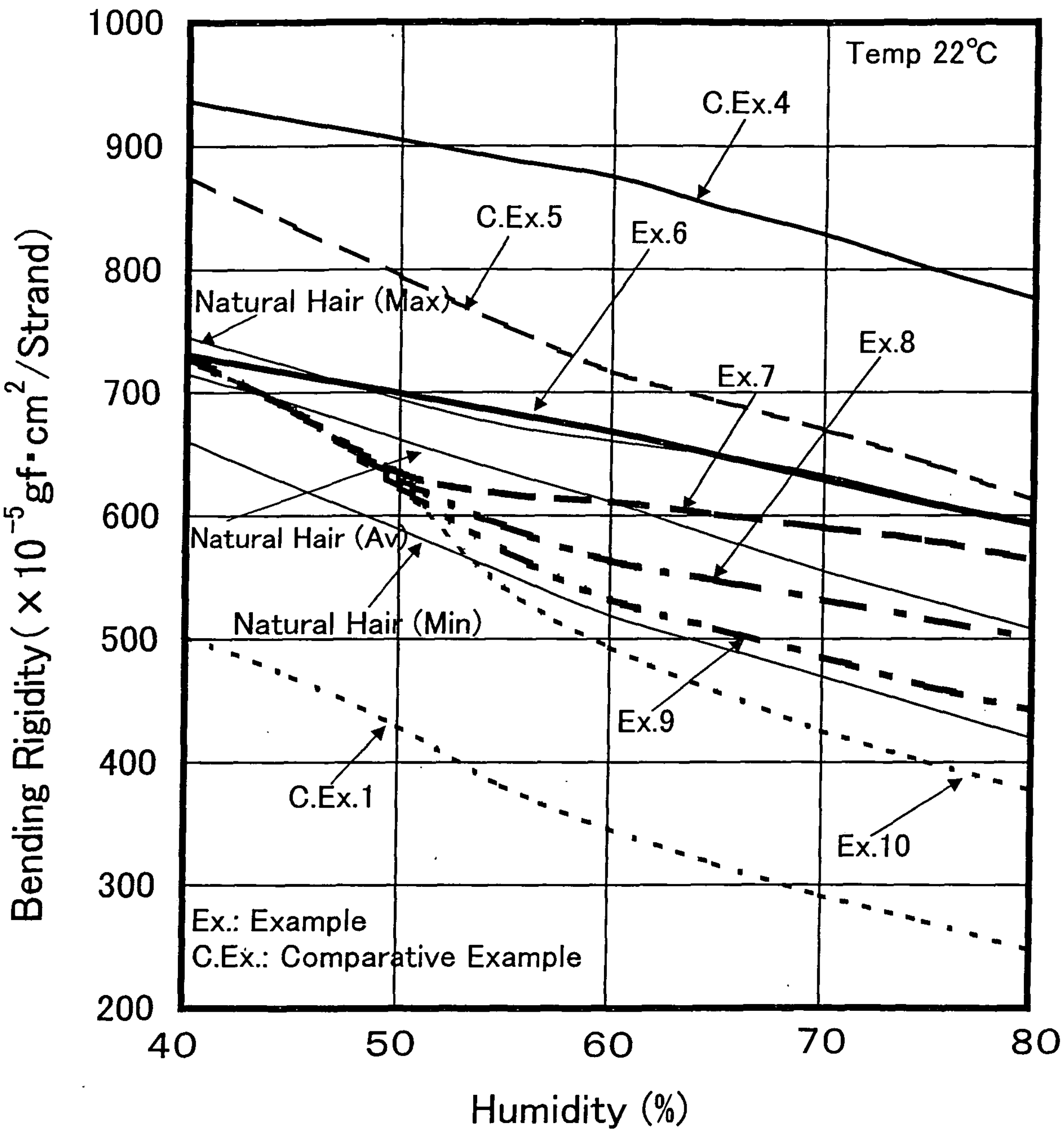
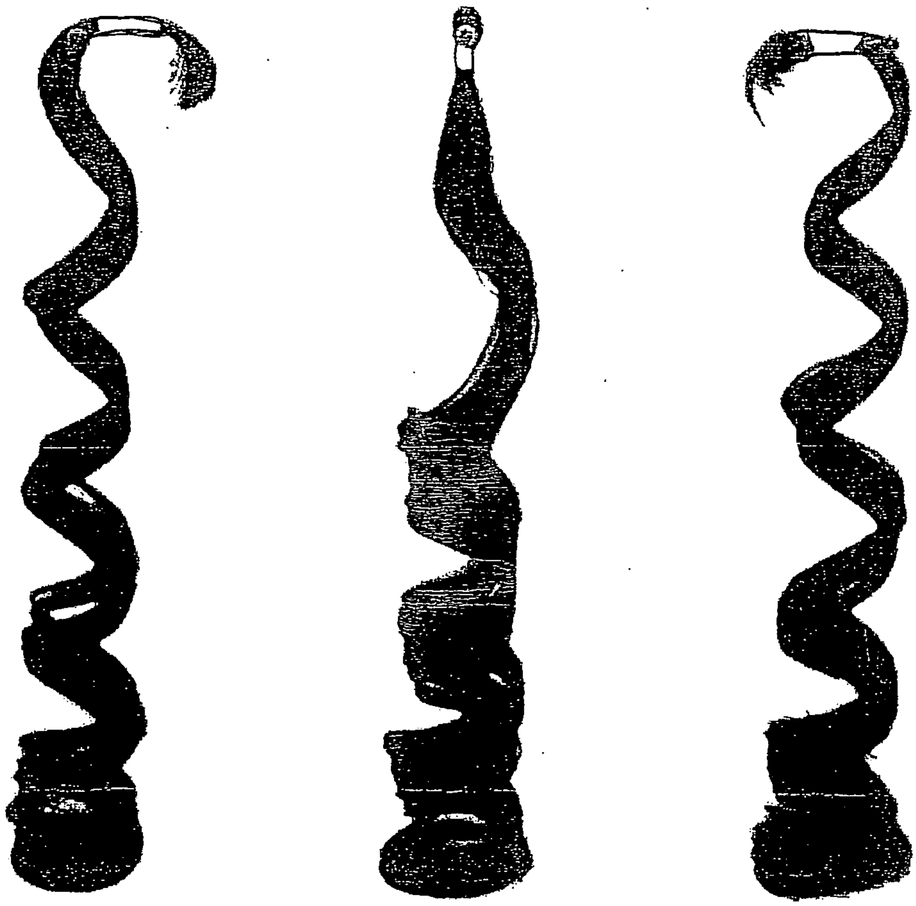
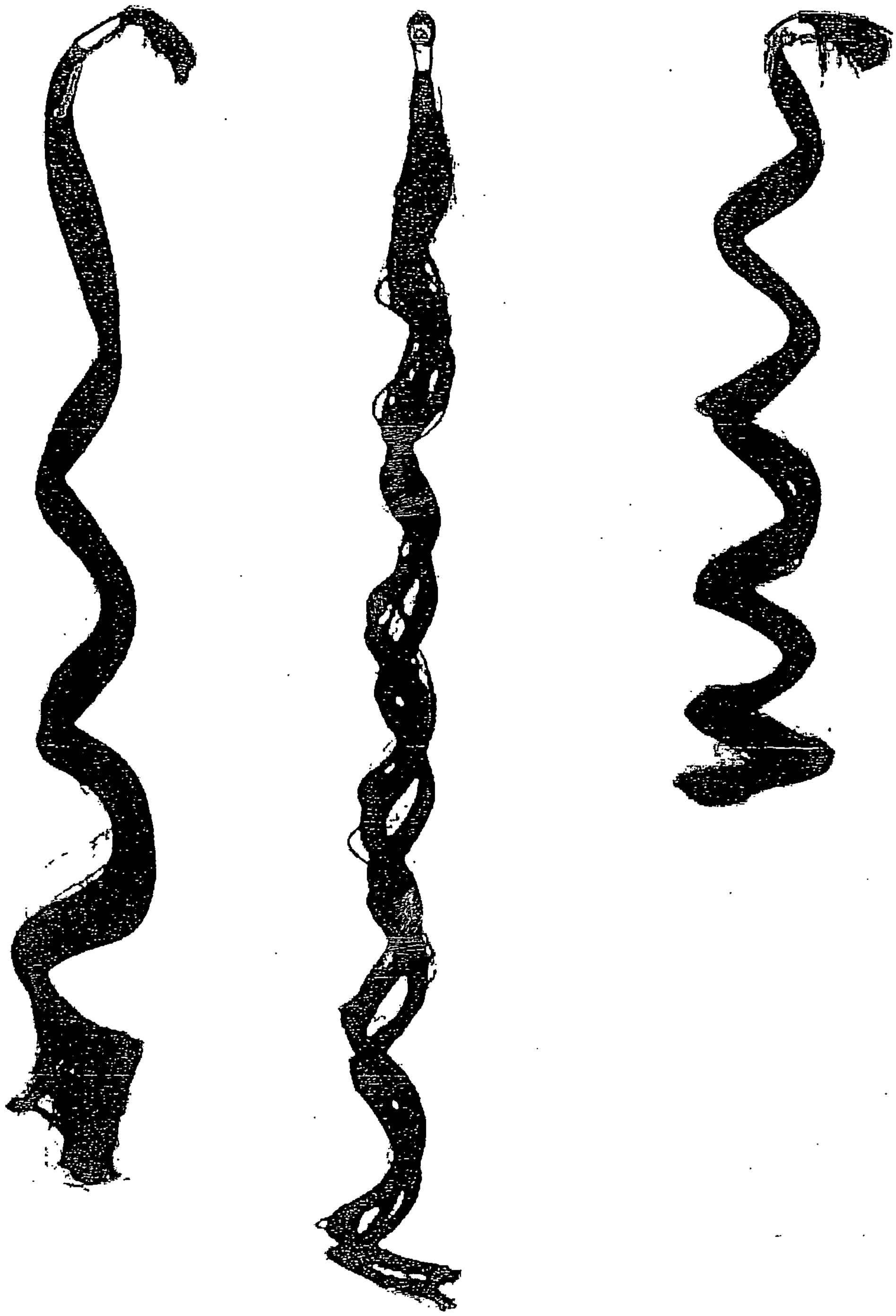

Temp 22℃
C.Ex.4
C.Ex.5
Ex.6
Natural Hair (Max)
Ex.8
Ex.7
Natural Hair (Av)
Natural Hair (Min)
Ex.9
C.Ex.1
Ex.10
Ex.: Example
C.Ex.: Comparative Example
1000
900
800
700
600
500
400
300
200
40
50
60
70
80
Bending Rigidity(× 10^-5 gf·cm^2 /Strand)
Humidity (%)

FIG. 14



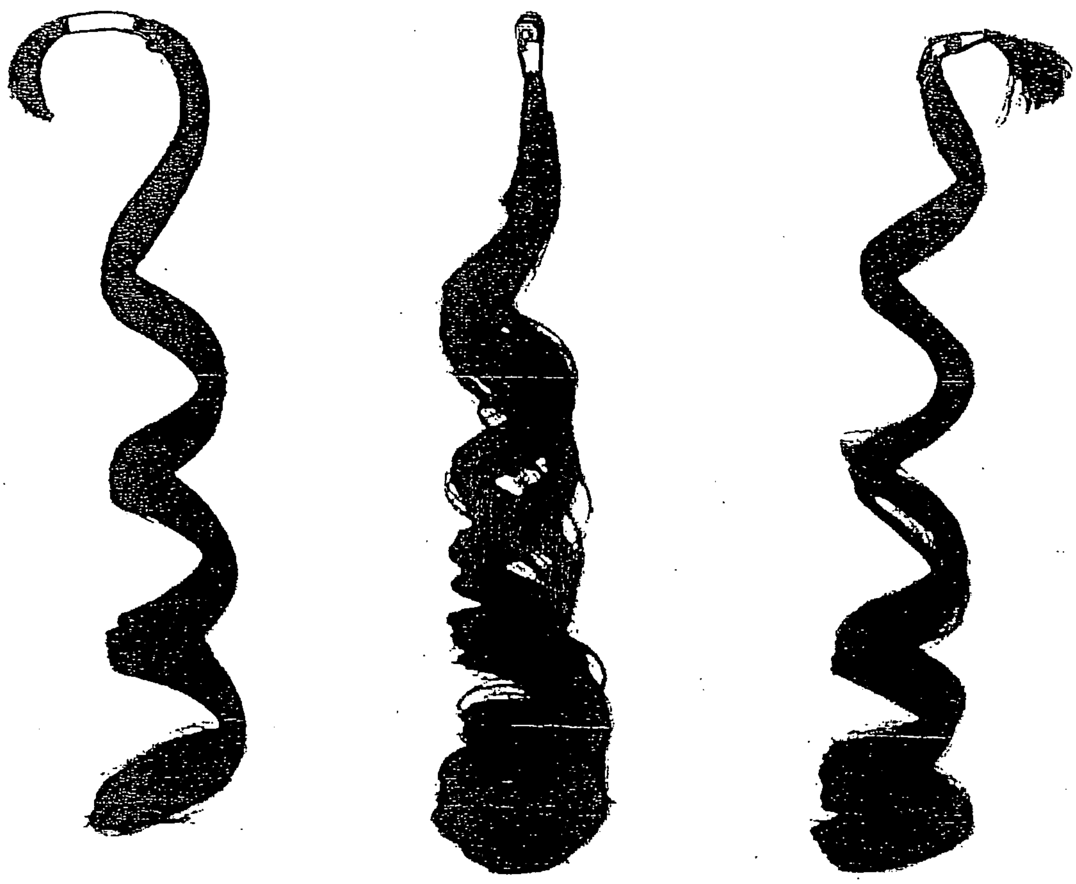
(A) (B) (C)

FIG. 15



(A) (B) (C)

FIG. 16



(A) (B) (C)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/301647

A. CLASSIFICATION OF SUBJECT MATTER
A41G3/00(2006.01), *D01F8/12*(2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A41G3/00, D01F8/12

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 3-185103 A (Toray Industries, Inc.), 13 August, 1991 (13.08.91), Page 3, lower left column, line 18 to page 4, lower left column, line 17 (Family: none)	1-16
Y	JP 1-282309 A (Unitika Ltd.), 14 November, 1989 (14.11.89), (Family: none)	1-16
Y	JP 7-157909 A (Aderans Kogei Co., Ltd.), 20 June, 1995 (20.06.95), Par. Nos. [0010] to [0013] (Family: none)	3,11

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

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"&" document member of the same patent family

Date of the actual completion of the international search 19 April, 2006 (19.04.06)	Date of mailing of the international search report 25 April, 2006 (25.04.06)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2006/301647

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-52184 A (Yugen Kaisha Di Ti Ei), 19 February, 2004 (19.02.04), (Family: none)	9-16

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP S646114 A **[0010]**
- JP 2002129432 A **[0010]**
- JP 2005009049 A **[0010]**
- JP 2002161423 A **[0010]**

Non-patent literature cited in the description

- **SUEO KAWABATA.** *Sen'ikikai Gakkaishi,* 1973, vol. 26 (10), 721-728 **[0010]**
- Handling Manual of KES-SH Single Hair Bending Tester. KATOTECH LTD, **[0010]**