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PROCESS FOR MAKING PIECE-DYEABLE FRIEZE CARPETS FROM HEAT-SET MULTICOMPONENT ACRYLIC FIBER YARN

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ABSTRACT OF THE DISCLOSURE

A process comprising bulking a skein of yarn of multicomponent acrylic fibers free from applied tension by subjecting the skein to elevated temperature and steam, drying the bulk yarn under relaxed conditions, heat-setting the yarn by subjecting it to steam above atmospheric pressure and then drying the heat-set yarn under relaxed conditions. This controlled process sequence provides yarns which are highly suited for making frieze carpets which can be piece dyed without loss of frieze twist in the yarns.

This invention is concerned with frieze carpets. It is particularly concerned with a process for making piece-dyeable frieze carpets from acrylic fibers.

It is well known that polyacrylonitrile and copolymers containing a major portion of acrylonitrile have poorly defined crystalline structure as compared to polyamide and polyester fibers. It has not been possible to heat set the acrylic fibers as successfully as has been done with polyamide and polyester fibers. Thus the latter fibers, after heat-setting, can be boiled in water without losing their heat-set shape. But the hot-wet modulus of acrylic fibers is so low that an acrylic fiber usually "forgets" all its past history when it is boiled off. For this reason it has been considered impossible to piece-dye certain fabric structures made from acrylic fibers.

Frieze carpets are made from highly twisted pile yarns and after weaving or tufting the yarn loops are cut. To make a satisfactory frieze carpet it is essential that the cut yarns maintain their tightly twisted state so that each tuft of yarn remains as a distinct entity. If he frieze carpet is dyed or boiled off after weaving or tufting, and after the loops are cut, there is tendency for the yarns to untwist and lose their individuality, resulting in a mass of evenly distributed pile fibers. For this reason it has heretofore been considered impossible to piece dye frieze carpets made from acrylic fibers. Such carpets have been made by stock dyeing the fibers before spinning into yarn. Yarn dyeing can be done under carefully controlled conditions but is not attractive economically.

The present invention provides a process of making frieze carpets from acrylic fibers which carpets can be piece dyed without loss of frieze twist in the yarns.

This is accomplished by a process involving a carefully controlled sequence of bulking and texturing, relaxed drying, heat-setting, and further relaxed drying of yarn, followed by preparation of the fabric and dyeing it. The heat-setting of fibers is a well known art and is common practice with polyamide and polyester fibers, but is of only limited use with fibers of acrylonitrile

polymers. It is, therefore, surprising that a process has been discovered whereby piece-dyeable frieze carpets can be made from acrylonitrile polymer fibers.

Piece dyeability is an important factor in the economics of textile manufacture. Since dyeing is nearly the end of the production cycle, the problem of inventory is much simpler if only undyed fabric needs to be stocked so that orders can be filled quickly for any shade desired. Without piece dyeability there must be carried a large inventory of dyed staple or yarn, or a large inventory of carpets in all shades, to permit quick delivery. Piece dyeing is economical in other ways also and the broad advantages of piece-dyeability will be obvious to those skilled in the art of textile manufacture.

The fibers which are suitable for this invention are the multicomponent fibers, particularly bicomponent fibers spun from two different polymers or copolymers in a side-by-side relation along the length of the fiber as taught by U.S. Patent 3,038,236 of Breen. Certain blends of these bicomponent fibers with homofibers are also satisfactory as will be shown in the example. A fiber blend may also contain fibers spun from incompletely mixed solutions of different polymers according to British Patent 760,179 to Halbig.

The following example will demonstrate the manner in which this invention is carried out.

Example I

A frieze carpet is made from yarn spun from a blend of a bicomponent fiber and a homofiber. The two fibers have the following polymer compositions:

Fiber I—Bicomponent fiber:	Percent
Polymer A—Polyacrylonitrile	50
Polymer B—96% acrylonitrile, 4% sodium styrenesulfonate	50

Fiber II—Homofiber:	Percent
Acrylonitrile	93.6
Methyl acrylate	6.0
Sodium styrenesulfonate	0.4

Fiber I is a 12 denier (1.33 tex) fiber spun according to Example VI of U.S. Patent 3,038,236. After spinning it is washed and drawn 265% (3.65×), cut into 3-inch (7.62 cm.) staple and dried.

Fiber II is a 17 denier (1.89 tex) fiber. After washing, it is stretched 112% (2.12×), cut into 3-inch (7.62 cm.) staple and dried.

Fibers I and II are blended in a 50/50 ratio and spun on the wollen system into 1.25 Wool Run (248 tex) yarn having 3.5 turns per inch (t.p.i.) (1.38 turns per cm.) Z twist. Two of these yarns are plied and twisted 8 t.p.i. (3.1 t.p. cm.) S twist.

The yarn is next wound into 54-inch (137 cm.) skeins of 1 pound (0.45 kilogram) each and laced loosely to allow for bulking. The skeins are then treated as follows to develop frieze texture and bulk:

(1) Steam 30 seconds in a slow-speed tumbler (such as a commercial washing machine).

(2) Flex (work) the steamed skeins to develop texture and bulk.

(3) Steam 30 seconds.

(4) Flex.

(5) Steam 30 seconds.

(6) Dry in a relaxed state at 77° C. as by low speed tumbling or by tray drying. Drying at this stage can be

omitted if the yarns are handled carefully to transport them to the heat setting equipment. However, it is usually considered good practice to dry before proceeding to heat setting. If the skeins are dried in a hanging position the crimp is partly removed and the final carpets are not piece-dyeable.

(7) Heat-set in an autoclave by the following steps:

(a) Vacuum at 26 to 28 inches (66 to 71 cm.) of mercury	min.	4
(b) Steam 10 p.s.i.g. (0.7 kilogram per square cm.)	min.	4
(c) Lag, reduce to 2 p.s.i.g. (0.14 k./sq. cm.)	sec.	20
(d) Steam 10 p.s.i.g. (0.7 k./sq. cm.)	min.	4
(e) Lag, reduce to 2 p.s.i.g. (0.14 k./sq. cm.)	sec.	20
(f) Steam 10 p.s.ig. (0.7 k./sq. cm.)	min.	4
(g) Lag, reduce to 2 p.s.i.g. (0.14 k./sq. cm.)	sec.	20
(h) Steam 10 p.s.i.g. (0.7 k./sq. cm.)	min.	8
(i) Vacuum 26–28 inches (66–71 cm.) of mercury	min.	4
(j) Exhaust to atmosphere	sec.	30

(8) Dry relaxed by tumbling or on tray at 77° C.

Following heat-setting and relaxed drying the yarns are made into carpets by tufting on a 40-inch (102 cm.) tufting machine to 26 to 28 oz./sq. yd. (871 to 938 gm./sq. meter), 0.375 inch (0.95 cm.) pile height and 0.187 inch (0.47 cm.) gauge. The loops are cut after tufting. The individual yarns retain twist and identity.

The tufted carpet is 30 inches (76 cm.) wide. A 36 yard (32.8 meter) length is dyed in a 4 foot (1.2 meter) wide dye-beck by the following schedule:

(A) Scour 30 minutes at 50° C. with 0.5 g./l. non-ionic detergent.

(B) Add: 1.5% non-ionic detergent and 10.0% glaubers salt (based on weight of carpet).

(C) Run 5 minutes.

(D) Adjust pH to 4.5–5.0 with acetic acid.

(E) Adjust reel speed to 40 yards (36.4 meters) per minute.

(F) Add:

0.030% Sevron Blue BGL (Color index Basic Blue 35),
0.032% Sevron Blue B (Color index Basic Blue 21),
0.058% Sevron Red GL (Color index Basic Red 18), and
0.040% Sevron Yellow MF (Color index Basic Yellow 31).

(G) Raise temperature to 71° C., run 30 minutes.

(H) Add 1.5% aromatic dispersing agent, run 5 minutes.

(I) Raise temperature to 88° C. during 20 minutes.

(J) Raise tempearture to 94° C. during 10 minutes.

(K) Run 30 minutes at 94° C.

(L) Raise temperature to 98° C. during 5 minutes.

(M) Cool slowly to 77° C., rinse slowly with fresh water.

(N) Remove from beck and pass over vacuum slot.

(O) Dry on pin tenter at 121° C.

(P) Latex back of carpet and cure at 121° C.

This carpet retains its frieze pattern with each yarn tuft remaining tightly twisted. This result is similar, in clarity of frieze pattern, to a carpet tufted from yarns spun from stock dyed fiber. It is greatly superior in tuft clarity to a similar carpet made from yarns, which at steps 6 and 8 above, were dried by hanging and blowing with hot air. In the latter case the tufts untwisted to a large extent yielding mostly a smooth pile carpet.

Other means of drying the yarns may be used in steps 6 and 8 of the bulking and heat setting operations but the yarns must be relaxed. Tumble drying is preferred because it gives good results and is economical and convenient. Drying can be done in bags, if desired, and will help prevent yarn entanglement. Yarns may also be dried on trays.

Efforts to produce piece dyeable frieze carpets of acrylic fibers by other methods of bulking and heat-setting the yarns have been unsuccessful.

The temperature of drying the yarns in steps 6 and 8 is not critical and may vary from room temperature (20° C.) to 130° C. or higher.

Example II

A frieze carpet yarn is made from a bicomponent fiber spun from two different polymer compositions as follows:

	Parts
Composition I:	
Polyacrylonitrile	84.0
Terpolymer of acrylonitrile, 93.6%; methyl acrylate, 6.0%; sodium styrenesulfonate, 0.4%	9
Tris(dibromopropyl)phosphate (TBP)	7.0
Composition II:	
Terpolymer of acrylonitrile, 93.6%; methyl acrylate, 6.0%; sodium styrenesulfonate, 0.4%	93.0
Tris(dibromopropyl)phosphate	7.0

The bicomponent fiber is spun in the same way as the bicomponent fiber of Example I. After spinning the fiber is washed and drawn 3×, then crimped in a stuffer box crimper to impart from 6 to 8 crimps per inch. It is cut into 3-inch (7.6 cm.) staple and dried at 130° C.

The staple fiber is spun on the woolen system to 2.4 cotton count (250 tex) 4 turns per inch (1.6 turns per cm.) Z twist. Two of these yarns are plied and twisted 8 t.p.i. (3.2 t.p. cm.) S twist.

The two-ply yarns are bulked and heat set as in Example I and tufted into a carpet with cut loops. When piece dyed as in Example I the yarns retain their curled structure to yield a good frieze appearance.

Another useful fiber blend for use in practicing the invention is composed of composite fiber one side of which is formed of a mixture of 90 parts of polyacrylonitrile and 10 parts of a copolymer (a) of 95.8 parts of acrylonitrile and 4.2 parts of sodium styrenesulfonate and the other side of which is the copolymer (a) just given, and homofiber composed of a terpolymer of acrylonitrile. Another useful fiber blend is composed of a composite fiber having the composition of the bicomponent fiber of Example II, and homofiber comprising Composition II of Example II, that is a mixture of the terpolymer and phosphate as given therein. All parts stated in this specification are by weight.

The polymers of acrylonitrile useful in practicing the present invention are well known. Generally these comprise homopolymers of acrylonitrile or copolymers of acrylonitrile and one or more ethylenically unsaturated monomers which are copolymerizable with acrylonitrile. Examples of typical copolymerizable monomers are well known and may be found in U.S. Patents 2,837,501, 2,485,241 and 2,436,926. The polymers generally have a molecular weight of about 15,000 to 250,000, and comprise at least 70 weight percent of acrylonitrile. In addition, it should be apparent that conventional additives may be incorporated in the polymers in the usual amounts without departing from the scope of this invention. The polymers are spun to bicomponent or other form useful for the invention in accordance with techniques known in the patent literature for example as in U.S. Patent 3,038,-236 and similar patents.

In choosing polymers for use as the different components of the fibers and yarns in the invention, due consideration must be given to the required difference in shrinkage so that bulking will occur upon heat relaxing. Similarly, fiber denier characteristic of carpet manufacture is to be employed.

While the invention has been described with detailed embodiments, it will be appreciated that changes can be made without departing from its scope. By way of example, it will be apparent that changes and modifications can be made in the detailed heat-setting and dyeing procedures. Other changes will occur to those skilled in the art.

What is claimed is:

1. In the process of making piece-dyeable frieze carpet from yarn comprising composite acrylic fibers, the steps comprising forming a skein of the yarn, subjecting the skein of yarn free from applied tension to elevated temperature and steam to bulk the yarn, drying the bulked and relaxed yarn, heating the yarn with steam above atmospheric pressure to set it, and then drying the heat-set yarn free from applied tension.

2. A process according to claim 1 in which the acrylic fibers comprise a blend of (1) homofiber composed of a terpolymer of acrylonitrile and (2) composite fiber one side of which is composed of polyacrylonitrile and the other side of which is a copolymer of acrylonitrile and sodium styrenesulfonate.

3. A process according to claim 2 in which the yarn is heat relaxed at a temperature of about 77° C.

4. A process according to claim 1 in which the acrylic fibers comprise bicomponent fibers the components of which have different shrinkage characteristics.

5. A process according to claim 1 in which the acrylic fibers comprise a blend of (1) composite fiber one side of which is a mixture of 90 parts by weight of polyacrylonitrile and 10 parts by weight of a copolymer of 95.8 parts of acrylonitrile and 4.2 parts of sodium styrenesulfonate, and the other side of which is composed of copolymer of 95.8 parts of acrylonitrile and 4.2 parts of sodium styrenesulfonate, and (2) homofibers composed of a terpolymer of acrylonitrile.

6. In the process of making piece-dyeable frieze carpet from yarn comprising a blend of (1) composite fiber one side of which is polyacrylonitrile and the other side of which is a terpolymer of acrylonitrile, methyl acrylate and sodium styrenesulfonate, and (2) homofiber composed of terpolymer of acrylonitrile, methyl acrylate and sodium styrenesulfonate, the steps comprising forming a skein of the yarn, subjecting the skein of yarn free from applied tension to elevated temperature and steam to bulk the yarn, drying the bulked and relaxed yarn, heating the yarn with steam above atmospheric pressure to set it, and then drying the heat-set yarn free from applied tension.

7. A process according to claim 6 in which the composite fibers are formed on one side of a mixture of 84 parts, by weight, of polyacrylonitrile, 9 parts by weight of a terpolymer of 93.6 parts of acrylonitrile, 6 parts of methyl acrylate and 0.4 part of sodium styrenesulfonate, and 7 parts by weight of tris(dibromopropyl)phosphate, and on the other side a mixture of 93 parts of a terpolymer of 93.6 parts of acrylonitrile, 6 parts of methyl acrylate and 0.4 part of sodium styrenesulfonate, and 7 parts of tris(dibromopropyl)phosphate.

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