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WOOL-LIKE ACRYLIC FOR DOUBLE KNITS

Louis S. Hovis, Triangle Forest, Rte. 1, Cary, N.C. 27511, and James P. Craig, Jr., 4130 Rockingham St., Raleigh, N.C. 27609

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ABSTRACT OF THE DISCLOSURE

A wool-like acrylic fiber blend is provided which comprises a low denier fiber consisting of at least 50% of a bicomponent acrylonitrile polymer fiber and a high denier fiber consisting of an acrylonitrile polymer fiber.

BACKGROUND OF THE INVENTION

This invention relates to the preparation and provision of fiber blends of a low denier acrylonitrile polymer fiber which is at least 50% bicomponent and a high denier acrylonitrile polymer fiber.

Of the many available synthetic fibers, acrylonitrile polymer fibers have usually been considered one of the best candidates for replacing wool in areas of end use long dominated by wool. Acrylonitrile polymer fibers have successfully replaced wool, although not completely, in sweaters, jersey knitwear, and carpets. This replacement has been due primarily to the fact that acrylonitrile polymer fibers can be produced with a much wider range of properties than wool by altering the fiber denier, denier distribution, single filament stress-strain behavior, distribution of fiber stable length, fiber geometry including type of fiber crimp, crimp frequency and crimp amplitude.

In spite of this versatility acrylonitrile polymer fibers have never been fully equivalent in aesthetics to 100% wool fabrics, particularly in subjective evaluation of hand and resilience.

This invention presents an acrylonitrile polymer fiber blend which is a combination of bicomponent, monocomponent, high and low denier fibers that have wool-like properties with respect to hand and resilience.

SUMMARY OF THE INVENTION

Recognizing that wool in almost all of its end uses is a blend of different types of wool and that any given wool has a wide denier distribution and a wide distribution of crimp frequency this invention provides a blend of acrylonitrile polymer fibers which duplicates wool, particularly in hand and resilience. The acrylonitrile polymer fiber blends of this invention comprise (1) 60 to 75% by weight of a low denier fiber having a denier per filament of less than about 4.0, preferably between about 3.5 and 1.0, and comprised of at least about 50%, preferably 85 to 100% by weight, of a bicomponent acrylonitrile polymer fiber and up to 50%, preferably 0 to 15% by weight, of a non-bicomponent acrylonitrile polymer fiber, blended with (2) 40 to 25% by weight of a high denier fiber having a denier per filament of greater than about 4.0, preferably between about 4.0 and 8.0, comprised of a non-bicomponent acrylonitrile polymer fiber. Novel synthetic yarns having wool-like properties may be prepared from these blends.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the practice of this invention the low denier fiber may consist of at least about 50% and preferably 85 to 100% by weight of a bicomponent acrylonitrile polymer fiber. The bicomponent fiber may be selected from any of the conventional and generally widely known acrylonitrile bicomponent fibers of the prior art as exemplified

by U.S. Pat. Nos. 2,931,091 and 3,038,236. Preferably, the bicomponent fiber is prepared from those polymers wherein one component is a copolymer of 85 to 98% by weight of acrylonitrile and 2 to 15% by weight of a monoolefinic monomer copolymerizable with acrylonitrile, for example, vinyl acetate. The other component may consist of a copolymer differing from the first in amounts or types of monomers or both, for instance, 0.5 to 1.5% difference in acrylonitrile content.

The low denier fiber may also consist of up to 50% by weight of a fiber prepared from an acrylonitrile homopolymer, copolymer, terpolymer or interpolymer.

The high denier fiber preferably may consist of an acrylonitrile polymer fiber prepared from any of the well known acrylonitrile polymers such as polyacrylonitrile, copolymers and terpolymers, particularly those containing at least 80 percent by weight of polymerized or copolymerized acrylonitrile.

For example the polymer for the high denier fiber may be a copolymer of from 80 to 98 percent of acrylonitrile and from 2 to 20 percent of another copolymerizable mono-olefinic monomer. Suitable copolymerizable mono-olefinic monomers include acrylic, alpha-chloroacrylic and methacrylic acids, the acrylates, such as methylmethacrylate, ethylmethacrylate, butylmethacrylate, methoxymethyl methacrylate, beta-chloroethyl methacrylate, and the corresponding esters of acrylic and alpha-chloroacrylic acids; vinyl chloride, vinyl fluoride, vinyl bromide, vinylidene chloride, 1-chloro-1-bromoethylene; methacrylonitrile; acrylamide; and methacrylamide; alpha-chloroacrylamide, or monoalkyl substitution products thereof; methyl vinyl ketone; vinyl carboxylates, such as vinyl acetate, vinyl chloroacetate, vinyl propionate, N-vinylimides, such as N-vinylphthalimide and N-vinylsuccinimide; methylene malonic esters; itaconic acid and itaconic ester; N-vinyl carbazole; vinyl furan; alkyl vinyl esters; ethylene alpha, beta-dicarboxylic acids or their anhydrides or derivatives, such as diethylcitraconate, diethylmesaconate; styrene; vinyl naphthalene; vinyl-substituted tertiary heterocyclic amines such as the vinylpyridines and alkyl-substituted vinylpyridines for example, 2-vinylpyridine, 4-vinylpyridine, 2-methyl-5-vinylpyridine, and the like; vinylpyrrolidone, vinylpiperidone, and other mono-olefinic copolymerizable monomeric materials.

The polymer can be a ternary interpolymer, for example, products obtained by the interpolymerization of acrylonitrile and two or more of any of the monomers, other than acrylonitrile, enumerated above. More specifically, and preferably, the ternary polymers contain from 80 to 98 percent of acrylonitrile, from 1 to 10 percent of a vinylpyridine or a 1-vinylimidazole, and from 1 to 18 percent of another copolymerizable mono-olefinic substance, such as methacrylonitrile, vinyl acetate, methylmethacrylate, vinyl chloride, vinylidene chloride, and the like.

In preparing the products of the present invention, conventional equipment ordinarily employed in the manufacture of artificial and synthetic fibers and filaments may be used and particularly the equipment which is usually employed in the manufacture of fibers and filaments from acrylonitrile polymers. The present invention is applicable to the usual methods for forming synthetic filaments and fibers such as dry spinning and wet spinning. Any of the well known prior art solvents, for example, dimethyl acetamide, dimethyl formamide, dimethyl sulfoxide, nitric acid, concentrated aqueous solutions of certain salts such as soduim thiocyanate, zinc chloride and the like may be used in the practice of the invention. Coagulation baths, consisting essentially of a solution of solvent and non-solvent, orientation and washing methods normally used on solution spinning are suitable for preparing the fibers of the invention.

It will be understood that in preparing the compositions of this invention they may contain further modifying ingredients such as heat and light stabilizers, delusterants, plasticizers, anti-static agents, lubricants, optical brighteners and other like modifying agents without departing from the scope of the invention and without detrimental effects from the addition of such additives, whether added before, during or after spinning.

The ability of the fiber blends of this invention to act as useful substitutes for wool to give fabrics with essentially wool aesthetics appears to be due to a large measure to the limitations of the blends with respect to denier and proportions of high and low denier fiber in the blend. For example, blends of much less than 60% low denier fiber give fabrics that tend to be too stiff and to have poor drape. Blends of more than about 75% low denier fiber result in a soft, loose, flimsy fabric. Furthermore, bicomponent fiber appears to be required only in the lower denier portion of the blend in order to produce the desired hand and resiliency. Also, the bicomponent fiber has a fairly critical range since more than 75% bicomponent fiber in general produced a fabric with too harsh a hand while less than 60% produced fabric without the desired resiliency.

The invention is further illustrated by the following examples in which all parts and percents are given by weight unless otherwise indicated.

Example 1

In this example a fiber blend was prepared which contained 60% of a 3.0 denier per filament (d.p.f.) bicomponent fiber composed of a 50/50 blend of a copolymer of 92.5% acrylonitrile (AN) and 7.5% vinyl acetate (VA) and a second copolymer of 91.0% AN and 9.0% VA. The remaining 40% consisted of a 5.5 d.p.f. fiber consisting of a copolymer of 92.5% AN and 7.5% VA.

Preparation of this fiber blend was by conventional wet spinning processing under the following conditions.

	3 d.p.f. bicomponent	5.5 d.p.f. copolymer
Dope solids, percent	25	25
Spin bath (dimethylacetamide solvent):		
Percent solvent/water	57/43	57/43
Temp., ° C	40	40
Stretch bath:		
Temp., ° C	100	100
Stretch	5.3×	5.3×
Wash godet:		
Temp	60	60
Speed, f.p.m	107	107
Drier:		
Steam pressure, p.s.i	40	50
Speed, f.p.m	107	107

The fiber blend in tow form was crimped and annealed in steam 7 cycles at 35 p.s.i.g. Staple was variable cut 3 to 4½ inches and processed into finished double knit fabric. The fabric was subjectively tested for hand and resilience using a target wool fabric for comparison. Subjective testing methods for this fabric and subsequent ones involved a panel of personnel independently assessing each experimental fabric as to hand (harshness, softness to the touch) and a comparison of the resilience and drape of the fabric with the target wool fabric. In the Hand Ranking table a 1 rating is very soft and a 6 rating means very harsh. These methods and terms and others used to describe fabrics are analyzed in ASTM Standard D 123–65 "Terms Relating to Textile Materials," and in 1965 Book of ASTM Standards, Part 24.

Example 2

Following the procedures of Example 1 the following additional fabric samples were prepared with the indicated percentages and deniers in Table I. The copolymer and bicomponent composition and ratios were the same as in Example 1 unless otherwise indicated.

TABLE I

Sample No.	Percent	Denier	Comments
2	75 copolymer	3.0	
	25 copolymer	5.0	
3	65 copolymer	3.0	4.25×.
	35 bicomponent 60/40 blend	3.5	4.25×.
4	65 copolymer	3.0	No crimp.
	35 copolymer	3.0	
5	65 copolymer	3.0	
	35 copolymer	3.0	Do.
6	65 copolymer	3.0	Do.
	35 bicomponent	3.0	
7	65 bicomponent	3.0	
	35 copolymer	3.0	Do.
8	65 bicomponent, copolymer (50/50)	3.0 / 5.0	
	35 copolymer	3.0 / 5.0	50/50
9	65 copolymer	3.0 / 5.0	50/50
	35 bicomponent copolymer	3.0 / 3.0	50/50
10	50 bicomponent	3.0 / 4.0 / 5.0	Equal parts
	50 copolymer	3.0 / 4.0 / 5.0	do
11	17.5 copolymer	3.0	Do.
	do	5.0	
	32.5 bicomponent	3.0	
	do	5.0	
12	17.5 bicomponent	3.0	
	do	5.0	
	32.5 copolymer	3.0	Do.
	do	5.0	
13	50 copolymer	3.0	Do.
	50 bicomponent	3.0	
14	25 copolymer	3.0	
	do	3.0	Do.
	50 bicomponent	3.0	
15	65 copolymer	3.0	Recrimped and reannealed.
	35 bicomponent	3.0	
16	20 bicomponent	2.0	
	40 bicomponent	3.0	
	40 copolymer	5.5	

TABLE I—Continued

Sample No.	Percent	Denier	Comments
17	60 bicomponent	2.0	Double annealed.
	40 bicomponent	3.0	Do.
18	60 bicomponent	3.0	Do.
	40 copolymer	5.5	
19	60 copolymer	2.0	
	40 bicomponent (second copolymer 91.5 AN and 8.5 VA)	4.25	
20	40 copolymer	4.25	
	30 bicomponent	2.0	Equal parts
	Second copolymer 91.5 AN and 8.5 VA	3.0	
21	40 copolymer	4.25	
	60 bicomponent (second copolymer 90.9 AN and 9.1 VA)	2.0	
22	75 copolymer	3.0	
	25 bicomponent	5.0	
23	37.5 copolymer	3.0	
	37.5 bicomponent	3.0	
	25 bicomponent	5.0	
24	75 bicomponent	3.0	
	25 bicomponent	5.0	
25	75 bicomponent	3.0	
	25 copolymer	5.0	
26	37.5 copolymer	3.0	
	37.5 bicomponent	3.0	
	25.0 copolymer	5.0	
27	75 copolymer	3.0	
	25 copolymer	5.0	

All samples were given a rating using the procedure described in Example I and the results were as follows.

TABLE II.—HAND RATING

(Subjective fabric evaluation)

Rating					
1	2	3	4	5	6
Example Number					
2	3	6	Wool	10	7
22	4	8	1	13	11
27	5	9	16	14	12
----	15	19	17	24	----
----	20	21	18	----	
----	----	23	25	----	
----	----	26	----	----	

A comparison of these samples with wool clearly indicates that those samples which are defined by the claims in general were rated closer to wool than the rest of the samples which either did not have the bicomponent ratio or denier of the claims or did not contain bicomponent fiber in the lower denier.

The foregoing detailed description has been given for clearness of understanding only, and unnecessary limitations are not to be construed therefrom. The invention is not to be limited to the exact details shown and described since obvious modifications will occur to those skilled in the art, and any departure from the description herein that conforms to the present invention is intended to be included within the scope of the claims.

We claim:

1. A new composition of matter comprising a blend of about

(a) 60 to 75% of a fiber having a denier per filament of less than about 4.0 and comprised of at least about 50% by weight of a bicomponent acrylonitrile polymer fiber and up to 50% by weight of an acrylonitrile polymer fiber and

(b) 40 to 25% of a fiber having a denier per filament of greater than about 4.0 and comprised of an acrylonitrile polymer fiber.

2. A synthetic yarn having wool-like properties with respect to hand and resilience and comprising a blend of

(a) 60 to 75% by weight of a fiber having a denier per filament of between about 3.5 and 1.0 and comprised of at least about 50% by weight of a bicomponent acrylonitrile polymer fiber and up to 50% by weight of an acrylonitrile polymer fiber and

(b) 40 to 25% of a fiber having a denier per filament of between about 4.0 to 8.0 and comprised of an acrylonitrile polymer fiber.

3. The composition of matter of claim 1 wherein the bicomponent acrylonitrile polymer fiber comprises a first component consisting of a copolymer of 85 to 98% by weight of acrylonitrile and 2 to 15% by weight of a mono-olefinic monomer copolymerizable with acrylonitrile and a second component consisting of a copolymer differing from the first component in that it contains at least about a 0.5 percent by weight difference in acrylonitrile content.

4. The composition of matter of claim 1 wherein the acrylonitrile polymer fiber is a copolymer of 85 to 98% by weight of acrylonitrile and 2 to 15% by weight of a mono-olefinic monomer copolymerizable with acrylonitrile.

5. The composition of matter of claim 1 wherein the fiber of (a) has a denier of between about 3.5 to 1.0 and the fiber of (b) has a denier of between about 4.0 and 8.0.

6. The composition of matter of claim 1 wherein the fiber of (a) comprises 100% by weight of a bicomponent acrylonitrile polymer fiber.

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JOHN PETRAKES, Primary Examiner

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