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BICOMPONENT SELF-CRIMPING MODACRYLIC TEXTILE FIBER

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ABSTRACT OF THE DISCLOSURE

Bicomponent textile fibers comprising mixtures of an acrylonitrile-vinylidene chloride copolymer, a poly(N-isopropyl acrylamide) homopolymer, and a cellulose ester. These fibers are characterized by their self-crimping properties.

This invention relates to novel bicomponent self-crimping modacrylic based fibers possessing improved bulk and cover.

The most significant factors determining the basic natural crimp frequency of a bicomponent fiber are differential shrinkage and the geometrical distribution of the two components. The latter encompasses, in a broad sense, side-by-side and sheath-core configurations, whereas the former includes virtually all fiber forming polymers. It is thus apparent that the choice of polymers becomes a primary consideration in the production of a bicomponent fiber having self-crimping characteristics. In practice, the choice, however is limited. Some restrictions are that the two components be compatible in a filament to allow them to stay as an entity (integral unit) throughout all phases of textile processing steps, and that the two component polymers preferably be soluble in a common solvent system, should dry or wet spinning be the method of fiber formation.

The self-crimping fibers of this invention are formed by physically placing two fiber-forming polymers in desired proportions in each fiber. Depending on the method of formation, the component polymers may reside in the fiber in either a side-by-side or a sheath-core arrangement. In this invention, a side-by-side arrangement of the components of the fiber is preferred. In addition, splitting a conjugate film or dry spinning of a partially mixed stream of selected fiber-forming polymers through a standard spinneret are two methods employed to make fibers of this invention.

For two polymer solutions to achieve a steady common undisrupted flow through a common orifice, viscosities of the solutions need to be approximately the same. A difference not greater than 5% of a mean value is desirable. Variables that may be used to control the viscosity include polymer properties (molecular weight and its distribution, degrees of branching and polymerization), solution concentration, and temperature. It is apparent that the viscosity limitation becomes unnecessary, if two films or filaments are formed separately, but joined together before solidification outside the die or spinneret.

The examples given in this application limit themselves to the use of hot air as a medium of solvent removal. A liquid coagulant is equally functional when solvents of a high boiling point, of high toxicity, or potential fire-hazard are employed. Additionally, the examples illustrate the use of a spinneret, which conventionally is employed for spinning monocomponent fibers, for the production of bicomponent fibers. A special spinneret in which devices are incorporated to isolate physically the two streams up to a point just behind the spinneret orifices also is applicable.

The fibers of this invention may be made from acetone solutions of 15% to 35% concentrations prepared from the following polymers or polymer mixtures: Acrylonitrile-vinylidene chloride copolymer having 40% to 50% by weight of vinylidene chloride; a mixture of acrylonitrile-vinylidene chloride copolymer having 40% to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide); an acrylonitrile-vinylidene chloride copolymer having about 40% to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and up to about 5% by weight of cellulose acetate having an acetal content of about 40 weight percent.

To illustrate the invention two types of experiments were performed: Film casting to demonstrate a combination of polymers likely to yield fibers having self-crimping properties and fiber spinning of bicomponent fibers from polymer combinations deemed likely to yield self-crimping properties.

The method used to make bicomponent films comprises casting a first film on a sheet of glass followed by casting another film on top of the first film before it had dried. The composite film was then peeled off the glass and dried for about 1 hour in an oven at 120° C. The dried film, measuring about 4 inches wide, 20 inches long, and 1.5 mils thick, was then placed on the sheet of glass, and a section of about 1.5 inches wide and 6 inches long was cut from the central portion for use in fiber making. This piece of film was cut lengthwise into strips about 1 mm. wide. These strips were converted into filaments by hand drawing.

The invention will be further illustrated by the following examples and it should be understood that these examples are set forth for purposes of illustration only and are not to be construed as limiting the invention in any manner.

Examples 1, 2, and 3 set forth the details of the experiments with the fibers made from the bicomponent film. Examples 4 and 5 set forth the details of experiments with fibers made by spinning bicomponent fibers.

EXAMPLE 1

A 1.5-mil thick composite film was cast from a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide). The film was dried for one hour in air at 120° C. and then cut lengthwise into strips of 1 mm. wide. Upon drawing the strips to 6 to 12 times their original lengths in superheated steam at 135° C., followed by stabilizing the strips in a relaxed state for 3 min. in air at 120° C., the resulting filament showed fine spiral crimps superposed on large helices. Physical properties of a 12×-drawn filament in air at 23° C. were: 22.5 denier, 2.80 g./den. tenacity, 27% elongation, and 29 g./den. elastic modulus.

EXAMPLE 2

A 1.5-mil thick composite film was cast from a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide); and a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide), and about 1% by weight of cellulose acetate having an acetyl content of 39.4%. The film was dried and cut in the same manner as that described in Example 1. Filaments drawn to 12× in superheated steam at 120° C. and heat-set, in a relaxed state, for 3 min. in air at 120° C. exhibited spiral crimps of high frequency. The stabilized fiber was 25.1 denier and had these prop-

erties determined in air at 23° C.: 1.94 g./den. tenacity, 24% elongation, and 29 g./den. elastic modulus.

EXAMPLE 3

A composite film of 0.8-mil thickness was cast from a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide); and a 15% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and about 3% by weight of cellulose acetate having an acetyl content of 39.4%. The film was dried and then cut according to the procedure indicated in Example 1. The filaments drawn to 12× in superheated steam at 140° C. and then heat-set in a relaxed state for 2 min. in air at 110° C. developed crimps. The crimps were of spirals distributed in a random fashion along the length of the filament. Properties determined in air at 23° C. were: 11.7 denier, 2.50 g./den. tenacity, 20% elongation, and 49 g./den. elastic modulus.

EXAMPLE 4

Bicomponent fibers were spun from a 32% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide) and a 30.3% solution of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and about 3% by weight of cellulose acetate having an acetyl content of 39.4%. The two component streams were fed separately by two Zenith gear pumps kept isolated from each other by a concentric flow device up to a point about ¼-in. distance above the filter medium in a spinneret, and then allowed to enter, as a composite stream, into a spinneret having 8 orifices. The orifices, each measuring 9 mils in diameter and 9 mils in length, were arranged at equal distances on a circle of 1-in. diameter. Overall dimensions of the spinneret were: 1½ in. inside diameter and ½-in. depth. Spinning was conducted at a combined rate of 4.15 cc./min. and a take-up speed of 20 m./min. at a distance of 25 ft. below the spinneret. Solution temperature was 45° C. and the curing air temperature was 130° C. flowing in a direction opposite to that of the filaments. Fibers containing 66 to 72% of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide) developed crimps when drawn to 8× to 18× in superheated steam at 110° C. and then heat-set wtih free shrinkage for 2 min. in air at 145° C. Tensile properties of the filament drawn to 18× were: Determined in air at 23° C., 3.19 g./den. tenacity, 15% elongation, 46 g./den. elastic modulus, 1.48 g./den. stress at 8% extension; determined in water at 70° C., 1.89 g./den. tenacity, 15% elongation, 20 g./den. elastic modulus, 0.72 g./den. stress at 8% extension. The fibers showed excellent dyeability and, after dyeing, retained the crimps.

EXAMPLE 5

Drawn filaments obtained by the method described in Example 4 were cut into staple of 3-in. length. The cut fibers were then heat-set with free shrinkage for 2 min. in air at 145° C. Crimps developed. The resulting fibers were carded and spun into yarn. A knit fabric from this yarn possessed appearance similar to that attainable by a fabric made from mechanically crimped staple fibers.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. Self-crimping composite textile fiber comprising two polymeric components arranged in a side-by-side or sheath-core configuration, said components selected from acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride; a blend of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide); and a blend of acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and a blend of about 1% to about 5% by weight of cellulose acetate having an acetyl content of about 40%.

2. Self-crimping composite textile fiber of claim 1, wherein said two polymeric components of said fiber are in side-by-side arrangement.

3. Self-crimping composite textile fiber of claim 1, wherein said two polymeric components of said fiber are in sheath-core arrangement.

4. Self-crimping composite textile fiber of claim 1, wherein said two components are heterogeneously and asymmetrically disposed in said composite textile fiber.

5. Self-crimping composite textile fiber of claim 1, wherein said two polymeric components are acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride; and acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide).

6. Self-crimping composite textile fiber of claim 1, wherein said two polymeric components are acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride; and acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and about 1% to about 5% by weight of cellulose acetate having an acetyl content of about 40%.

7. Self-crimping composite textile fiber of claim 5, wherein said two polymeric compositions are acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride and about 15% by weight of poly(N-isopropyl acrylamide); and acrylonitrile-vinylidene chloride copolymer having about 40 to 50% by weight of vinylidene chloride, about 15% by weight of poly(N-isopropyl acrylamide) and about 1% to about 5% by weight of cellulose acetate having an acetyl content.

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