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[54] **PROCESS FOR PRODUCING LOW CRIMP POLYETHYLENE OXYBENZOATE YARNS**

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[51] **Int. Cl.** **D02j 1/22**

[58] **Field of Search** ..... 28/72.17; 264/168, 264/290 T; 8/130.1

[56] **References Cited**

UNITED STATES PATENTS

2,926,065 2/1960 Coplan et al. 8/130.1

Primary Examiner—Louis K. Rimrodt

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[57] **ABSTRACT**

The present invention relates to a process for producing low crimp polyethylene oxybenzoate (hereinafter designated as PEOB) yarns, and more particularly, multifilament yarns having natural silk-like beautiful appearance and excellent feelings which is characterized by heat treating a PEOB drawn yarn having a β-value of from 20 to 80 and a shrinkage value in boiling water of from 20 to 35 percent under substantially no tension so as to decrease the β-value by more than 10.

8 Claims, 6 Drawing Figures

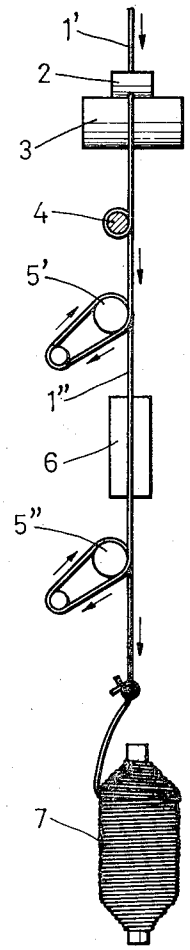


FIG. 1

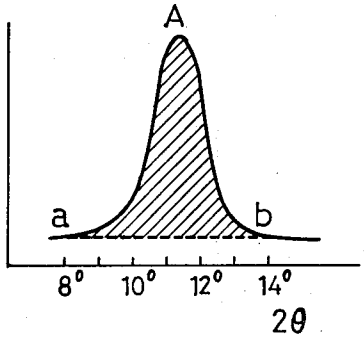


FIG. 2

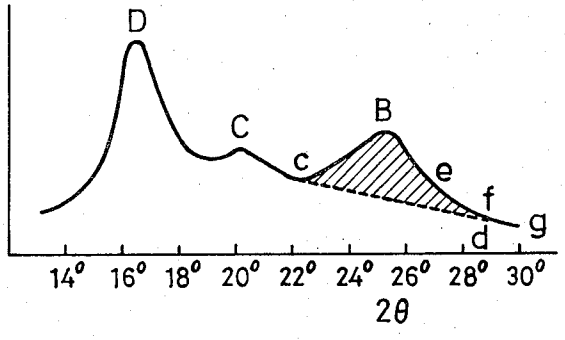


FIG. 6

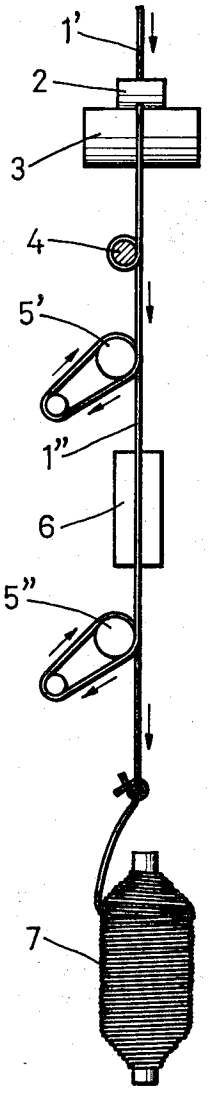
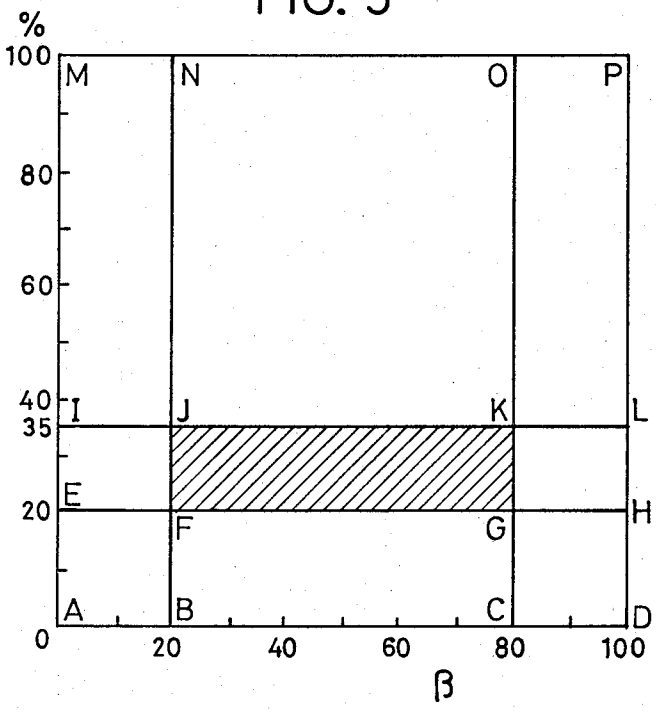


FIG. 3

FIG. 4

FIG. 5



PROCESS FOR PRODUCING LOW CRIMP POLYETHYLENE OXYBENZOATE YARNS

DESCRIPTION OF THE DRAWINGS

FIG. 1 graphically shows the intensity curve of X-ray diffraction pattern of α-type crystalline structure;

FIG. 2 graphically shows the intensity curve of X-ray diffraction pattern of β-type crystalline structure;

FIG. 3 is a photographic reproduction of the side view of polyethylene oxybenzoate fibers prior to development of low crimps by the process of the present invention;

FIG. 4 is a photographic reproduction of the side view of polyethylene oxybenzoate low crimp fibers by the process of the present invention;

FIG. 5 is a schematic reproduction of the ranges of β-values and shrinkage values in boiling water, which may be used for the purpose of the present invention; and

FIG. 6 shows an example of the process for drawing PEOB yarns according to the present invention.

SUMMARY OF INVENTION

According to the present invention, there is provided a process for producing low crimp PEOB yarns having silk-like properties, which is characterized in that a PEOB multifilament drawn yarn having a β-value of from 20 to 80 and a shrinkage value in boiling water of from 20 to 35 percent is heat-treated under substantially no tension so as to give a decrease of more than 10 in β-value.

With respect to the specific gravity (1.34), Young's modulus (400–900 kg/mm^2), toughness in the bent state, draping property and the like, the properties of PEOB fiber are most similar to those of natural silk, and this synthetic fiber appears to be most suitable for producing textile articles having silk feelings.

In contrast to conventional crimp yarns, PEOB yarns produced by the process of the present invention have silk-like low crimps and furthermore, are suitably bulky and bright. The thus-obtained low crimp PEOB yarns, as well as knitted or woven fabrics made thereof, are extremely analogous to natural silk.

An object of the present invention is accordingly to provide a process for producing PEOB drawn yarns having low crimps in a simple manner.

Another object of the present invention is to provide low crimp PEOB yarns having silk-like beautiful attraction.

A further object of the present invention is to provide a process for producing silk-like fabrics composed of low crimp PEOB yarns.

In the specification, PEOB yarns obtained by the process of the present invention are designated as low crimp PEOB yarns, the shape of which is exemplified in FIG. 4. As is apparent from the figure, the crimp of the yarn is tridimentional curve and has a long wave length and a low wave height. Each wave has a relatively smooth curve, i.e., having very little fine undulation. This type of wave resembles more or less the so-called wave of conjugate yarn (core spun yarn), but is unique. Since the crimps of the yarns of the present invention are not forceably imparted by mechanical or chemical means, the yarns of the present invention belong to structural crimp yarns.

As is already known, there are two types of PEOB crystals which are designated as the α- and β-type crystals. Besides the α -and β -type PEOB fibers, by selection of production conditions it is possible to obtain co-existence-types having different properties.

In this specification, the term β-value denotes the percentages of the β-type component in a coexistence type crystal consisting of the combination of α - and β-type crystals, where β -value is calculated by the following formula:

$$\beta\text{ -value} = (I\beta/I\alpha + I\beta) \times 100$$

wherein $I\alpha$ is the intensity at the diffraction point (at A in FIG. 1) which characterizes α-type crystal, i.e., the intensity at the diffraction point positioned at about $2\theta = 11.5°$ on the meridian line, and $I\beta$ is intensity at the diffraction point (at B in FIG. 2) which characterizes β-type crystal, i.e., the intensity at the diffraction point positioned at about $2\theta = 25.2°$ on the equatorial line. A further description of β-value and β-type crystals will be found in Korematsu and Kuriyama, J. Chem. Soc. Japan, 81, 6, 852 (1960); Korematsu, Masuda and Kuriyama, J. Textile Soc. Japan, 16, 633 (1960), and Ishibashi, JPS B81, p.629 (1963).

A counter such as Geiger-Muller counter may be used for determining the intensities of Iα and Iβ in the following manner.

The counter is scanned on the meridian and equatorial lines respectively to measure the intensities which are then recorded on a recorder. From each of the respectively obtained figures, the background and the non-crystalline scatterings are deducted to give each area at the peak of the diffraction, from which the intensities can be calculated respectively. In case of the determination of Iα , as shown in FIG. 1, a dotted line a–b passing through the background is used for defining the area marked with oblique lines defining Iα value. In case of the determination of Iβ , as shown in FIG. 2, a dotted line c–d passing through a point, at which the intensity reaches α minimum between the peaks of the diffraction of B–D, and intersecting with curves *e*, *f* and *g* is used for determining the definition of the area marked with oblique lines. This area defines Iβ .

The crystal structure of PEOB fiber is not yet completely clarified, but it is believed that the α-type crystal has a compact and stable structure while the β-type crystal has an elongated and unstable structure. The crystalline structure of the heat-treated PEOB fiber is liable to shift to the stable α -type with simultaneous decrease in β -value. The lower the tension used for heat-setting and the higher the treating temperature, the greater this liability of shifting is.

According to the present invention, a PEOB fiber is heat-treated under substantially no tension so as to obtain PEOB fiber having low crimps as well as silk-like appearance and feeling. For this purpose, PEOB fiber can be characterized by its shrinkage value in boiling water and the β-value. As a result of considerable experimentation with the heat treatment of PEOB fibers having different shrinkage values in boiling water and β-values, it has been found that the imparting of low crimps to the fiber (i.e., the shifting to the silk appearance and feeling) is closely related to the shrinkage value in boiling water and β-value of PEOB fiber prior to heat-treatment as well as to the decrease in β-value due to the heat-treatment, and that PEOB yarns having desired low crimps can be obtained only when these conditions are completely and simultaneously satisfied.

That is to say, it is possible to obtain PEOB yarns having low crimps together with good appearance, feeling and elasticity by the heat-treatment of PEOB fibers having a shrinkage in boiling water of from 20 to 35 percent and a β-value of from 20 to 80 in such a manner so that a decrease in β-value of more than 10 occurs by this treatment.

The term shrinkage in boiling water in this specification denotes

$$(A - B/A) \times 100$$

wherein

A: length of a sample loaded with a weight of 1/30 g/total denier prior to treatment in boiling water, and

B: length of a sample loaded with a weight of 1/30 g/total denier after heat treatment in boiling water at 100° C for 30 minutes under no tension with subsequent drying.

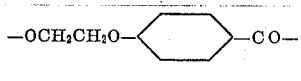
The term "Decrease in β-value" as used in the specification denotes:

"decrease in β-value" = (β-value before heat treatment) minus (β-value after heat treatment

As is apparent from FIG. 5, PEOB yarns having a shrinkage in boiling water of not more than 20 percent (as shown by the area bounded with letters A-D-H-E in FIG. 5) are poor in shrinkability so that the crimping can hardly occur by heat treatment regardless of the β-value thereof. On the other hand, PEOB yarns having a β-value of not more than 20 (as shown by the area bounded with letters A-B-N-M in FIG. 5) present difficulties as to the development of the latent crimping property regardless of the shrinkage values in boiling water. With respect to PEOB yarns having a shrinkage in boiling water of more than 35 percent (as shown by the area bounded with letters I-L-P-M in FIG. 5), the heat-treated yarns are hardened due to the excessively large shrinkage values irrespective of the development of the latent crimping property, and their feelings and appearances are significantly deteriorated so that it is diffi-cult to obtain PEOB yarns having the desired silk feelings and appearances. With respect to PEOB yarns having a β-value of more than 80 (as shown by the area bounded with letters C-D-P-O in FIG. 5), the brightness, feelings, elasticity, etc. of the PEOB yarns obtained by heat-treatment are different from those of natural silk, and it is difficult to produce PEOB yarns having silk-like low crimps.

When the decrease in β-value is below 10, it is difficult to obtain low crimp yarns. It is only possible to obtain PEOB yarns having low crimps, brightness, elegant appearance and attractive feeling similar to those of natural silk) by the heat-treatment of PEOB yarns having a shrinkage in boiling water of from 20 to 35 percent and a β-value of from 20 to 80 (as shown by the area bounded with letters F-G-K-J in FIG. 5) so as to give a decrease in β-value of more than 10.

PEOB fibers which may be used for the purpose of the present invention are produced by melt-spinning of a PEOB in conventional manner. They have a repeating unit substantially represented by the formula:



The fibers are then drawn and heat-set to give a β-value of from 20 to 80 and a shrinkage in boiling water of from 20 to 35 percent. That is to say, the β-value of the drawn fiber changes, depending mainly upon the changes of the draw ratio and the draw temperature. The shrinkage in boiling water varies, depending mainly upon the draw ratio and the changes of the heat-setting temperature after drawing. It is accordingly possible to control β-value and shrinkage in boiling water by adjusting the conditions as set forth in suitable manner. It was found that the lower the temperature of the hot pin and the greater the draw ratio, the greater the beta-value becomes; while the higher the temperature of the hot plate and the greater the draw ratio, the smaller the shrinkage value in boiling water.

PEOB fibers which may be used for the purpose of the present invention are produced by drawing a yarn at 75° to 105°C and a draw ratio of from 3.0 to 5.0, and heat-setting the drawn yarn at 75° to 110°C so as to keep its length constant. Otherwise, the obtained PEOB fibers may have a β-value of below 20 or above 80 and a shrinkage in boiling water of below 20 percent or above 35 percent, and good results cannot be obtained by using them.

The procedure for preparing the PEOB fibers according to the present invention are fully and clearly described below.

Chips of PEOB having a molecular weight which is substantially suitable for carrying out the melt-spinning are melt-spun by use of an extruder-type melt-spinning apparatus with a winding speed of 300 m/min to give an undrawn filament which is then drawn by the drawing process exemplied by the system shown in FIG. 6.

As is shown in FIG. 6, undrawn filament 1′ is guided by a nip roller 2 and a feed roller 3 through a hot pin 4 maintained at a temperature of from 75° to 100°C to a draw roller 5 where the filament is drawn at a draw ratio of from 3.0 to 5.0 times. The drawn filament 1″ is heat-set by means of a hot plate 6 kept at a temperature of from 75° to 110°C and is passed through a draw roller 5″ to reach to a wind-up means where the filament is wound onto a bobbin 7. The ratio of drawing between two draw rollers 5′ and 5″ is usually 1.0 so that the length is kept substantially constant.

Any and all PEOB fibers may be used for the purpose of the present invention, so long as the drawn filament has a shrinkage in boiling water of from 20 to 35 percent and a β-value of from 20 to 80, i.e, regardless of its form, deniers, numbers, cross-sectional comfiguration, the presence or absence of any additive. The preferred total deniers and single deniers of the filament, however, are respectively 15 to 200 and 1.0 to 6.5 deniers.

While the cross section of the fiber may be conventional round-shaped, better results can be achieved when the cross section is deformed irregularly, e.g., into X, Y, or T-shaped multilobal yarns.

The fiber is heat-treated in either dry or wet state under substantially no tension, so as to give a decrease of more than 10 in β-value. Good results can be obtained by using temperatures of about from 140° to 180°C and a treating time of from 10 minutes to 60 minutes in dry state or a temperature of about from 90° to 140°C and a treating time of from 10 to 120 minutes in the wet state. In accordance with the present invention, the tension burdened on the fiber should not be so great as to harm the shrinking of the fiber.

The heat-treatment in relexed state can be carried out, for example, by the cake method, the jet method, etc., whereby especially good results are obtained. In the former method, the filament yarn is wound onto a bobbin which is then pulled out of the wound yarn to form the so-called cake, which is then subjected to the heat-treatment. In the latter method, the yarn is jetted from nozzle with accompanying steam. When the heat-treatment is carried out continuously, it is preferred to overfeed the filament at a ratio of from 20 to 70 percent. The various types of known apparatus for carrying out the heat-treatment may be used for the purpose of the present invention.

The shrinkage value in boiling water of the PEOB filament which is heat-treated by the present invention becomes considerably smaller. However, it is advantageous for improving weaving or knitting efficiencies and for increase in commercial values of the thus-obtained woven or knitted articles to carry out the heat-treatment so as to give a remaining shrinkage in boiling water of from 5 to 10 percent. A shrinkage in boiling water of from 5 to 10 percent can preferably be given either by dry heat-treatment at a temperature of from about 140° to 170°C for 10 to 60 minutes or by wet heat-treatment at a temperature of from about 70° to 120°C for 10 to 120 minutes. The number of twists of the starting yarns are relatively small and preferably less than 20 turns/meter, while those of the treated yarn are preferably not more than 200 turns/meter.

Woven or knitted fabrics made of PEOB yarn having low crimps, producdd by the process of the present invention, have excellent appearance and feel like natural silk. In addition, excellent characteristics of the PEOB yarns having low crimps which have been used for weaving textile fabrics can further be improved according to another aspect of the present invention.

As is already known, raw silk consists of about 75 percent of fibroin and about 25 percent of sericin, and the characteristic feeling of silk fabrics can be obtained by scouring a woven fabric to remove off about 25 percent of sericin therefrom.

Based upon this knowledge, a process for producing fabrics made of PEOB yarns have been discovered, in which the interstices between respective filaments of a PEOB yarn are preliminarily expanded and fixed in a desired state by using a sizing liquid which is applied to a yarn in an amount of from 10 to 30 percent (by solid weight). After drying, the PEOB yarns are used for weaving or knitting a fabric and the sizing agent is removed off. In this manner it is possible to obtain fabrics composed of PEOB yarns having feeling and appearance similar to natural silk. According to the present invention, low crimp PEOB yarns are preliminarily fixed with a sizing liquid so as to expand the interstices and are then woven or knitted without any change of the pre-fixed state so that a fabric maintaining excellent properties of low crimp PEOB yarns and having silk-like properties can be produced.

Sizing liquid which may be used for the purpose of the present invention are composed of 1 to 10 percent by weight of a viscous sizing agent, 5 to 20 percent of a voluminous powder and 0.1 to 5 percent by weight of a softening agent (solids in sizing liquid: 100 percent), but is is also possible to add a foaming agent preferably in an amount of 0.5 to 2.0 percent by weight which enhances the voluminous effects of the sizing liquid and expands the interstices of the filaments.

Viscous sizing agents which may be used for the purpose of the present invention include, for example, acryl-type sizing agents, polyvinyl alcohol-type sizing agents, CMC (carboxymethyl cellulose) and α-starch. Voluminous powders which may be useful for the purpose of the present invention are those whose relative viscosities are hardly variable depending upon the change of the concentration of the sizing agent in use and are exemplified by β-starch, talc, montmorillonite type clay, etc. As the softening agents according to the present invention, for example, various surface active agents of the cationic, non-ionic and neutral types may be used. The foaming agents which may be used for the purpose of the present invention include, for example, sodium hydrogen bicarbonate, ammonium carbonate, ammonium bicarbonate, ammonia, ammonium nitrite, diammonium benzene, azoisobutyl dinitryl, dinitropentaethylene tetramine, etc. The viscosity of the sizing liquid according to the present invention is preferably from 5 to 50 centapoises. After the application of the sizing liquid of the present invention, the yarns are preferably and continuously dried up at a temperature of from 60° to 80°C under a low tension of not more than 0.5 g/denier.

The following non-limitative examples illustrate the invention.

Examples 1–5

PEOB fiber was prepared by using PEOB having a relative viscosity of 1.38 when measured at 25°C in a mixed solution of phenol and tetrachloroethane (1:1) and containing titanium dioxide (0.2 percent by weight). The PEOB was melt-spun at a spinning temperature of 260°C and with a spinning speed of 1,000 m/min by the use of an extruder-type spinning apparatus provided with 24 extruding nozzles (each diameter — 0.3 mm) to give undrawn filaments.

The filaments thus obtained were drawn with a draw speed of 500 m/min by using a system provided with a hot pin and a hot plate (as shown in FIG. 6). The temperature of the hot pin and hot plate as well as the draw ratio were suitably changed to obtain different types (14 types) of PEOB yarns of 50 deniers/24 filaments.

Each of the PEOB yarns (14 types) obtained was wound onto each bobbin under a tension of 0.2 g/denier and the bobbin was pulled out to make a cake which was then heat-treated in wet state under no tension at 120°C for 20 minutes. As is apparent from Table 1, the PEOB yarns (Samples Nos. 4, 7, 8, 9 and 12) which satisfied all conditions of the present invention (a shrinkage in boiling water of 20 to 35 percent, a β-value of 20 to 80 and a decrease in β-value after heat-treatment of more than 10) exhibited low crimps and had silk-like elegant feeling and appearance. The form of typical low crimps of Sample No. 7 is illustrated by FIG. 4. Untreated yarns having a shrinkage value in boiling water of below 20 percent (Samples Nos. 1, 2, 3 and 5), or having a β-value of below 20 (Samples Nos. 5, 6 and 11), and/or having a decrease in β-value of below 10 after heat-treatment (Sample No. 5) produced commonly heat-treated yarns having poor crimps. Yarns having a shinkage in boiling water of about 25 percent before heat-treatment (Samples Nos. 13 and 14), or having a β-value of above 80 (Samples Nos. 2 and 10) gave low crimp yarns, whose feeling and appearance were different from those of natural silk.

TABLE 1

Wet-Heat-treatment of PEOB Yarns

A : untreated PEOB
B : heat-treated PEOB yarn (at 120°C for 20 minutes)
No. : sample number
SH : shrinkage in boiling water (%)
β : β-value
β (−) : decrease in β-value
AP : appearance (− poor; + silky)
F : feelings (− poor; + silky)
PIN : pin temperature (°C)
PL : plate temperature (°C)
DR : draw ratio (x)

	A		B						
No.	SH	β	β	β(−)	AP	F	PIN	PL	DR
1	7.1	32.0	1.2	30.8	−	−	100	185	3.4
2	14.8	83.2	12.2	71.0	−	−	70	130	3.4
3	15.2	32.0	0	32.0	−	−	90	130	3.2
4	25.9	72.3	13.1	59.2	+	+	85	105	3.4
5	18.7	9.2	0	9.2	−	−	110	120	3.1
6	27.2	12.1	0	12.1	−	−	110	100	3.2
7	21.1	33.2	0.9	32.3	+	+	90	115	3.2
8	21.4	57.6	2.1	55.5	+	+	100	115	3.6
9	25.7	72.7	4.7	67.5	+	+	75	105	3.2
10	28.2	93.5	5.2	88.3	−	−	70	100	3.6
11	25.2	14.3	0	14.3	−	−	110	105	3.3
12	34.2	33.2	0	33.2	+	+	90	80	3.2
13	37.2	52.3	2.3	50.0	−	−	80	65	3.4
14	48.1	48.7	1.4	47.3	−	−	80	60	3.4

NOTE.—Numbers of twists (turns/meter):
Untreated yarn 18
Treated yarn 150

Samples having sufficiently low crimps (Sample Nos. 4, 7, 8, 9 and 12 of Table − above, were respectively used for weaving fabrics (habutae) under the following conditions.

Weaving design: plain weave
Density of fabric in the warp direction: 124 filaments /2.54 cm
Density of fabric in the weft direction: 90 filaments /2.54 cm
Width of the finished fabric: 92 cm

The fabrics thus obtained were dyed and finished to give the physical properties shown in Table 2, which were commonly very similar to those of silk habutae in respect to their elegant feeling and attractive appearance.

TABLE 2

Physical Properties of Fabrics Made of Low Crimp PEOB Yarns

A: Total hand (g.)
B. Drape coefficient
C: Stiffness (mm.)
D: Friction coefficient
E: Crease recovery (percent)
WA: Warp direction
WE: Weft direction

			C		D		E	
Sample	A	B	WA	WE	WA	WE	WA	WE
4	101	0.50	3.6	3.0	0.29	0.28	54.9	53.1
7	99	0.42	3.7	3.0	0.33	0.31	60.3	50.1
8	102	0.55	3.6	3.2	0.28	0.28	58.2	50.9
9	106	0.60	3.7	3.3	0.31	0.29	57.9	53.2
12	105	0.61	3.8	3.2	0.31	0.28	58.3	50.0
Silk	102	0.43	3.9	3.3	0.33	0.31	56.6	51.6

The physical properties shown in Table 2 were determined in the following manner.

Drape coefficient:
A round test piece (diameter — 25.4 cm) was laid on the test place of a drape tester (commercial product available from Shimazu Seisaku-sho, Japan) for measuring the drape area, from which the drape coefficient was calculated by using the following formula:

$$\text{drape coefficient} = (C-D)/(E-D)$$

wherein C is an area of the vertical projection of the test piece, D is an area of the test plate and E in an area of the test piece.

Total hand:
A test piece (20 × 20 cm) was bent by using handle-0-meter (commercial product available from thwing Albert, U.S.A.) having a width of 5 mm to determine the resistance (gram) required for the bending. Smaller value of total hand indicates greater flexibility of the sample in the warp and weft directions.

Stiffness:
A test piece (2 cm × 15 cm) was slowly slided on the horizontal surface of a 45° cantilever-type tester (commercial product available from Toyo Seiki K.K., Japan) to determine the drape length (mm).

Crease recovery:
A test piece (1 cm × 4 cm) folded down the middle was sandwiched between glass plates and was applied with a load of 500 grams for 5 minutes. After the removal of the load, the test piece was hung on a pin with its folded line and was stood for 5 minutes. After this, the opening angle (F) was measured to determine the crease recovery by the following formula:

$$\text{crease recovery (\%)} = (F/180) \times 100$$

Friction coefficient:
This value is represented by tangent θ which is a minimum angle when a test piece commences to slide with a load of 16 g/cm^2.

In this example, the habutae fabric used as control was prepared under the following conditions.

used silk yarns as weft: 63 denier
used silk yarns as warp: 63 denier
each composed of 3 filaments (each 21 denier) placed in close and parallel relation under tension in usual manner
weaving design: plain weave
weave density
warp: 124 yarns/2.54 cm
weft: 90 yarns/2.54 cm
width of the finished fabric: 92 cm

Example 11

A drawn PEOB yarn (50 deniers/24 filaments) which was Sample No. 7 of Examples 1–5 (β-value: 33.2; shrinkage in boiling water: 21.1 percent) was wound onto a bobbin in a similar manner to that described in said Example under a tension of 0.2 g/denier to form a cake. The yarn was then heat-treated in wet state at a temperature of 80°C for 120 minutes to produce a PEOB yarn having silk-like low crimps (remaining shrinkage value in boiling water: 7.2 percent; β-value: 4.2). The low crimp PEOB yarn obtained was used for the production of habutae fabrics in a similar manner to that described in Examples 6–10, with the exception that different sizing procedures were used for weaving fabrics, as are shown by the following. For control purposes, another fabric was also produced in an analogous manner to that described above without the use of sizing liquid. The thus-obtained fabrics could easily be woven and processed to give elegant fabrics.

Sizing Procedure 1:

Composition of sizing liquid:	2.2%
polyvinyl alcohol	2.2%
α-starch	1.6%
acryl-type sizing agent (copolymer of acrylic acid and ethylene) (commercial product available from Matsumoto Yushi K.K., Japan)	3.6%
β-starch	8.9%
softner (anionic-type (commercial product available from Goo Kagaku K.K., Japan)	2.7%
water	81.0%
Viscosity	30 CPS
Sized amount as soilids (by weight of the fabric)	30%
Drying temperature	80°C
Drying tension	0.01 g/d

Sizing Procedure 2:

Similar to Procedure 1 with the following exceptions.

Sized amount of solids (by weight of the fabric)	10%
Drying temperature	40°C

Sizing Procedure 3:

Composition of sizing liquid:	
polyvinyl alcohol	1%
α-starch	0.5%
acid clay (montmorillonite-type) (commercial product available from Nippon Unigel K.K., Japan)	2.0%
ammonium carbonate (foaming agent)	1.0%
softner (non-ionic type) (commercial product available from Goo Kagaku K.K., Japan)	0.5%
water	95%
Viscosity:	5–10 CPS
Sized amount of solids (by weight of the fabric)	10%
Drying temperature	80°C
Drying tension	0.5 g/d

Four types of the fabrics composed of low crimp POEB yarns were prepared. They were scoured for the removal of the sizing liquid and were then dyed and finished. All of the fabrics thus obtained had silk-like appearances and feeling which were hardly distinguishable from those of natural silk. Amoung four types of the fabrics produced, those having been sized were silky and had attractive feeling as compared to the one without sizing treatment. In particular, the fabric sized by the Procedure No. 1 had excellent bulk and elasticity properties, as is apparent from the following Table 3 showing the results obtained from functional test to show significant difference between PEOB fabrics and silk fabric.

This test was carried out as the so-called "blind test" using 10 panel testers. The testers each evaluated samples of fabrics (each 20 × 20 cm) with bare hands and bandaged eyes to give to the fabrics marks of from 5 (as highest rank) to 1 (as lowest rank) which were then combined with others to result in the ranking of the samples.

TABLE 3

Sample	Sizing Procedure Nos. 1	2	3	No sizing	Silk (habutae)
pliable	44	33	29	20	24
soft	35	30	26	23	36
bulky	44	36	22	16	32
springy	41	31	30	27	21
smooth	33	30	27	30	30
warm	35	27	26	24	38
silky	41	25	24	24	36
overall ranking	39	25	24	24	36

Example 12

PEOB having a relative viscosity of 1.4 (when measured at 25°C in a mixed solution of phenol and tetrachloroethane at a weight ratio of 1:1) and containing titanium dioxide (0.5 percent by weight) was melt-spun at a spinning temperature of 260°C and with a spinning speed of 1,000 m/min by the use of an extruder-type spinning device provided with a nozzle having 36 Y-shaped holes. The extruded PEOB filaments were drawn under the following conditions:

Temperature of draw rollers	90°C
Temperature of hot plate	110°C
Draw ratio	× 3.2
Draw speed	500 m/min

A drawn PEOB yarn (50 deniers/36 filaments) was obtained having a trilobal cross section and a β-value of 32.1 and a shrinkage in boiling water of 22.3 percent. The yarns were reeled to form a hank and samples of the hank were respectively heat-treated in wet state under substantially no tension to produce yarns shown in Table 4. As apparent from this table, the heat-treated yarns were developed by low crimps and had silk-like appearance and feeling.

TABLE 4

Heat-Treatment in West State of PEOB Yarns

A : heat-treating conditions in wet state
B : properties of the heat-treated yarns
Temp. : treating temperature (°C)
Time : treating time (minute)
Ten. : tension (gram/denier)
$-\beta$: decrease in β-value
SH : remaining shrinkage value in boiling water (%)

	A					B	
Sample	Temp.	Time	Ten.	$-\beta$	SH	Appearance	Feelings
e	120	10	0	32.0	2.1	Silky	Silky.
f	120	20	0.05	32.1	1.1	do	Do.

Example 13

Three types of drawn PEOB yarns shown in Table 5 were respectively reeled to form hank which were then heat-treated in dry state under no tension at a temperature of 170°C for 10 minutes to yield PEOB yarns having silk-like low crimps.

TABLE 5

Type	A	B	C
β-value	35.2	31.4	42.3
Shrinkage in boiling water (%)	22.0	27.8	28.9
Composition (denier/filament)	200/36	15/6	30/30

Example 14

Drawn PEOB yarns having large β-values and shrinkage values in boiling water were respectively reeled to form hanks which were then heat-treated under substantially no tension in wet or dry state and at different temperatures for ten minutes to produce the yarns shown in Table 6.

As shown in Table 6, untreated PEOB yarns having a shrinkage in boiling water of below 15 percent could hardly give sufficient low crimps regardless of the increase in β-value. Untreated yarns having a shrinkage in boiling water of above 20 percent and a β-value of from 20 to 80 and furthermore, a decrease in β-value

after heat-treatment of above 10 developed silk-like low crimps whereas the low crimps were not developed when the yarn had a decrease in β-value of below 10 after heat-treatment.

TABLE 6

Heat-Treatment of PEOB Yarns

Yarn A	β-value — 85.1 Shrinkage in boiling water — 28.2%
Yarn B	β-value — 72.2 Shrinkage in boiling water — 12.8%
Yarn C	β-value — 67.0 Shrinkage in boiling water — 21.4%
−β	Decrease in β-value
F & A	Feelings and appearance
+	silky
−	poor
Temp.	Treating temperature (°C)
Time	10 minutes

		Yarn A		Yarn B		Yarn C	
State	Temp.	−β	F & A	−β	F & A	−β	F & A
Dry	100	0	−	1.0	−	3.2	−
Dry	120	3.2	−	4.8	−	8.0	−
Dry	140	7.2	−	10.2	−	11.2	+
Dry	160	42.0	−	39.3	−	67.0	+
Dry	180	67.0	−	70.2	−	67.0	+
Wet	100	0	−	2.0	−	48.2	+
Wet	110	3.2	−	6.8	−	65.1	+
Wet	120	8.2	−	14.2	−	67.0	+
Wet	130	12.3	−	23.2	−	67.0	+

Having described the present invention, that which is sought to be protected is set forth in the following claims.

What is claimed is:

1. A process for producing low crimp polyethylene oxybenzoate yarns having silky properties, which comprises subjecting a multifilament polyethylene oxybenzoate yarn having a β-value of from 20 to 80 and a shrinkage in boiling water of from 20 to 35 percent to heat-treated under substantially no tension so as to give a decrease of more than 10 in its β-value.

2. The process of claim **1**, in which said multifilament yarn is produced by drawing a melt-spun yarn at a temperature of from 75° to 100°C and a draw ratio of from 3 to 5, and then heat-setting the drawn yarn at a temperature of from 75° to 115°C so as to maintain its length substantially constant.

3. The process of claim **1**, in which the heat-treatment is carried out at a temperature of from 70° to 180°C for 10 to 120 minutes.

4. The process of claim **3**, in which the heat-treatment is carried out in dry state at a temperature of from 140° to 180°C for 10 to 60 minutes.

5. The process of claim **3**, in which the heat-treatment is carried out in wet state at a temperature of from 70 to 140 for 10 to 120 minutes.

6. The process of claim **1**, in which the yarn is composed of filaments having a multilobal cross section.

7. A process for producing low crimp PEOB multifilament yarns having silky properties, comprising the steps of

a. drawing a melt-spun PEOB yarn at a temperature from 75° to 100°C and a draw ratio of from 3 to 5,

b. heat-setting the draw yarn at a temperature from 75° to 115°C so as to maintain the length substantially constant, and

c. heat-treating the yarn at a temperature from 70° to 180°C for 10 to 120 minutes under substantially no tension so as to give low crimps.

8. The process of claim **7**, wherein the yarn produced by step (b) has a β-value of 20 to 80 and a shrinkage in boiling water of 20–35 percent, and after treatment by step (c) has a decrease of more than 10 in β-value.

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