United States Patent

McKay

[15] 3,691,749

[45] Sept. 19, 1972

[54] **MULTILOBAL MULTIFILAMENT YARN**

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[22] Filed: **Dec. 18, 1970**

[21] Appl. No.: **99,447**

[52] **U.S. Cl.** .....**57/140 J**, 57/157 TS, 161/177, 264/177

[51] **Int. Cl.** **D02g 3/34**

[58] **Field of Search**.....57/34 HS, 35, 140 BY, 140 J, 57/157 TS, 157 MS; 264/177; 161/177, 179, 180, 181

[56] **References Cited**

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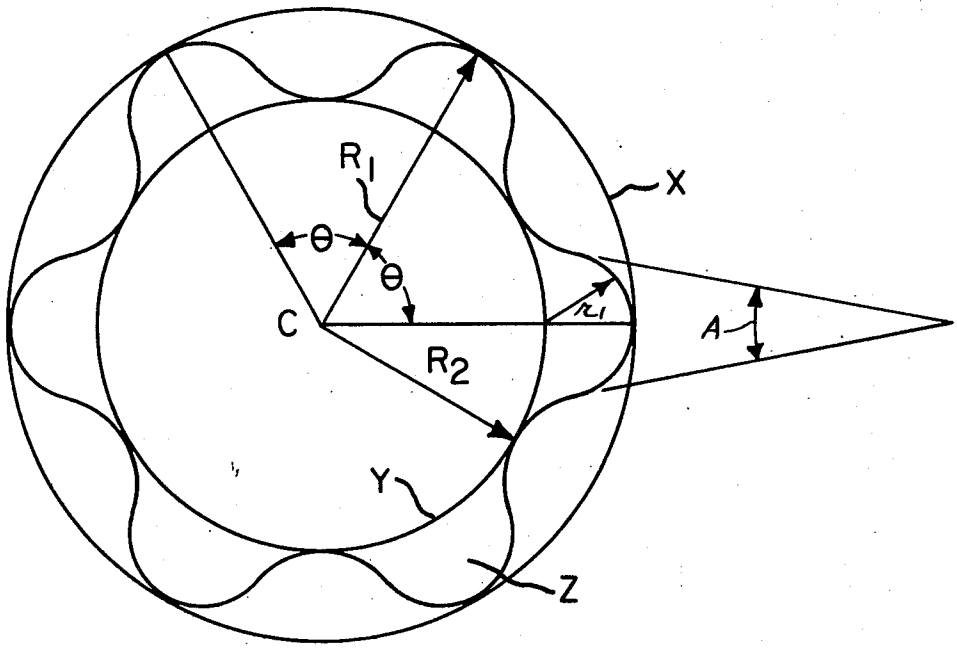
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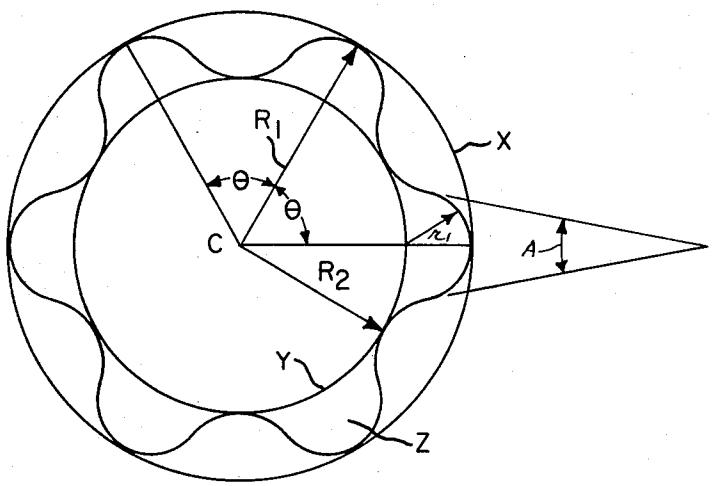
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[57] **ABSTRACT**

Multifilament PACM polyamide yarn, of multilobal filaments having specified cross-sectional characteristics, is false-twist textured into yarn which provides fabrics having improved visual aesthetics. Freedom from objectionable glitter is exemplified for yarns of hexalobal filaments composed of PACM-12 polyamide derived from bis(4-aminocyclohexyl)-methane and dodecanedioic acid.

3 Claims, 1 Drawing Figure





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MULTILOBAL MULTIFILAMENT YARN

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to multifilament yarns having continuous filaments of modified cross-section, and, more particularly, to PACM polyamide yarns for false-twist texturing.

2. Description of the Prior Art

Multifilament yarns have recently been disclosed which are prepared from PACM–12 polyamide which is derived from bis(4-aminocyclohexyl)methane (PACM diamine) and dodecanedioic acid (12 carbons). Filaments of PACM–12 prepared from PACM diamine containing at least 40 percent by weight of the trans-trans stereoisomer are particularly susceptible to large crystallinity increases when subjected to annealing, making them particularly useful in operations requiring them to be set in a predetermined configuration by thermal treatment. Polymer of this type is disclosed in Speck U.S. Pat. No. 3,393,210.

A process for texturing the PACM–12 and copolymers is disclosed in Edison U. S. Pat. No. 3,534,541, whereby a yarn with improved bulk is obtained. Another type of textured PACM polyamide yarn is disclosed in French Pat. No. 1,583,494 which was granted Sept. 22, 1969. This yarn contains two different types of filaments of differing shrinkability, each type being prepared from a polymer derived from PACM diamine or its substituted equivalents and from linear aliphatic dicarboxylic acids having 11 to 16 carbon atoms. The present application is limited to texturable polyamide yarns of the types disclosed in the Edison U.S. Pat. No. 3,534,541 and in the French Pat. No. 1,583,494.

Recently it has been discovered that the filament cross-sectional configuration of PACM polyamide yarns has a critical influence on the appearance and feel of textured yarns prepared by the false-twist method and this influence is particularly obvious in fabrics which have been woven or knit from the textured PACM polyamide yarns.

In the prior art the importance of the optics of fibers aesthetic qualities of fabrics has been often discussed. For example, it is known that filaments of trilobal cross-section have a high degree of sparkle (luster highlight), this being disclosed in Holland U. S. Pat. No. 2,939,201. While this sparkle is particularly desirable for some uses, such as in high fashion dresses or for its soil hiding qualities in carpets, there are other uses which require a substantial absence of sparkle points in the fabrics. In particular, there is a need in the textile trade for fabrics with high sheen (an overall high degree of uniform reflectance) without glitter. Glitter may also be termed sparkle or luster highlight. It is characterized by reflection of light in intense beams from tiny areas of the filament or fabric, contrasting greatly with the general background reflection.

Recently, it has been found that fabrics with high sheen may be obtained by use of filaments having a multilobal cross-section wherein the number of lobes is five or greater. In general, this improved sheen in the untextured yarn can be achieved with less sparkle by increasing the number of lobes, but spinnerets for preparing such filaments are increasingly difficult to make as the number of lobes increases.

While multilobal filaments with five or more lobes have increased sheen it has now been found that critical control of the lobe cross-sectional configuration is needed for avoidance of excessive deformation during texturing by any of the false-twist methods. When this deformation is of sufficient intensity to promote formation of a large number of flat spots in the filament, then this deformation is undesirable since the yarns or fabrics will have a high amount of sparkle. Sparkle is particularly noticeable when the fabric is dyed a deep shade such as navy blue.

SUMMARY OF THE INVENTION

The purpose of the invention is to provide a PACM polyamide yarn which can be textured by a false-twist process to produce a soft, bulky yarn with a high level of sheen (i.e., a high level of uniform reflectance) without developing objectionable glitter. This is accomplished by providing yarn composed of filaments having multilobal cross sections as defined hereinafter for use in the false-twist texturing operation.

In accordance with this invention, the multifilament feed yarn for false-twist texturing is composed of a PACM polyamide derived from bis(4-aminocyclohexyl)methane (at least 45 percent trans-trans isomer) and a linear aliphatic dicarboxylic acid having 11 to 16 carbon atoms in the molecule. The filaments in the yarn have a multilobal crosssection with at least five lobes (preferably five to 10 lobes), wherein the lobes are essentially symmetric about a center line through the lobe, are of substantially equal length, and are substantially equally spaced about the center of the filament. The filaments are further characterized in that;

(a) $$\frac{(MR)(N)}{d^{1/2}e^{.0352N}}$$

is at least 3.3 (preferably 3.5 to 5.5) and

(b) $$\frac{MR}{\text{Cosec}\left[\frac{90\ (N-2)}{N}\right]}$$

is about 1.03–1.6 (preferably 1.1 to 1.4), where MR is the modification ratio, N the number of lobes, d is the denier per filament and e is the base of the natural logarithm system.

The invention includes both the feed yarn and false-twist textured yarn. The textured yarn is characterized by a cross-section in which filaments may either be deformed or undeformed, the undeformed filaments having a cross-sectional shape of the type defined for the feed yarn, but less than 12 percent of the total filaments in the yarn cross-section have flattened surfaces of greater length than 10 microns.

BRIEF DESCRIPTION OF THE DRAWINGS

The single FIGURE of the drawing is a schematic representation of a hexalobal fiber cross-section.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The term "modification ratio" as used herein is best defined with reference to the drawing as R_1/R_2 where R_1 is the radius of circle X having center C circumscribed about the tips of the lobes Z, and R_2 is the radius of circle Y having center C inscribed within the cross-section.

By "essentially symmetrical lobes" is meant that a line joining the lobe tip to center C of circle Y will bisect the lobe area located above circle Y into two approximately equal areas which are preferably mirror images of one another. By "lobes substantially equally spaced about the center" is meant that a line joining a lobe tip to center C of circle X will be at an approximately constant angle θ from the line joining the tip of the adjacent lobe to point C. When the lobes are appreciably non-symmetrical and/or the angles θ are not approximately constant, this will produce a "weak" point in the filament cross-section which will be more likely to produce a flat surface during texturing.

By "lobes of substantially equal length" is meant that the distance from the center C to each of the lobe tips does not vary by more than about 10 percent. Small variations from perfect symmetry generally occur in any spinning process due to such factors as non-uniform quenching or imperfect spinning orifices. From the preceding paragraph, it is understood that such small variations are permissible provided the yarns give rise to glitter-free fabrics after texturing.

The preferred number of lobes for the polyamide filaments of the invention is in the range 5–10. It is difficult to fabricate spinneret orifices to produce filaments having more than 10 lobes. Within the ranges of 2 to 4 denier per filament and 1.15 to 2 modifications ratios normally encountered, it has not been possible to produce glitter-free fabrics from yarns having less than five lobes. Of course, by reducing the filament denier sufficiently (e.g., to about 0.5 dpf with round cross-sections) it is possible to produce glitter-free yarns after texturing regardless of the starting cross-section. However, such low denier filaments are difficult to produce and give rise to fabrics which are too soft and lack crispness. The preferred yarns of the invention are generally composed of filaments all having the same cross-sectional configuration before texturing. The yarn may also contain other filament shapes and other polymer species, but substantially all of the filaments should be PACM polyamide fibers with five to ten lobes and have the previously-defined values of modification ratio and denier per filament.

In order to provide satisfactory texturing performance, the feed yarns of this invention may have applied thereon a finish in an amount sufficient to provide a yarn friction coefficient of less than about 0.3. The friction coefficients are measured using a modification of the procedure in J.S. Olsen, Tex. Res. J., 31–37 (1969), FIG. 1, wherein a heated metal block is located between the pretensioner and first strain gauge. The block is 3-inches long and had canted idler rollers at each end to allow multiple wraps. Six and one-half wraps are used for a total contact length of 39 inches (vs. 40 inches for typical texturing heater plate). The heater is set at 220° C. and the pretensioner adjusted to give about 10 gms. pretension. The test pin used is Al-SiMag 513, 3/16 inch diameter, Moh hardness 9, surface roughness 24 ± 2 micro inches RMS and located 4 inches from the heated block. A wrap angle of 495° was used where possible, though a smaller angle (225°) was necessary for unfinished yarn. A yarn speed of 100 ypm was used.

The friction coefficient was determined from the equation:

$$T_2/T_1 = e^{f\theta}$$

where T_1 and T_2 are the input and output tensions, f is the friction coefficient and θ is the wrap angle around the test pin in radians.

Suitable adjustments in the frictional qualities of the fiber may also be made by introducing kaolinite particles or other such materials. Preferably however the filaments should not contain appreciable quantities of pigments (i.e., not over 1 percent) since these tend to dull the yarn and reduce the sheen of the fabrics prepared from the yarn.

An especially preferred feed yarn of this invention has a value of

$$\frac{MR \times N}{d^{1/2} e^{.0352N}}$$

in the range 3.5–5.5 and MR/cosec

$$\left[\frac{90(N-2)}{N}\right]$$

in the range 1.1 to 1.4.

A variety of texturing processes are available for preparing false-twist textured yarns. For economic reasons continuous processes are preferred. In continuous false-twisting a substantial twist is applied to the yarn by passing it through a rotating spindle or other twist-imparting device. As the yarn approaches the twist-imparting mechanism, it accumulates a high degree of twist. While in this highly twisted configuration, the yarn passes through a heated zone and a permanent helical twist configuration is thereby set in the yarn. When the yarn emerges from the twist-imparting device the torsional restraint on the forward end of the yarn is released and the yarn tends to resume its twisted configuration, thereby promoting the formation of helical coils, or loops or crimps. The amount of crimp or bulk imparted to the yarn is dependent upon the torsion applied, amount of heat applied, frictional qualities of the twist-imparting mechanism, and the turns per inch of twist applied to the yarn.

False-twisting devices using a spindle or one or more belts to apply torque are readily available for use in the invention. In addition torque jets are available whereby twist is imparted by a rotating stream of gas. Suitable torque jets are describes in Breen and Sussman U.S. Pat. No. 3,279,169. Additional devices are available which apply false-twist in opposite directions to two ends of yarn. These permit preparation of bulked yarns with balanced twist when the two ends are brought together or highly twisted in the plied state.

Upon examination of the drawing, it should be evident that filaments of a given modification ratio may have a variety of shapes. For example, while the tips of the lobes generally assume a circular configuration, this circle outlining the tip of the lobe may have a high or low tip radius, r_1, relative to the circumscribing radius, R_1, of the cross-section. In addition to the lobe angle, A, formed by two tangents laid at the points of inflection of curvature on each side of the lobe may be either negative or positive. The lobe angle, A, is considered to be positive when the two tangents converge outside of the cross-section on the same side of the fiber as the lobe. A positive lobe angle, A, is indicated in FIG. 1.

Lobe angles which are positive are especially preferred in the feed yarns of the invention for lobes of this type are less likely to flatten in texturing.

EXAMPLE

a PACM-12 polyamide was prepared from bis(4-aminocyclohexyl)methane (70 percent trans-trans stereoisomer) and dodecanedioic acid as described in Speck U.S. Pat. No. 3,393,210. The resulting polymer contained no pigment but contained 0.12 percent antioxidant. Three different yarn samples were prepared from this type of polymer by melt spinning through a spinneret having 18 orifices. Each orifice consisted of six slots radiating from a central point with equal angles between slots. Each of the slots was 0.004-inch wide and 0.009-inch long (maximum orifice diameter 0.018-inch). Three different modification ratios were obtained by varying the melt viscosity of the polymer within the spinneret capillary. The yarns obtained by this spinning technique were drawn about **1:6** X. The resulting yarns were about **62** denier with **18** filaments and zero twist. The filaments are described by the following parameters:

	A	B	C
Modification Ratio MR	= 1.6	1.4	1.8
Denier per filament *d*	= 3.44	3.6	3.4
Number of lobes N	= 6	6	6
$(MR \times N)/(d^{1/2}e \cdot 0352N$	= 4.22	3.6	4.5
(MR/Cosec [90 (N−2)/N]	= 1.39	1.21	1.56

The filaments in each of the yarns had a positive lobe angle A. The yarns were each textured on a Leesona false-twist machine. A total twist of 60 turns per inch was applied. The hot plate in the twist zone was maintained at 355° F. (179°C.). The resulting false-twisted yarn was heat-set in steam for 45 minutes in an autoclave at 110° C. under relaxed conditions. After boil-off under 1.5 milligrams/denier load the filaments of the resulting yarn had an average of about 35 crimps per extended inch. Double knit fabrics were prepared using each of the false-twisted yarns, A, B, and C. One of these was knit in an interlock construction and the other in a Swiss pique construction. The resulting fabrics had a pleasing sheen and were free of objectionable glitter.

For comparison, another yarn with hexalobal cross-section was spun from the same polyamide and with a similar spinneret orifice except that the slots were enlarged at the outer ends by drilling circular holes at the end of the slots. Filaments of this yarn had the following parameters:

Modification ratio MR	=2.2
Denier per filament d	=3.41
Number of lobes N	=6
$MR \times N:/(de^{.0352N})$	=5.79
(mR)/Cosec [90(n-2)/N]	=1.9

The filaments in this yarn had a negative lobe angle. The cross-sectional parameters are outside of the scope of the present invention. Fabrics knit from this yarn had objectionable glitter.

I claim:

1. Multifilament feed yarn for false-twist texturing composed of PACM-12 polyamide derived from bis-4-aminocyclohexyl)methane (at least 45 percent trans-trans isomer) and dodecanedioic acid, wherein the filaments of the yarn have a multilobal cross section with at least five lobes, the lobes are essentially symmetric about a center line through the lobe, the lobes are of substantially equal length and are substantially equally spaced about the center of the filament, and the filaments are further characterized in that (MR) (N)/$(d^{1/2}e^{.0352N})$ is at least 3.3 and (MR)/cosec[90(N−2)/N] is about 1.03 to 1.6 where (MR) is the modification ratio, N is the number of lobes, *d* is the denier per filament and *e* is the base of the natural logarithm system.

2. Yarn as defined in claim **1** wherein said filaments have a hexalobal cross section.

3. Yarn as defined in claim **1** wherein (MR) (N)/ $(d^{1/2}e^{.0352N})$ is 3.5 to 5.5 and (MR)/cosec[90(N−2)/N] is 1.1 to 1.4.

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