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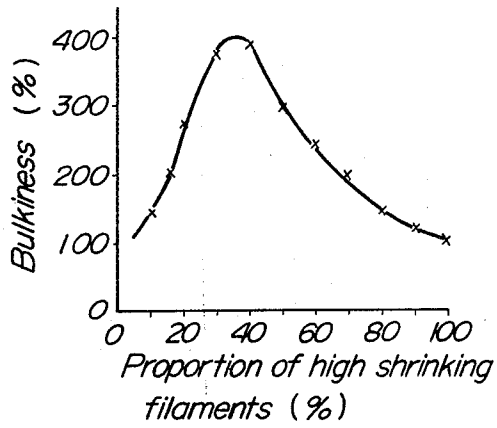

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SPECIFIC FILAMENT YARNS

Chozo Nakayama, Teiichi Kaku, Hiizu Aizawa, and Takeaki Iwamoto, Fuji-shi, Japan, assignors to Asahi Kasei Kogyo Kabushiki Kaisha, Osaka, Japan, a corporation of Japan

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ABSTRACT OF THE DISCLOSURE

A multifilament yarn composed of two kinds of filaments having different rates of thermal treatment shrinkage and having a cross-section in which the two different constituent filaments are united with each other in either a non-twisted state or an integrally twisted state. The filament having the greater rate of shrinkage comprises 15–70%, preferably 20–55% by weight of the yarn and the respective rates of shrinkage of the filaments differ by 10–40%, preferably 20–40%.

Generally, filament yarns are characterized in that they are lower in fluff and higher in strength when compared with spun yarns, and are not limited in the number of constituent filaments when they are produced so that fine yarns can be obtained with relative ease. They are however free of so-called bulkiness and hence have frequently been restricted in their uses. As a consequence of recent developments in the production of synthetic fibers the so-called textured processing has been invented to make it possible to impart bulkiness to filament yarns with the result that the scope of uses of filament yarns has been rapidly broadened. Yarns obtained according to the textured processing method are roughly classified as either stretch yarns according to conventional twist-heat set-untwist process, false-twist process, edge-crimping process, stuffer box process and knit-heat set-unravel process, or nonstretch yarns according to air jet process. These yarns find their uses in various fields to exhibit respective characteristics.

This invention relates to specific filament yarns characterized by the fact that they are so-called multifilaments constituted of two kinds of filaments which are different from one another in respect of their thermal treatment shrinkage and also by the fact that they have cross-sections in which the two different constituent filaments are admixed with each other. When a shrinking treatment is applied to the filament yarns without subjecting to textured processing, either before or after knitting or weaving, the high shrinking filaments shrink so to constitute cores for filament yarns and the non-shrinking or low-shrinking filaments swell out laterally to give a bulky yarn or a bulky knit or woven product. An important aspect of the present invention is that the yarn is constituted of different constituent filaments which are cross-sectionally admixed with each other. The yarn obtained in accordance with the present invention is entirely different from that obtained by merely twisting two filament yarns which are different in heat treatment shrinkage. Namely, a twisted yarn constituted of filament yarns different in heat treatment shrinkage is rather a fancy yarn and exhibits little bulkiness, which is the characteristic of the present filament yarns.

The expression in the present specification that the different constituent filaments are cross-sectionally admixed with each other signifies the form of the respective different constituent filaments united with each other in a non-twisted state or in the form of said filaments united with each other and then integrally twisted.

The filament yarns in accordance with the present invention can display bulkiness by knitting or weaving the yarns before they exhibit bulkiness and then subjecting the knitted or woven product to shrinking treatment. Alternatively, it is possible to form the yarns into a bulky knitted or woven product by twisting them to obtain a yarn, subjecting the yarn to heat shrinking treatment and then knitting or weaving the resulting bulky yarn. The relative proportion of filaments displaying high- and low- or nonshrinking properties is variable to a great extent according to the uses of the resulting product, but it has been found that the optimum bulkiness is attained when the proportion of filaments of high shrinking characteristic is within the range of from 15 to 70%, preferably from 20 to 55% by weight.

The accompanying drawing shows a curve indicating the results of experimental work carried out to investigate the effect of various proportions of high- and low-shrinking filaments on the bulky filament yarns constituted of filaments comprising acrylonitrile-methyl acrylate copolymers having a heat treatment shrinkage of 26% and 5%, respectively. The filament yarn used in the above experiment had a denier of 150 and each monofilament had a denier of 3. In the experiment, two such filament yarns were twisted together to prepare a composite yarn having a denier of 300, the composite yarn was subjected to thermal treatment, and the ratio of increase in specific volume of the yarn before and after the thermal treatment was measured. The ratio of the increase in specific volume was adopted as a standard of bulkiness and is shown in the drawing as a bulkiness index. The values of said specific volume were obtained by measuring before and after the shrinking treatment the apparent diameter of the composite yarn magnified to 50 times by means of a universal projector, and calculating the specific volume from the apparent diameter of the yarn before and after the shrinking treatment.

Filament yarns compirsing more than two or three kinds of filaments which are different in shrinkage rates also show the same effect but gives no particular advantage as compared with those comprising two kinds of such filaments.

Further, the difference in the amount of shrinkage between the different constituent filaments is also a factor which greatly affects the bulkiness, and a suitable value of difference should be selected according to the uses of the products. Namely, in a field where high bulkiness is required, a difference in shrinkage of the different constituent filaments from 20 to 40% is preferred, but there also are some cases where a shrinkage difference as low as about 10% is rather desired depending upon the uses of the products. Further, it is of course possible to change, if necessary, the monofilamentary denier of the different constituent filaments.

As mentioned above, an important characteristic of the present filament yarns is that they give bulky yarns or knit or woven products by a mere shrinking treatment, without subjecting them to the so-called textured processing. Another important characteristic is that they are knitted or woven and then subjected to shrinking treatment to produce bulkiness. That is, in the case of yarns produced according to textured processing, the yarns are knitted or woven after processing. Since processed yarns are used in this case, a tendency toward lowering in the knitting or weaving efficiency is inevitable. In contrast to this, in the case of the filament yarns according to the present invention, it is possible to produce bulkiness after knitting or weaving, and in the knitting or weaving operations, the present filament yarns show the same behavior as those of ordinary filament yarns. In view of the recent tendency toward increased speed of knitting or weaving machines, the characteristic of high

knitting or weaving efficiency of the present filament yarns has a markedly important characteristic.

The bulky yarns in accordance with the present invention are not the so-called stretchable bulky yarns but are nonstretchable bulky yarns. Although the stretchable bulky yarns have important applications utilizing the stretchability thereof, the nonstretchable bulky yarns of the present invention display excellent characteristics in the fields where dimensional stability is required.

The bulky yarns are produced according to various processes such as by heat stretching a tow of acrylic fibers by means of a turbostapler or pacific converter, cutting the hot stretched tow, subjecting about 30–70% of the cut tow to heat shrinking treatment with steam, mix-spinning the resulting shrunk fiber with unshrunk fiber to obtain a spun yarn and treating the spun yarn at a temperature of about 100° C. in the presence of moisture, or by cutting the hot stretched tow to a definite length to obtain a shrinkable staple fiber, mix-spinning the shrinkable fiber with an ordinary unshrinkable fiber to prepare a spun yarn and then treating the spun yarn in the same manner as above.

In contrast to the bulky products obtained according to the above processes, the filament yarns of the present invention have in general the characteristics of filament yarns such as, for example freedom from fluffs, high strength, and nonlimitativeness in the number of constituent monofilaments to give even fine filament yarns with ease. That is, when a spun yarn is required to have a so-called tenacious hand, it is effective to make the denier of monofilaments greater. When the monofilaments are made larger in denier, however, the yarn becomes uneven or is lowered in strength, whereby undesirable results are brought about in practice in most cases. The filament yarns, however, are not restricted in the number of constituent monofilaments and hence any monofilamentary denier can be adopted.

As stated above, the important significance of the present filament yarns resides in that they not only maintain such characteristics of filament yarns as ease of production and prominent physical properties but the products thereof have the appearance and hand characteristics of spun yarns.

The filament yarns of the present invention can be produced by arranging in parallel and in a nontwisted state multifilaments different in heat treatment shrinkage, or by extruding filaments different in shrinkage through one spinneret or two or more spinnerets positioned close to each other and effecting the subsequent treatments simultaneously together. The former process encounters practical difficulty in arranging different filament yarns so as to be cross-sectionally admixed with each other but has such advantages that, after spinning, the treatments such as stretching and taking-up can be effected separately under optimum conditions. On the other hand, the latter process is restricted in that the stretching and taking-up treatments after spinning should be carried out simultaneously and together, but is easy in arranging different filaments so as to be cross-sectionally admixed with each other and is relatively easy in controlling the arrangement in cross section of different filaments as occasion demands.

The filaments constituting the filament yarns of the present invention include those of polyacrylonitrile.

The essential points of the present invention will be discussed below.

In the present invention, the fiber-forming polymers are ordinarily prepared by copolymerizing acrylonitrile with a suitable amount of monoethylenically unsaturated compound such as, for example, acrylate, methacrylate, acrylamide, methacrylamide, vinyl acetate, vinyl chloride or vinylidene chloride. In this case, it is possible to produce a difference in thermal treatment shrinkage by varying the copolymer composition. Even when the same polymer is used, the shrinkage difference can be provided by varying the composition of the spinning solution, e.g., by varying the polymer concentration or by adding a plasticizer and varying the amount of the plasticizer added.

The following examples illustrate the present invention:

EXAMPLE 1

A copolymer comprising 94% by weight of acrylonitrile and 6% by weight of methyl acrylate and having an intrinsic viscosity of 1.5 when measured at 35° C., at a polymer concentration of 0.2 g./100 cc. using dimethyl formamide as a solvent was dissolved at 0° C. in 67% nitric acid to a concentration of 15% by weight to prepare a dope A. Similarly, a copolymer comprising 88% of acrylonitrile, 11.5% of methyl acrylate and 0.5% of sodium methallyl sulfonate and having an intrinsic viscosity of 1.5 when measured in the same manner as above was dissolved at 0° C. in 67% nitric acid to a concentration of 15% by weight to prepare a dope B. Using a spinneret having 50 holes, dopes A and B were extruded through 30 holes and 20 holes, respectively, at a rate of 6 m./min. into a coagulating liquid comprising 32% nitric acid maintained at —4° C. The resulting filaments were washed with water, stretched to 7 times their length in hot water at 100° C., dried in a dryer at 120° C. while applying restricted shrinkage 12%, coated with a finishing oil agent, and taken up while being twisted to obtain a 150 denier-filament yarn comprising monofilaments of 3 deniers. The filament yarn was knitted into a circular knit jersey by use of a Stibbe Knitter, model GS–II, and the jersey was subjected to steam treatment at 125° C. in a steam setter and was then air-dried. After the knitting, the jersey did not differ in state at all from one obtained by the use of ordinary filament yarns, but after the steam treatment, it was observed that excellent bulkiness was developed due to shrinkage.

Separately, the above filament yarn was woven according to a known process to obtain a cloth, and, in this case, the weaving step was effected as smoothly as in the case of ordinary filament yarns. After dyeing and finishing, it was observed that the cloth was provided with bulkiness, which is the characteristic of spun yarns.

It was further recognized that the above filament yarn was twisted and was then treated with steam at 125° C. in a steam setter to become a bulky yarn, and the bulky yarn was woven to give a bulky fabric.

EXAMPLE 2

Using a spinneret having 500 holes, the dopes A and B prepared as in Example 1 were extruded through 350 holes and 150 holes, respectively, at a rate of 8 m./min. into a coagulating liquid comprising 30% nitric acid at —4° C. The resulting filaments were washed with water, stretched to 8 times their length in hot water at 100° C., dried in a dryer at 120° C. while conducting restricted shrinking of 10%, coated with a finishing oil agent and then taken up while being twisted to obtain a 200° denier-filament yarn comprising monofilaments of 4 deniers. Two of such yarns were twisted together and then treated with steam in a steam setter at 120° C. to obtain a bulky yarn. The yarn was used to weave a carpet cloth and the product was excellent in bulkiness.

EXAMPLE 3

An acrylonitrile polymer having an intrinsic viscosity of 1.5 when measured according to the procedure stated in Example 1 was dissolved at 0° C. in 67% nitric acid to a concenrtation of 15% by weight to prepare a dope A. On the other hand, a copolymer comprising 95% of weight of acrylonitrile and 5% of sodium p-styrene sulfonate and having an intrinsic viscosity of 1.5 when measured in the same manner as above was dissolved at 0° C. in 67% nitric acid to a concentration of 15% by weight to prepare a dope B. Using a spinneret having 32

holes, dopes A and B were extruded through 16 holes each at a rate of 6 m./min. into a coagulating liquid comprising 30% nitric acid at —4° C. The resulting filaments were washed with water, stretched to 7 times their length in hot water at 100° C., dried in a dryer at 110° C. while effecting restricted shrinking of 15%, coated with a finishing oil agent and taken up while being twisted to obtain a 95 denier-filament yarn comprising monofilaments of 3 deniers. The filament yarn was woven to a fabric and, in this case, the weaving step was carried out as smoothly as in the case of ordinary filament yarns. The fabric was dyed and was then dried at about 90° C. with the result that the fabric was provided with bulkiness, which is peculiar to fabrics obtained from spun yarns, and had general characteristics of filament yarns.

What is claimed is:

1. A filament yarn of acrylic polymer constituted of two different constituent filaments which are cross-sectionally admixed with one another in a noncomposite form, one of said filaments having a relatively high rate of shrinkage upon thermal treatment and the other of said filaments having a relatively low rate of shrinkage upon thermal treatment, said rates of shrinkage differing by 10–40% relative to one another and said filament having the relatively high shrinkage comprising 15–70% by weight of the filament yarn.

2. The filament yarn as claimed in claim 1 wherein the rates of shrinkage differ by 20–40% and the filament having the relatively high rate of shrinkage comprises 20–55% by weight of the filament yarn.

3. The filament yarn as claimed in claim 1 wherein one of said filaments is constituted of polymerized acrylonitrile and the other of said filaments is constituted of a copolymer of acrylonitrile and a monoethylenically unsaturated compound.

4. The filament yarn as claimed in claim 3 wherein the copolymer consists of 95% by weight of acrylonitrile and 5% by weight sodium p-styrene sulfonate.

5. The filament yarn as claimed in claim 1 wherein both filaments are constituted of copolymers of acryonitrile and at least one monoethylenically unsaturated compound.

6. The filament yarn as claimed in claim 5 wherein one of said copolymers consists of 94% by weight of acrylonitrile and 6% by weight of methyl acrylate and the other of said copolymers consists of 88% by weight of acrylonitrile, 11.5% by weight of methyl acrylate and 0.5% by weight of sodium methallyl sulfonate.

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DONALD E. WATKINS, Primary Examiner

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