

[54] METHOD OF MAKING WIGS OR THE LIKE

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[56]

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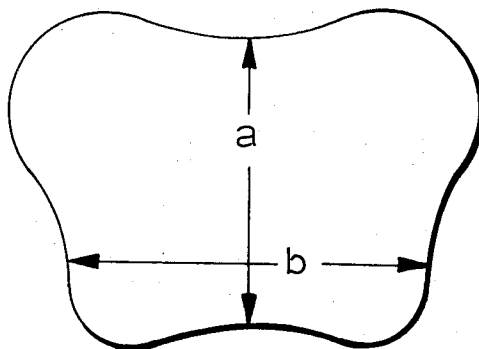
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[57]

ABSTRACT

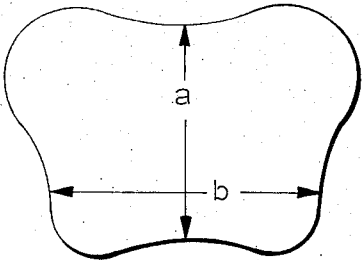
A method of making wigs or the like is provided herein from synthetic fibers in which four concave arcs and convex arcs are formed alternatively on the peripheral edge of the cross-section of the fibers and the drape index of the fibers is maintained in a specific range. The fibers are sewed together as wefted hairs which are then heat-set into the desired wig product.

1 Claim, 1 Drawing Figure



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METHOD OF MAKING WIGS OR THE LIKE

This invention relates to a method of making wigs or the like wherein the drapability and curled form settability are remarkably improved and more particularly to a method of making wigs or the like from novel synthetic fibers in which respectively four concave arcs and convex arcs are formed on the peripheral edge part of the cross-section and the drape index is maintained in a specific range.

As a trend of the fashion in recent years, it has become common to wear wigs and the demand of wig forming materials excellent in the drapability and curled form settability has quickly increased with it. Human hairs have been mostly used as such wig forming materials. However, as the supply of human hairs is quantitatively limited, it is attempted to use synthetic fibers as wig forming materials.

However, such synthetic fibers lack the human hair-like natural wave retainability and pliability as a general defect due to the characteristics of the polymer forming said synthetic fibers and have often resulted in the remarkable reduction of the commodity value of the final products. As a matter of fact, many industrial discoveries have been already suggested with a view to making the characteristics of such synthetic fibers for wigs similar to those of human hairs and to impart an improved curled form retainability and drapability to such synthetic fibers. There can be enumerated, for example, a method wherein the drapability is improved by reducing the frictional resistance of wig forming fibers by treating them with a chemical solution and a method wherein the drapability and curled form settability are improved by adjusting the cross-sectional shape of wig-forming fibers as suggested in Japanese Patent application No. 33217/1970. By these methods, the object of making the hand of wig forming fibers similar to that of human hairs has been attained to some extent. However, a difficulty in practice has been still recognized in working these methods on an industrial scale because it is necessary to adopt a special treating step with a chemical solution or spinning conditions in them.

Here, as a result of making hard researches to eliminate all of such conventional technical restrictions and to establish an industrial means of making the drapability and curled form settability of wigs made of synthetic fibers very close to those of human hair wigs, the present inventors have reached the present invention by discovering a method of making novel wigs wherein synthetic fibers having a peculiar peripheral edge shape of the cross-section and drape index are used as wefted hair forming component.

A main object of the present invention is to provide a method of making synthetic fiber wigs in which the curled form heat-setting treatment is possible at a comparatively low temperature and the drapability and curled form retainability of the final product are remarkably improved.

Another object of the present invention is to establish a means of making wigs of synthetic fibers satisfying simultaneously the pliability as of monofilaments very similar to the touch of human hairs and the drapability of wefted hairs as of a fiber aggregate and excellent in the beauty.

Other objects of the present invention will become clear from the following description which is made by referring partly to the accompanying drawing (FIG. 1)

which is an explanatory view showing a cross-sectional shape of a wig-forming fiber embodying the present invention and wherein a is the short diameter and b is the long diameter.

These objects of the present invention can be effectively attained by adopting a method of making novel wigs having it as a subject matter to sew as wefted hairs the synthetic fibers in which respectively four concave arcs and convex arcs are arranged alternately on the peripheral edge part of the cross-section as shown in FIG. 1, the relation of

$$1.0 \leq b/a \leq 3.5 \quad (1)$$

is maintained between the short diameter a and long diameter b connecting the opposed concave arcs and intersecting rectangularly with each other and the drape index K (in cm^{-3}) obtained by dividing the bending deflection Y (in $\text{cm}.$) at the free end of a cantilever on the entire length of which the dead-weight of the wig forming fibers is uniformly distributed by the fourth power of the span length l of the cantilever from the fixed end to the free end is maintained in the range of

$$0.07 \times 10^{-5} \leq K \leq 0.16 \times 10^{-5} \quad (2)$$

and then heat-set the fibers as curled.

The method of the present invention shall be detailed in the following with reference to the accompanying drawing.

The present inventors have reached the present invention by discovering the fact that a soft hand very similar to that of human hairs can be imparted to a wig and the curled form retainability and drapability can be also greatly improved by using as a wefted hair forming component which is a fiber aggregation such synthetic fibers in which the cross-sectional shape and the drape index defined as a function of the modulus of direct elasticity E (in kg./cm^2) and the secondary moment of inertia of area I (in cm^4) of the cross-section are maintained in specific ranges.

Here the drape index and its physical significance shall be first explained.

The drape index K (in cm^{-3}) is a coefficient obtained by supposing a cantilever of wig forming fibers of a span length l (in $\text{cm}.$) on which a uniform dead weight W (in $\text{kg./cm}.$) is made to act per unit length and dividing the bending deflection Y (in $\text{cm}.$) at the free end of said cantilever substantially identical with the wefted hair supporting form by the fourth power of the above mentioned span length l (in $\text{cm}.$) and is a physical quantity quantitatively indicating the drapability and curled form retainability of wefted hairs made by sewing arranged fiber bundles at one end. As shown by the below mentioned relative formula (3), the bending deflection Y (in $\text{cm}.$) at the free end of the above mentioned cantilever is a dynamic characteristic value of the fibers defined by the modulus of direct elasticity E (in kg./cm^2) and the moment of inertia of area I (in kg./cm^2) of the cross-section of the wig forming fibers and is a physical quantity quantitatively indicating the bending deflection of the wig forming fibers including the monofilament denier and cross-sectional shape. That is to say, the bending deflection Y (in $\text{cm}.$) at the

free end of the cantilever consisting of the wig forming fibers can be theoretically calculated from the well known formula

$$Y = Wl^4/8EI$$

for determining the deflection of a beam subjected to uniformly distributed loads.

Here the curl setting conditions for wig forming fibers sewn as wefted hairs shall be considered. There is generally adopted a method wherein wig forming fibers are heated as wound on such cylinder as a hair curler and are heat-set as curled while an internal strain is given to said fibers. Therefore, it is understood that the curl retainability after the heat-setting is influenced by the heat-setting temperature, heating time and the thermal characteristics of the polymer component forming said fibers.

However, in fact, these factors are greatly limited in the selection ranges by the degree of the heat hysteresis in the fiber producing step and do not always have sufficient selection ranges as means of improving the drapability and curled form retainability of wig forming fibers.

Therefore, if the drapability and curled form retainability of wig forming fibers are to be improved while practically satisfying restrictions in practice on the kind of the polymer component forming said fibers, the degree of the heat hysteresis in the fiber producing step and the curl setting temperature after the fibers are sewn into a wig, it will be necessary to improve the curl setting effect of the wefted hairs which are a fiber aggregation by adjusting the bending rigidity and cross-sectional shape which are other factors contributing to the elastic properties of said fibers than the above mentioned heat hysteresis.

As a result of making a series of systematic experiments to elucidate the interrelations of the above mentioned factors contributing to the curled form retainability and drapability and arranging the experiment results by a regression analysis, the present inventors have elucidated the fact that the objects of the present invention can be effectively attained by maintaining in a specific range the drape index derived from the cross-sectional shape of wig forming fibers and the deflection at the free end of a cantilever over the entire span length of which the dead-weight of said fibers is uniformly distributed.

That is to say, by simultaneously satisfying the relations of

$$1.0 = b/a = 3.5$$

and

$$0.7 \times 10^{-5} = K = 0.16 \times 10^{-5}$$

wherein $K = Y/4$ wherein $Y = Wl^4/8EI$ in wig forming fibers, the drapability and curl settability of a wig on which wefted hairs are formed of synthetic fibers can be greatly improved to be higher than of a wig made of synthetic fibers having conventional flat cross-sections.

As it can be easily understood also from the formula (3) for determining the deflection at the free end of the above mentioned cantilever having uniformly distributed loads, if the curl settability of wig forming fibers

is to be improved under the same heat-setting temperature conditions, it will be desirable to make the value of the bending rigidity EI as large as possible and to reduce the dead-weight W of the wefted hair forming fibers sewn to be in the form of a cantilever. However, if the value of the bending rigidity EI is increased unlimitedly, the pliability in the touch will be rather reduced. Therefore, it is clear that, by a method of adjusting only such mechanical properties as a bending rigidity, a limit is recognized in the modification as of wig forming fibers.

The reason why not only such mechanical properties as the bending rigidity but also the peripheral edge form of the cross-section of wig forming fibers is specified in the method of the present invention should be solely found here. If the curled form retainability and drapability of wefted hairs which are a fiber aggregation or of a wig are to be improved, it will be necessary to elucidate not only the bending rigidity as of monofilaments but also the peculiarity of the cross-sectional arrangement in the monofilament group forming a fiber aggregation or so-called fiber bundle forming wefted hairs or a wig and the characteristic of the bending behavior caused by it.

To explain more particularly, as means of improving the curled form retainability of wefted hairs or a wig as a fiber aggregation, there can be enumerated a method wherein the friction coefficient on the fiber surface is made large by a treatment with chemicals and a method wherein pleats are formed on the fiber surface. However, the former is accompanied with a defect that the wig forming fibers will squeak and stick and the latter is accompanied with a defect that the wig forming fibers will reduce in the combing properties. In a wig in which synthetic fibers having known flat cross-sectional shapes are used as wefted hair forming component, when the fiber bundle is deformed by being wound on a hair curler to set the curled form, the individual monofilaments forming the fiber bundle will be rearranged in the cross-sectional shapes in the direction of minimizing the bending moment.

On the other hand, in the wig forming fibers in which respective four concave arcs and convex arcs satisfying the determined dimensional characteristics in the peripheral edge part of the cross-section as suggested in the present invention are alternately arranged, the bending behavior as of a fiber bundle in case a bending deformation is given is made essentially different from that of the above mentioned flat cross-section fibers so that the respective four concave arc parts and convex arc parts may keep a line contact state favorable to impart a frictional force in the wefted hairs which are a fiber aggregation and the cross-sectional shapes may not be always rearranged only in the direction of minimizing the bending moment in the bending deformation. Therefore, the bending rigidity EI as of not only the individual monofilaments forming the wefted hairs but also the monofilament group forming the fiber aggregation will not greatly reduce as seen in the flat cross-section fiber bundle. Thus, the level of the bending rigidity required to retain the heat-set curled form can be well retained.

In this sense, it has a critical significance to adjust the mechanical properties of the monofilaments forming the wefted hairs which are a fiber aggregation as a more preferable manner of working the method of the present invention. It is desirable to maintain the bending ri-

gidity EI (in kg.cm.²) and the product EI·K (in kg./cm.) of the bending rigidity EI and draping index K in the specific ranges defined in the below mentioned relative formulas (4) and (5). That is to say, it is desirable to simultaneously satisfy the relations of

$$2 \times 10^{-6} \leq E \leq 10 \times 10^{-6}$$

and

$$0.26 \times 10^{-11} \leq EI \cdot K \leq 1.12 \times 10^{-11}$$

The bending rigidity EI in the present invention is calculated according to the below mentioned formula (6)

$$EI = \alpha/3 \times l$$

(wherein α is a value read from the below mentioned stress-strain curve and has a relation of $W = \alpha X$ and l is a length (in cm.) of the sample fiber) from the initial gradient α of the stress-strain curve obtained by recording the relation of the bending stress W (in kg.) and bending deflection X (in cm.) by using a measuring apparatus suggested by R. M. Khayatt and N. H. Chamberlin (pages 185 to 197 of the Journal of Textile Institute, Vol. 39, 1948).

Here synthetic fibers in which the bending rigidity EI is less than 2×10^{-6} (kg.cm.²) and the drape index K exceeds 0.16×10^{-5} (cm.⁻³) are very soft in the hand in the touch, lack the softness in the sight, have a hand quite different from the pliability of human hairs and are not proper to use as wig forming fibers. Further, a wig made of synthetic fibers in which the bending rigidity EI exceeds 10×10^{-6} (kg.cm.²) and the drape index K is less than 0.07×10^{-5} (cm.⁻³) is rigid in the touch, lacks the softness in the sight and is very low in the commodity value. Wig forming fibers in which the product of the bending rigidity EI and the drap index K exceeds 1.12×10^{-11} (kg.cm.) are small in the modulus of bending elasticity but are very large in the monofilament denier, lack the strength and will therefore break during the fiber producing step or during the use of the final product to remarkably reduce in the durability and beauty. Further, the wig forming fibers themselves are very thick, give a rigid feel, therefore show a rigid touch and hand far different from the hand of human hairs and show no pliability in the sight.

On the other hand, in case the product of EI and K is smaller than 0.26×10^{-11} (kg./cm.), the monofilament denier will be small but the fibers will be like wires, will show a hand quite different from that of human hairs and therefore will not be desirable.

By working the method of the present invention, the curl settability under the same curl setting temperature conditions will distinctly improve to be higher than in the case of conventional flat cross-section fibers and, even at a lower curl setting temperature, for example, dry heat of 60° to 90°C. in a beauty salon or general home, a curled form high in the durability can be effectively kept.

Further, by imparting such specific cross-sectional shape and bending rigidity as are mentioned above to wig forming fibers, a line contact friction state will be held between the monofilaments forming the fiber bundle and the drapability of the wig forming fibers which are a fiber aggregation will remarkably improve. Further, the wig forming fibers according to the method of the present invention show no such difficulty in combing as is seen in flat cross-section fibers. Such surprising effect that, even in the lustrous properties, they retain a tone rich in the shade and depth not comparable with those of conventional wig forming fibers containing a delustering agent is recognized.

The method of the present invention can be generally used as a means of making wigs by using such synthetic fibers as acrylic synthetic fibers, polyesteric synthetic fibers or polyamidic synthetic fibers as a wefted hair or wig forming component. Particularly, as acrylic synthetic fibers have a clear dyeability and touch and hand very similar to those of human hairs, an advantage of industrially working the method of the present invention as a method of making wigs of synthetic fibers by using acrylic synthetic fibers as a wefted hair forming component is recognized.

Examples of the method of the present invention are mentioned in the following. The present invention is never restricted in the scope of the right by the description of such examples. By the way, in the following reference example and examples, the parts and percentages are by weight as a rule unless otherwise specified.

REFERENCE EXAMPLE

On each of five kinds of wigs made of commercial synthetic fibers and one kind of wig made of human hairs, the bending rigidity EI and drape index K of the monofilaments were measured and the bending rigidity index of the wefted hairs which were a fiber aggregation was measured. Further, the hand consisting mostly of the touching softness of the wig forming fibers and the drapability of the curled form was functionally evaluated by two wig manufacturers and three beauty experts. The results of the judgements are shown in the following Table 1.

The bending rigidity index of the sample fiber bundle was obtained by holding a sample fiber bundle of total

Table 1

Sample No.	Wig forming material	Monofilament denier	Bending rigidity EI (kg.cm. ²)	Drape index (cm. ⁻³)	Bending rigidity index (g.)	Results of functional evaluation
1	Human hairs	48	5.8×10^{-6}	0.12×10^{-5}	17.8	Favorable
2	Acrylic synthetic fibers	48	5.9	0.115	16.5	do.
3	do.	49	10.2	0.060	20.5	Excess bending rigidity
4	do.	40	3.5	0.155	14.8	Passable
5	Polyvinyl chloride fibers	54	5.2	0.140	15.3	Favorable
6	Nylon-6 fibers	48	4.0	0.180	12.8	Short bending rigidity

deniers of 60,000 deniers and a length of 6 cm. in the center part of the lengthwise direction with a circular ring of an inside diameter of 5 mm. made of a steel wire of a diameter of 1 mm., pulling out said fiber bundle through a circular ring of an inside diameter of 2 cm. made of a stainless steel smooth on the surface and measuring the maximum stress (in g.) at the time of pulling it out.

From the results of the evaluation shown in Table 1, it is understood that the wigs made of synthetic fibers

EXAMPLE 2

Each of wigs made respectively of the sample fibers 7 and 8 and acrylic fibers of a flat cross-section having a b/a ratio of 10/1 and drape index of 0.120×10^{-6} and prepared separately as a comparative sample had curls set at five curl setting temperatures of 70°, 80°, 90°, 100° and 110°C. and the curl setting rate was measured. Then the hairs were washed and the curl set retention was measured.

Table 3

Curl setting temperature (°C.) and time (min.)	Curl set index (%)			Curl set retention (%) after washing hairs		
	Sample No. 7	Sample No. 8	Comparative sample	Sample No. 7	Sample No. 8	Comparative sample
°C.						
70	91	90	84	70	68	62
80	96	94	90	75	75	66
90	98	97	95	78	76	70
100	98	98	98	83	80	74
110	98	98	97	83	80	73

not satisfying the drape index range suggested in the present invention do not meet the practical requirements in the drapability and touching hand.

EXAMPLE 1

12 parts of an acrylonitrile polymer obtained by copolymerizing 90 percent acrylonitrile and 10 percent vinyl acetate were dissolved in an aqueous solution of sodium thiocyanate in an ordinary manner to prepare a spinning solution. Then this spinning solution was extruded into a low temperature coagulating bath consisting of a known aqueous solution of sodium thiocyanate through a spinneret provided with an I-shaped spinning orifice forming the final fiber to be of a peripheral edge shape of the cross-section defined by the relative formula (1) and was then water-washed, stretched and dried or heat-treated to make six kinds of sample fibers.

Then these sample fibers were dyed and dried in an ordinary manner to obtain wig forming fibers.

Then, on each of the thus obtained six kinds of sample fibers, the bending rigidity EI, drape index K and bending rigidity index were measured and the hand was functionally judged by the five experts mentioned in the reference example. The results are shown in Table 2. It will be understood from this example that each of the four kinds of sample fibers shown in the sample Nos. 7, 8, 9 and 12 satisfying simultaneously the cross-sectional shape and mechanical properties defined in the present invention has a very favorable hand and drapability.

Table 2

Sample No.	b/a	Monofilament denier	Bending rigidity EI (kg.cm. ²)	Drape index K (cm. ⁻³)	Bending rigidity index (g.)	Results of functional judgments
7	1.6	47	7.2×10^{-6}	0.10×10^{-5}	18.8	Favorable
8	1.9	34	4.6	0.120	17.5	do.
9	2.5	46	4.6	0.140	16.3	do.
10	2.2	41	2.2	0.250	14.8	Hot bending rigidity
11	1.0	55	11.9	0.060	23.0	Excess bending rigidity
12	1.0	48	7.1	0.095	17.8	Favorable

By the way, there was adopted a method of setting curls wherein a fiber bundle forming wefted hairs of total deniers of 100,000 deniers and a length of 45 cm. was wound and fixed on an aluminum pipe of an outside diameter of 30 mm. and was made to stay for 30 minutes in a hot air dryer adjusted to be at the above described setting temperature.

Then the wig was taken out of the hot air dryer, the curl diameter D_1 (in mm.) was measured and the curl set index was calculated according to the following formula.

$$\text{Curl set index} = 30/D_1 \times 100 \text{ (percent)}$$

After the curl set index was measured the operation of dipping the sample wig in warm water at 30°C., then pulling it up and squeezing out the deposited water was repeated 30 times during 3 minutes, then it was dehydrated and was air-dried for 24 hours, then the curl diameter D_2 (in mm.) was measured and the curl set retention after washing the hairs was calculated by the following formula.

$$\text{Curl set retention after washing hairs} = D_1/D_2 \times 100 \text{ (percent)}$$

As clear from Table 3, it is understood that the sample fibers shown in the sample Nos. 7 and 8 totally satisfying the conditions defined in the present invention are remarkably improved in the curled form settability in a low temperature range as compared with the flat cross-section fibers having substantially the same drape index.

EXAMPLE 3

Each of wigs made respectively of the sample fibers 7 and comparative sample fibers mentioned in Example 2 was wound on an aluminum pipe of an outside diameter of 50 mm. and had curls set at 90°C. by the method mentioned in Example 2. Further, in order to compare the curled form settability in general homes, it was left standing for three days and nights, was then again wound on an aluminum pipe of an outside diameter of 20 mm. and had curls set again at 70°C. and the curl set index was determined.

Table 4

	Curl set index (%) after the first setting of curls	Curl set index (%) after the second setting of curls
Comparative sample	96	73
Sample No. 7	97	84

As clear in the above mentioned Table 4, the sample fibers shown in the sample No. 7 satisfying the definition of the present invention showed a very excellent curled form resettability.

EXAMPLE 4

The flat cross-section acrylic fibers prepared as the comparative sample in Example 2 and the sample fibers shown in the sample No. 7 were respectively dyed and were then sewn into wefted hairs. The thus obtained two kinds sample wigs had curled set and were then functionally evaluated in the shade and luster in the sight by the paneler of three beauty experts. The results of the judgments are shown in Table 5. By the way, the result of the judgment of the human hair wig indicated as the sample No. 1 in the reference example as a reference material is also mentioned (All the sample fibers were thickly dyed to correspond to J.L. Color No. 3).

Table 5

	Cross-section: Long diameter/short diameter	Results of functional judgments of the tone/and luster
Sample No. 1 (human hairs)	1.3	Quiet favorable tone
Sample No. 7	1.6	Deep tone and luster
Flat cross-section acrylic fibers	1.8	Metallic luster

What we claim is:

1. A method of making wigs or the like characterized by sewing, as wefted hairs, the synthetic fibers in which respectively four concave arcs and convex arcs are arranged alternately on the peripheral edge part of the fiber cross-section, the relation of

$$1.0 \leq b/a \leq 3.5$$

(1)

is maintained between the short diameter a and long diameter b connecting the opposed concave arcs and intersecting rectangularly with each other and the drape index K (cm.⁻³) obtained by dividing the bending deflection Y (cm.) at the free end of a cantileter on the entire length of which the dead-weight of the wig forming fibers is uniformly distributed by the fourth power of the span length l of the cantilever from the fixed end to the free end is maintained in the range of

$$0.07 \times 10^{-5} \leq K \leq 0.16 \times 10^{-5}$$

(2)

and then heat-setting the wefted hairs as curled.

* * * * *