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COMPOSITE YARN

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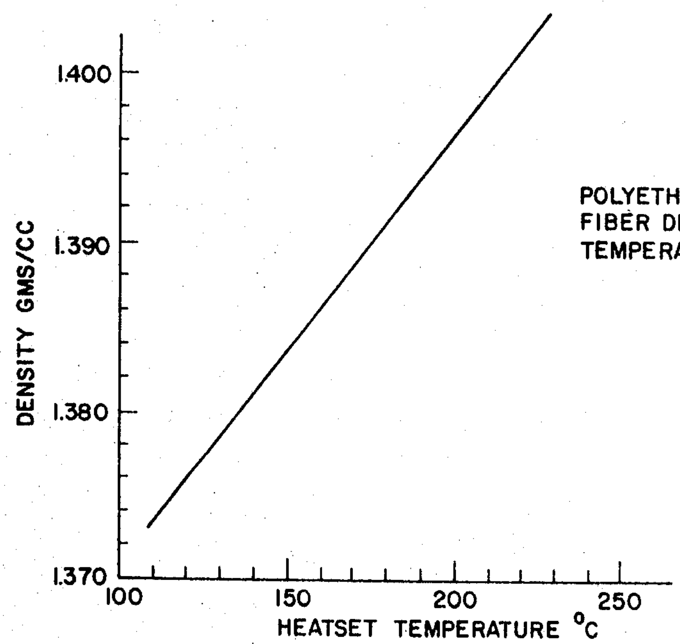

FIG. 1

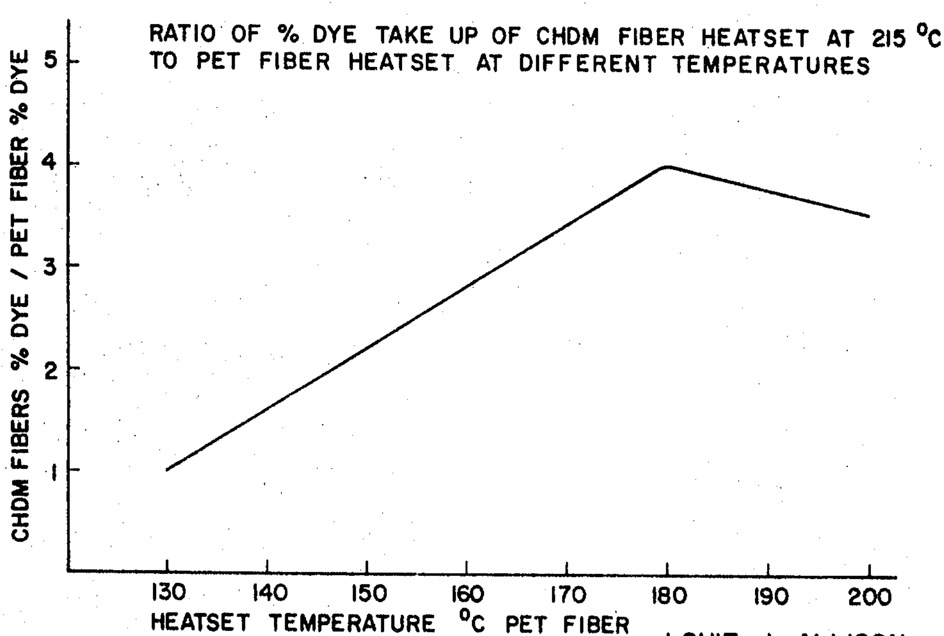

FIG. 2

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COMPOSITE YARN

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ABSTRACT OF THE DISCLOSURE

This invention relates to composite carpet yarns comprising at least two different types of polyester fiber. This invention further relates to a method of treating poly(ethylene terephthalate) fiber to improve the resilience and crush resistance thereof and to lower the affinity of the fiber for disperse dyes.

In the prior art, pile fabrics, such as carpets, rugs and fur fabrics, have been made from yarns containing poly(ethylene terephthalate) fibers. However, one of the chief shortcomings of poly(ethylene terephthalate) fiber for use in pile fabrics has been its poor resilience and recovery from crushing. In this respect, the poly(ethylene terephthalate) fiber is inferior to polyester fiber made from poly(1,4-cyclohexylene dimethylene terephthalate) which fiber is characterized by having excellent crush resistance and excellent affinity for disperse dyes.

It is known that heatsetting poly(ethylene terephthalate) fibers at high temperatures while the fibers are held under tension will alter the degree of crystallinity and the degree of crystalline orientation and thus will stabilize the fibers against slack aging and will increase the load-bearing capacity of the fibers. However, to achieve these results the crush resistance and crimp retention properties are adversely affected.

We have found that the crush resistance and crimp retention properties of poly(ethylene terephthalate) fibers can be improved and that the disperse dye-take-up characteristics of the poly(ethylene terephthalate) fibers can be altered by proper heatsetting procedures.

A general object of this invention is to provide a composite polyester fiber yarn which has good crush resistance and crimp retention and which when dyed with a disperse dye will exhibit a tone-on-tone color effect. Other objects will become apparent as the description of the invention proceeds.

This and other objects are obtained by treating fibers made from poly(ethylene terephthalate) and having an I.V. of at least .55 to enhande the crush resistance and crimp retention characteristics by subjecting the fiber to heatset temperatures of at least 165° C. to about 200° C. while the fibers are in a relaxed state to raise the fiber density to about 1.385 g./cc. but not over about 1.395 g./cc.

The treated fibers are then blended or plied as desired with fibers of poly(1,4-cyclohexylene dimethylene terephthalate), heatset at about 215° C., and having an I.V. of at least about .60 and a density of about 1.225 g./cc. to about 1.235 g./cc.

The term "density," as used in this specification, is defined as the weight in grams of a cubic centimeter of fiber, corrected to base polymer for any additives such as TiO_2 or other pigments, dulling agents, catalysts, etc. Thus, we are speaking of the true density of the material forming the fiber and not the total density of the fiber forming material and the additives which may be present in the fiber.

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FIGURE 1 is a graph illustrating the change in density of poly(ethylene terephthalate) fibers when subjected to heat while in a relaxed condition.

FIGURE 2 is a graph illustrating the ratio of percent dye takeup of poly(1,4-cyclohexylene dimethylene terephthalate) fiber heatset at 215° C. to poly(ethylene terephthalate) fiber heatset at temperatures ranging from 130° to 200° C.

The practice of the present invention requires that the fibers or yarns to be treated are first melt extruded, drafted to obtain the required physical properties, crimped or texturized and then heatset in a tensionless state at 165° C. or higher for a sufficient time to insure complete penetration of heat into the fiber.

After heatsetting, the fiber is dealt with in a manner which depends upon the desired final yarn structure. For instance, the heatset fiber may be cut into staple lengths for processing into carpet yarns on conventional staple processing equipment. If a textured continuous filament yarn is required, the fiber may be extruded, drafted, texturized in a manner such as is described in U.S. Patent 3,099,064 or by other suitable texturizing means, then heatset at 165° C. or higher, depending on the particular polyester polymer composition of the filaments. It is possible to accomplish the heatsetting after the yarn has been processed into carpeting. The carpeting may, prior to any latex application to the carpet backing, be heatset in an oven, apron dryer, or the like.

The manner in which the heat is applied is not critical. It is only required that the temperature be at least 0.60 times the melt temperature, the yarns or fibers be in a tensionless state, the duration of the heat application be sufficient to insure complete penetration, equilibrium, and maximum crystallization of the fiber, and the heatsetting step follow extrusion, drafting and crimping or texturizing. It is important that the heat be applied uniformly to avoid variation in dye take-up due to variations in the crystalline structure of the heatset yarn.

The improving of fiber resilience by heatsetting appears to be attained when the ratio of the heatset temperature in degrees centigrade to the melt temperature in degrees centigrade falls in the range of 0.65 to 0.80. Higher temperatures may result in discoloration of the fibers while lower temperatures result in loss of resilience, texture retention, and appearance of carpets made from these fibers. In general, polyester fibers with higher melting or softening points require higher heatsetting temperatures to achieve maximum fiber crystallinity and the resultant maximum resilience in carpet piles. It appears that the heatset temperature should be equal to or greater than about 0.65 times the melt temperature and less than 0.80 times the melt temperature. The time of application of the heatsetting treatment should be sufficient to insure that all the fibers in a yarn or carpet pile are affected and achieve maximum crystallization. Shorter times can be used if the heat treating process is such that each individual fiber is surrounded by the heatsetting media, i.e., steam, hot air, etc. Heavy compact bundles of filaments as for example a highly twisted heavy denier carpet yarn will require longer exposure to the heatsetting media to insure that the innermost filaments of the bundle are brought up to the heatsetting temperature for a sufficient length of time to insure maximum crystallinity. Heatsetting may be performed in an oven, apron dryer, heated tube, or other suitable device.

We have found that we can ply a strand of poly(ethylene terephthalate) fiber and strand of poly(1,4-cyclohexylene dimethylene terephthalate) fiber to form a composite yarn having good crush resistance and crimp retention properties and which can be dyed with a single disperse dye to achieve a tone-on-tone color effect.

One outstanding color effect that we can achieve with our novel composite yarn is that in which both groups of fibers are of a color, that is of the same hue but with one group of filaments being of a lighter shade than the remaining group of filaments. For example, fibers of similar shades or hues and intimately mixed will result in yarns which one sees in fabrics as a single color only with a more scintillating effect than can be produced from yarn of truly only one color. At the other extreme, one can produce fabrics from our novel composite yarn, wherein the fabric is formed from strands of poly(ethylene terephthalate) fiber and strands of poly(1,4-cyclohexylene dimethylene terephthalate) fiber, and dye it with a disperse dye to obtain a tone-on-tone color effect.

The following examples are included for a better understanding of the invention.

EXAMPLE I

The density of polyethylene terephthalate fibers is one measure of the degree of crystallinity of the fiber, high density fibers having a higher degree of crystallinity than low density fibers. FIGURE 1 depicts the change in density, and degree of crystallinity, which is effected when extruded, drawn, and crimped polyethylene terephthalate fiber is subjected to increasing levels of heatset temperature while the fiber is free to relax. It will be noted that at the conventional heatset temperature of 130° C. to 150° C. the crystallinity of the fiber is relatively low as indicated by the low density measurements in the range of 1.378 to 1.384 g./cc. By contrast the highly crystalline poly(ethylene terephthalate) fibers which have been subjected to the high temperature heat treatments to impart improved carpet crush resistance have a high degree of crystallinity as reflected by their densities in the range of 1.385 to 1.395 when subjected to heatsetting temperatures in the range of 170° to 210° C.

EXAMPLE II

A quantity of 15 d./f. fiber poly(ethylene terephthalate) was melt extruded, drafted, and crimped in a stuffer box crimper. One portion was heatset at room temperature (22° C.–25° C.); one at 125° C., and one at 180° C., on an apron dryer for five minutes. After heatsetting, the three portions were cut to 4-inch staple, and processed into 2.5/3 ply cotton counts yarns. The three yarns heatset at different temperatures were then tufted into 25 ounces per square yard loop pile carpeting. The carpeting was piece dyed and tested on the floor for 20,000 steps or walkovers. The following table shows the degree of improvement obtained with the 180° C. heatset sample as compared to the room temperature, and the 125° C. heatset samples.

TABLE

Sample number	1	2	3
Heatsetting temperature, ° C	22–25	125	180
Heatset temperature/melt temperature	0.09	0.50	0.73
Percent original thickness retained after—			
10,000 steps	80	82	84
20,000 steps	72	73	78
Texture retention (appearance)	Poor	Poor	Good

EXAMPLE III

The comparative dye rate between fibers spun from poly(ethylene terephthalate) and those spun from poly-(1,4-cyclohexylene dimethylene terephthalate) may be changed by adjusting the temperature at which the poly-(ethylene terephthalate) fibers are heatset.

A 500 pound lot of 15 d./f. I.V. fiber was spun from poly(ethylene terephthalate) at the following conditions:

Extrusion temperature	° C.	295
Rate	lbs./hr.	25
Draw ratio		4.8:1

This fiber was then processed into eight separate lots, each being heatset at a different temperature. The following processing conditions were used:

Water bath temperature	° C.	65
Steam tube temperature	° C.	150
Draw ratio		4.8:1
Heatset temperature	°C.	130, 140 . . . 200
Heatset time	min.	5
Crimps	c.p.i.	5–7
Staple length	inches	6

Each of these eight samples was paired with a 15 d./f. poly(1,4 - cyclohexylene dimethylene terephthalate) sample which had been processed at the following conditions:

Extrusion temperature	° C.	320
Rate	lbs./hr.	80
Draw ratio		3.4:1
Draft tube temperature	° C.	200
Heatset temperature	° C.	215
Heatset time	min.	5
Crimps	c.p.i.	5–7
Staple length	inches	6

Each pair of samples was dyed two separate colors:

Avocado shade	Color index name
Eastman Polyester Blue BLF (−4%)	Disperse Blue 120.
Eastman Polyester Yellow 5R (1.75%)	Disperse Yellow 23.
Eastman Polyester Brilliant Red FFBL (0.3%)	Disperse Red 60.

	Percent
Dye Carrier assistant (Carolid 3F)	10
Calgon	1
Monosodium phosphate	1

Navy formula	Color index name
Eastman Polyester Blue BLF (2.7%)	Disperse Blue 120.
Eastman Polyester Yellow W (2.7%)	Disperse Yellow 42.
Eastman Polyester Violet R (2.4%)	Disperse Violet 27.
Eastman Polyester Brilliant Red FFBL (.9%)	Disperse Red 60.

	Percent
Dye carrier assistant (Carolid)	21
Calgon	1
Monosodium phosphate	1
Wetting agent (Standapon)	.75

Methylene chloride extractions were used to determine the total amount of dye absorbed by the fibers.

Results show that as the heatsetting temperature of the polyester terephthalate samples is increased from 130° C. to 180° C., the difference in dye rate between the two types of fiber increased linearly from a ratio of about 1:1 at 130° C. to a ratio of about 4:1 at 180° C., with the polyester terephthalate fibers dyeing lighter. As the heatset temperature was increased further (from 180° C. to 200° C.), the contrast between fibers decreased. The same results were obtained with both dye furmulae as shown in FIGURE 2.

The novel yarns of this invention are particularly useful for the production of carpets. The yarn exhibits good covering power and is more resistant to crushing and matting when heavy objects are placed on carpets made with the yarns. The crush resistance of the yarn is due in part to the excellent crush resistance of the poly(1,4-cyclohexylene dimethylene terephthalate) fiber and in part to the improved crush resistance of the poly(ethylene terephthalate) fiber. Further, the novel yarn of this invention being composed of two different polyester fibers, each having been treated to possess desired disperse dye take-up characteristics make possible the manufacture of carpets, fur fabrics, sweaters, woven fabrics and the like which will retain their bulk characteristics and which can be easily dyed to tone-on-tone colors with a disperse dye.

This 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 as described hereinabove and as defined in the appended claims.

We claim:

1. Textile yarn having good crush resistance and crimp retention properties comprising at least two plied strands of fibers, the fibers of at least one of said strands being poly(ethylene terephthalate) fibers characterized by having an I.V. of at least .55 and a density of 1.385 to about 1.395 g./cc.

2. Textile yarn of claim **1** wherein the density of said poly(ethylene terephthalate) fiber is about 1.390 g./cc.

3. Textile yarn of claim **1**, wherein the fibers of the other of said strands are poly(1,4-cyclohexylene dimethylene terephthalate) fibers having an I.V. of at least .60 and a density of 1.225 to about 1.235.

4. Textile yarn of claim **3**, wherein the ratio of disperse dye take-up of said poly(1,4-cyclohexylene dimethylene terephthalate) fibers to said poly(ethylene terephthalate) fibers is at least about three to one, whereby said yarn when dyed with a disperse dye will exhibit a tone-on-tone color effect.

5. Textile yarn having a good crush resistance and crimp retention properties comprising a blend of at least two kinds of polyester fibers, one of said polyester fibers being poly(ethylene terephthalate) fibers having an I.V. of at least .55 and a density of 1.385 to about 1.395 g./cc. and the other of said polyester fibers being poly(1,4-cyclohexylene dimethylene terephthalate) fibers having an I.V. of at least .60 and a density of 1.225 to about 1.235 g./cc.

6. Textile yarn of claim **5** wherein the ratio of disperse dye take-up of said poly(1,4-cyclohexylene dimethylene terephthalate) fibers to said poly(ethylene terephthalate) fibers is at least about three to one, whereby said yarn when dyed with a single disperse dye will exhibit a tone-on-tone color effect.

7. Textile fabric having good crush resistance and bulk characteristics, said fabric including yarn made from poly(ethylene terephthalate) fibers having an I.V. of at least .55 and a density of 1.385 g./cc. to about 1.395 g./cc., and yarn made from poly(1,4-cyclohexylene dimethylene terephthalate) fibers having an I.V. of at least .60 and a density of 1.225 g./cc. to about 1.235 g./cc., the ratio of disperse dye take-up of said poly(1,4-cyclohexylene dimethylene terephthalate) fiber to said poly (ethylene terephthalate) fibers is at least three to one, whereby said fabric when dyed with disperse dye will exhibit a tone-on-tone color effect.

8. Textile fabric of claim **7**, wherein said poly(ethylene terephthalate) yarn and said poly(1,4-cyclohexylene dimethylene terephthalate) yarn is a composite plied yarn.

9. Textile fabric of claim **7**, wherein said yarn comprises a blend of said poly(ethylene terephthalate) fibers and said poly(1,4-cyclohexylene dimethylene terephthalate) fibers.

10. Textile fabric of claim **7**, wherein said fabric is a carpet dyed with a dispersed dye.

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