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(54) **Multilobal polymer filaments and articles produced therefrom**

Multilobale polymerische Filamente und daraus hergestellte Artikel

Filaments polymères multilobés et articles produits à partir desdits filaments

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(56) References cited:  
**US-A- 3 097 416 US-A- 3 508 390**  
**US-A- 4 041 689**

• **PATENT ABSTRACTS OF JAPAN vol. 016, no. 283**  
**(C-0955), 24 June 1992 (1992-06-24) & JP 04**  
**073209 A (MITSUBISHI RAYON CO LTD), 9 March**  
**1992 (1992-03-09)**

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**Description****FIELD OF THE INVENTION**

5 **[0001]** This invention provides synthetic polymer bicomponent filaments having multilobal cross-sections. The filaments may be used in their as-spun form, for example, in yarns resulting from high speed spinorientation or coupled spin-drawing processes, or may be used as feed yarns for de-coupled drawing or draw texturing processes. The multifilament yarns made from these filaments are useful to make articles with subdued luster and low glitter.

**BACKGROUND OF THE INVENTION**

10 **[0002]** There is a desire to provide textured multifilament yarns capable of being converted into knitted or woven fabrics having no undesired glitter. Draw false twist texturing is a method for producing textured multifilament yarns by simultaneously drawing and false-twist texturing undrawn multifilaments. Draw false twist texturing of filaments eliminates the undesirable slickness of fabrics made from synthetic filaments as well as provides filaments with bulk, which provides better cover. However, false twist texturing and draw false twist texturing of filaments having round cross-sections deform the cross-sections of the filaments to a multi-faceted shape having essentially flat sides. As a result, fabrics made from these textured filaments exhibit a specular reflection from the flattened fiber surfaces creating an undesired glittering or sparkle. In addition, the denier per filament (dpf) may be reduced, for example, to improve the softness of the yarns, fabrics and articles produced therefrom, to less than about 5 dpf, or even to deniers below about 1. Such subdenier filaments are also known as "microfibers". At these subdeniers, the total amount of this specular reflection is dramatically increased, due to the increase in total fiber surface area.

20 **[0003]** Efforts to eliminate the glitter and sparkle associated with filaments having a round cross-section has led to the development of various multilobal cross-sections. For example, U.S. Patent Nos. 5, 108, 838, 5,176,926, and 5,208,106 describe hollow trilobal and tetralobal cross-sections to increase the cover to minimize the weight of fiber needed to spread over an area. These patents relate specifically to carpet yarns and higher denier filaments, and not to filaments suited for apparel or twist texturing.

25 **[0004]** Other modified cross-sections have also been attempted to reduce the glitter from round crosssectional filaments. For example, U.S. Patent No. 4,041,689 relates to filaments having a multilobal cross-section. Moreover, U.S. Patent No. 3,691,749 describes yarns made from multilobal filaments prepared from PACM polyamide. However, the filaments described in these patents still need to be textured prior to use and do not provide a means to reduce glitter of fine denier and especially subdenier filaments, yarns, fabrics and articles produced therefrom.

30 **[0005]** Other efforts to reduce glitter include the use of polymer additives. For example, delustrants, such as titanium dioxide, have been used to decrease the glittering effect from textured yarns. However, such delustrants alone have been ineffective in reducing the glitter of fibers having fine deniers.

35 **[0006]** Various fiber and fabric treatments have been proposed that effect glitter including caustic treatments. However, such caustic approaches have inherent disadvantages such as added costs and/or increased waste by-products.

40 **[0007]** The use of multicomponent fibers to reduce the glitter effect has also been attempted. For example, U.S. Patent No. 3,994,122 describes a mixed yarn comprising 40-60% by weight of trilobal filaments having a modification ratio within the range of 1.6-1.9, and 40-60% by weight of trilobal filaments having a modification ratio within the range of 2.2-2.5. In addition, U.S. Patent No. 5,948,528 describes obtaining a filament having modified cross-sections for bicomponent fibers, wherein the fibers are composed of at least two polymer components having different relative viscosities. While yarns made from such multicomponent filaments have a bulking effect that does not necessarily require additional texturing, the production of these fibers are encumbered by the necessity to use a mixture of two or more different polymers or fibers.

45 **[0008]** Accordingly, there is a need to obtain a filament that can be used to make yarns, and articles therefrom, such as fabrics and apparel, having reduced glitter and shine without the necessity for high levels of added delustrants or fabric after- treatments, and that provide the desirable low glitter and shine without the need for additional texturing. Additionally, there is a need, that, if desired, the filaments can be textured, including by false- twist texturing or by draw false- twist texturing, and still provide the desirable low glitter and low shine to the yarns, fabrics and articles produced therefrom. There is additionally a need to obtain a low denier filament, preferably a filament that can be drawn to a subdenier filament, and especially preferred a filament that is subdenier as- produced, that provides low glitter and shine to the fine denier yarns, fabrics and articles produced therefrom. These low denier and subdenier filaments should have sufficient tensile properties to enable the filaments to be subsequently processed, with low levels of broken filaments, into fabrics and articles therefrom.

**SUMMARY OF THE INVENTION**

[0009] In one embodiment of the invention, a filament having a multilobal cross-section, wherein the lobe angle is  $\leq$  about  $15^\circ$  and a denier of less than about 5 dpf is disclosed.

[0010] The present invention is further directed to multifilament yarns formed at least in part from the filaments of the present invention, and fabrics and articles formed from such yarns.

[0011] Thus, according to one embodiment of the invention, there is provided a multilobal bicomponent filament comprising a first component and a second component, characterised in that the filament has a multilobal cross-section with at least 3 lobes, a tip ratio of  $\geq 0.2$ , the tip ratio being defined as the average lobe radius divided with the radius of a circle circumscribed about the tips of the lobes, a lobe angle of  $\leq 15^\circ$ , the lobe angle being defined as the angle of two tangent lines laid at the point of inflection of curvature of each side of the lobe, and a denier of less than about 5 dpf.

[0012] According to other embodiments of the invention, there is provided: a garment or fabric formed at least in part from a filament of the above aspect; and a use of multifilament yarns comprising multilobal filaments for forming a fabric characterised in that at least a portion of the filaments of the yarn are bicomponent filaments comprising a first component and a second component, the filaments having a multilobal cross-section with at least 3 lobes, a tip ratio of  $\geq 0.2$ , the tip ratio being defined as the average lobe radius divided with the radius of a circle circumscribed about the tips of the lobes, a dpf less than 5, and a lobe angle less than  $15^\circ$ , the lobe angle being defined as the angle of two tangent lines laid at the point of inflection of curvature of each side of the lobe.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0013]

Fig. 1 represents an illustration of how the modification ratio, lobe angles, and filament factors may be determined based upon measurements of the filament cross-sections.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION**

[0014] The filaments of the present invention have a multilobal cross-section. A preferred multilobal includes a cross-section having an axial core with at least three lobes of about the same size. Preferably, the number of lobes is between 3 to 10 lobes, most preferably between 3 to 8 lobes, for example, having 3, 4, 5, 6, 7, or 8 lobes. The lobes of the cross-section may be symmetrical or asymmetrical. The lobes may be essentially symmetrical having substantially equal lengths and equispaced radially about the center of the filament cross-section. Alternatively, the lobes may have different lengths about the center of the filament cross-section, but where the cross-section is still symmetrical, i.e., having two sides being essentially mirror images of each other. For example, Figure 12 shows a cross-section of the present invention having four lobes, wherein the lobes have different lengths, but the lobes are arranged symmetrically around the core. In yet another embodiment, the lobes may be symmetrical having different lengths about the center of the filament cross-section and the cross-section may be symmetrical.

[0015] The core and/or lobes of the multilobal cross-section of the present invention may be solid or include hollows or voids. Preferably, the core and lobes are both solid. Moreover, the core and/or lobes may have any shape provided that the tip ratio is  $\geq$  about 0.2, preferably  $\geq$  about 0.3, most preferably  $\geq$  about 0.4, and either the filament factor is  $\geq$  about 2 or the lobe angle is  $\leq 15^\circ$ , as described. Preferably, the core is circular and the lobes are rounded and connected to the core, wherein adjacent lobes are connected to one another at the core. Most preferably, the lobes are rounded, for example, as shown in Figure 1.

[0016] The filaments of the invention may have a filament factor of about 2 or greater, wherein the filament factor is determined according to the following formula:

$$FF = K_1 * (MR)^A * (N)^B * (1/(DPF))^C * [K_2 * (N)^D * (MR)^E * 1/(LAP) + K_3 * (AF)] ,$$

wherein  $K_1$  is 0.0013158;  $K_2$  is 2.1;  $K_3$  is 0.45; A is 1.5; B is 2.7; C is 0.35; D is 1.4; E is 1.3; MR is  $R/r_1$ , wherein R is the radius of a circle centered in the middle of the cross-section and circumscribed about the tips of the lobes, and  $r_1$  is the radius of circle centered in the middle of the cross-section and inscribed within the cross-section about the connecting points of the lobes; N is the number of lobes in the cross-section; DPP is the denier per filament; LAP is  $(TR) * (DPF) * (MR)^2$ , wherein TR is  $r_2/R$ , wherein  $r_2$  is the average radius of a circle inscribed about the lobes, and R is as set forth above, and DPF and MR are as set forth above; and AF is 15 minus the lobe angle, wherein the lobe angle is the average angle of two tangent lines laid at the point of inflection of curvature on each side of the lobes of the

filament cross-section, and an average tip ratio of  $\geq$  about 0.2.

**[0017]** The term "essentially symmetric lobes" means that a line joining the lobe tip to center C will bisect the lobe area located above (outside of) circle Y, as shown in Figure 1, into two approximately equal areas, which are essentially mirror images of one another.

**[0018]** By "lobes equispaced radially" is meant that the angle between a line joining any lobe tip to center C, as shown in Figure 1, and the line joining the tip of the adjacent lobe is about the same for all adjacent lobes.

**[0019]** The term "equal length" when applied to lobes means that in a cross-sectional photomicrograph, a circle can be constructed, which passes the margins of each of the tips of the lobes tangentially. Small variations from perfect symmetry generally occur in any spinning process due to such factors as non-uniform quenching or imperfect spinning orifices. It is to be understood that such variations are permissible provided that they are not of a sufficient extent to cause glitter in fabrics after texturing.

**[0020]** The tip ratio (TR) is calculated according to the following formula:  $TR = r_2/R$ , where  $r_2$  is the average radius of the lobes and R is the radius of circle X centered at C and circumscribed about the tips of the lobes Z. When all the lobes have essentially the same radius  $r_2$ , the tip ratio is essentially the same for each lobe. However, the lobes may have different lengths  $r_1$  relative to each other for both symmetrical and asymmetrical cross-sections of the present invention. For example, a cross-section of the present invention may include four lobes, wherein two lobes have one length and the other two lobes have a different length, but where the two sides of the cross-section are symmetrical. Alternatively, the lobes may have different lengths  $r_2$ , wherein the two sides of the cross-section are asymmetrical. Moreover, it is noted that the radius R may be different for lobes having different lengths because R is based on a circle X circumscribing the tips of the lobes. For both symmetrical and asymmetrical lobes, the tip ratio for each lobe is calculated based on the particular  $r_2$  length of the lobe and the radius R of the circle X circumscribing each lobe. Then, an average of the tip ratios for each of the lobes is calculated. As used herein, the "tip ratio" refers to the average tip ratios for a cross-section unless otherwise specified. Preferably, the tip ratio is  $\geq$  about 0.2, more preferably,  $\geq$  about 0.3, and most preferably  $\geq$  about 0.4. Also, when the lobes are asymmetrical the lobes may differ in other geometric parameters such as lobe angle or modification ratio, or in combinations of differing geometric properties such as modification ratio and lobe angle, as long as the average filament factor for the filament is at least 2.0.

**[0021]** The lobe angle of the lobes of the filament cross-section is the angle of two tangent lines laid at the point of inflection of curvature on each side of the lobe and may be either negative, positive, or zero. Referring to Figure 1, the lobe angle, A, is considered to be negative when the two tangent lines  $T_1$  and  $T_2$  converge at a point X inside of the cross-section or exterior to the cross-section on the side opposite to the lobe. Conversely, a lobe angle is positive when the two tangent lines converge at a point exterior to the cross-section on the same side of the lobe (not shown). As used herein, the "lobe angle" of the cross-section is the average lobe angle unless otherwise specified. The cross-section of the filaments of the present invention can have any lobe angle. In one preferred embodiment, the lobe angle is  $\leq 15^\circ$ , more preferably,  $\leq 0^\circ$ , and even most preferably,  $\leq -30^\circ$ . Negative lobe angles are especially preferred in the filaments of the present invention.

**[0022]** The geometric cross-sections of filaments of the present invention may further be analyzed according to other objective geometric parameters. For example, the filament factor (FF) is calculated according to the following equation:

$$FF = K_1 * (MR)^A * (N)^B * (1/(DPF))^C [K_2 * (N)^D * (MR)^E * (1/(LAF))] + K_3 * (AF) \quad (1)$$

wherein, referring to Figure 1, modification ratio (MR) =  $R/r_1$ ; tip ratio (TR) =  $r_2/R$ ; N is the number of lobes in the cross-section, DPF is the denier per filament, lobe angle is as described above, angle factor (AF) = (15 - Lobe Angle), and lobe area factor (LAF) (TR) \* (DPF) \* (MR)<sup>2</sup>.  $K_1$  is 0.0013158,  $K_2 = 2.1$ ,  $K_3 = 0.45$ , A = 1.5, B = 2.7, C = 0.35, D = 1.4, and E = 1.3. R is the radius of circle X centered at C and circumscribed about the tips of the lobes Z.  $r_1$  is the radius of circle Y centered at C and inscribed within the cross-section.  $r_2$  is the average radius of the lobes. As used herein, the "filament factor" of the cross-section is the average filament factor for the cross-section. It has been generally found that the greater the filament factor, the less glitter. Preferably, the filaments of the present invention have a filament factor  $\geq 2.0$ , more preferably, the filament factor is  $\geq 3.0$ , and most preferably, the filament factor is  $\geq 4.0$ .

**[0023]** The filaments of the present invention may be made of homopolymers, copolymers, terpolymers, and blends of any synthetic, thermoplastic polymers, which are melt-spinnable. Melt-spinnable polymers include polyesters, such as polyethylene terephthalate ("2-GT"), polytrimethylene terephthalate or polypropylene terephthalate ("3-GT"), polybutylene terephthalate ("4-GT"), and polyethylene naphthalate, poly(cyclohexylenedimethylene), terephthalate, poly(lactide), poly(ethylene 2,7-naphthalate), poly(glycolic acid), poly(.alpha.,.alpha.-dimethylpropiolactone), poly(para-hydroxybenzoate) (akono), poly(ethylene oxybenzoate), poly(ethylene isophthalate), poly(hexamethylene terephthalate), poly(decamethylene terephthalate), poly(1,4-cyclohexane dimethylene terephthalate) (trans), poly(ethylene 1,

5- naphthalate), poly (ethylene 2, 6- naphthalate), poly (1, 4- cyclohexylidene dimethylene terephthalate) (cis), and poly (1, 4- cyclohexylidene dimethylene terephthalate) (trans) ; polyamides, such as polyhexamethylene adipamide (nylon 6, 6) ; polycaprolactam (nylon 6) ; polyenanthamide (nylon 7) ; nylon 10; polydodecanolactam (nylon 12) ; polytetramethyleneadipamide (nylon 4, 6) ; polyhexamethylene sebacamide (nylon 6, 10) ; the polyamide of n- dodecanedioic acid and hexamethylenediamine (nylon 6, 12) ; the polyamide of dodecamethylenediamine and n- dodecanedioic acid (nylon 12, 12), PACM- 12 polyamide derived from bis (4- aminocyclohexyl) methane and dodecanedioic acid, the copolyamide of 30% hexamethylene diammonium isophthalate and 70% hexamethylene diammonium adipate, the copolyamide of up to 30% bis- (P- amidocyclohexyl) methylene, and terephthalic acid and caprolactam, poly (4- aminobutyric acid) (nylon 4), poly (8- aminooctanoic acid) (nylon 8), poly (haptamethylene pimelamide) (nylon 7, 7), poly (octamethylene suberamide) (nylon 8, 8), poly (nonamethylene azelamide) (nylon 9, 9), poly (decamethylene azelamide) (nylon 10, 9), poly (decamethylene sebacamide (nylon 10, 10), poly [bis (4- amino- cyclohexyl) methane- 1, 10- decanedicarboxamide], poly (m- xylene adipamide), poly (p- xylene sebacamide), poly (2, 2, 2- trimethylhexamethylene pimelamide), poly (piperazine sebacamide), poly (metaphenylene isophthalamide) poly (p- phenylene terephthalamide), poly (11- amino- undecanoic acid) (nylon 11), poly (12- aminododecanoic acid) (nylon 12), polyhexamethylene isophthalamide, polyhexamethylene terephthalamide, poly (9- aminononanoic acid) (nylon 9) ; polyolefins, such as polypropylene, polyethylene, polymethylpentene, and polyurethanes; and combinations thereof. Methods of making the homopolymers, copolymers, terpolymers and melt blends of such polymers used in the present invention are known in the art and may include the use of catalysts, co- catalysts, and chain- branchers to form the copolymers and terpolymers, as known in the art. For example, a suitable polyester may contain in the range of about 1 to about 3 mole % of ethylene- M- sulfo- isophthalate structural units, wherein M is an alkali metal cation, as described in U.S. Patent No. 5, 288, 553, or 0.5 to 5 mole% of lithium salt of glycollate of 5- sulfoisophthalic acid as described in U.S. Patent No. 5, 607, 765. Preferably, the polymer is a polyester and/or polyamide, and most preferably, polyester.

**[0024]** Filaments of the invention are formed from any two polymers as described above into so- called "bicomponent" filaments, including bicomponent polyesters prepared from 2- GT and 3- GT. The filaments can comprise bicomponent filaments of a first component selected from polyesters, polyamides, polyolefins, and copolymers thereof and a second component selected from polyesters, polyamides, polyolefins, natural fibers, and copolymers thereof, the two components being present in a weight ratio of about 95: 5 to about 5: 95, preferably about 70: 30 to about 30: 70. In a preferred bicomponent embodiment, the first component is selected from poly (ethylene terephthalate) and copolymers thereof and the second component is selected from poly (trimethylene terephthalate) and copolymers thereof. The cross- section of the bicomponent fibers can be side- by- side or eccentric sheath/ core. When a copolymer of poly (ethylene terephthalate) or poly (trimethylene terephthalate) is used, the comonomer can be selected from linear, cyclic, and branched aliphatic dicarboxylic acids having 4- 12 carbon atoms (for example, butanedioic acid, pentanedioic acid, hexanedioic acid, dodecanedioic acid, and 1, 4- cycle- hexanedicarboxylic acid) ; aromatic dicarboxylic acids other than terephthalic acid and having 8- 12 carbon atoms (for example, isophthalic acid and 2, 6- naphthalenedicarboxylic acid) ; linear, cyclic, and branched aliphatic diols having 3- 8 carbon atoms (for example, 1, 3- propane diol, 1, 2- propanediol, 1, 4- butanediol, 3- methyl- 1, 5- pentanediol, 2, 2- dimethyl- 1, 3- propanediol, 2- methyl- 1, 3- propanediol, and 1, 4- cyclohexanediol) ; and aliphatic and araliphatic ether glycols having 4- 10 carbon atoms (for example, hydroquinone bis (2- hydroxyethyl) ether, or a poly (ethyleneether) glycol having a molecular weight below about 460, including diethyleneether glycol) . Isophthalic acid, pentanedioic acid, hexanedioic acid, 1, 3- propane diol, and 1, 4- butanediol are preferred because they are readily commercially available and inexpensive. Isophthalic acid is more preferred because copolyesters derived from it discolor less than copolyesters made with some other comonomers. When a copolymer of poly (trimethylene terephthalate) is used, the comonomer is preferably isophthalic acid. 5- sodium- sulfaisophthalate can be used in minor amounts as a dyesite comonomer in either polyester component.

**[0025]** Also, a yarn or fabric formed at least in part from a filament having the cross- section of the present invention may also include other thermoplastic melt spinnable polymers or natural fibers, such as cotton, wool, silk, or rayon in any amounts. For example, a natural fiber and polyester filament of the present invention in an amount of about 75% to about 25% of the natural fiber and 25% to about 75% of the polyester filament of the present invention.

**[0026]** It will be understood by one skilled in the art that filaments of identical configuration but prepared from different synthetic polymers or from polymers having different crystalline or void contents can be expected to exhibit different glitter. Nevertheless, it is believed that improved glitter will be achieved with any synthetic polymeric filament of the now- specified configuration regardless of the particular polymer selected.

**[0027]** The polymers and resultant fibers used in the present invention can comprise conventional additives, which are added during the polymerization process or to the formed polymer, and may contribute towards improving the polymer or fiber properties. Examples of these additives include antistatics, antioxidants, antimicrobials, flameproofing agents, dyestuffs, pigments, light stabilizers, such as ultraviolet stabilizers, polymerization catalysts and auxiliaries, adhesion promoters, delustrants, such as titanium dioxide, matting agents, organic phosphates, additives to promote increased spinning speeds, and combinations thereof. Other additives that may be applied on fibers, for example, during spinning and/or drawing processes include antistatics, slickening agents, adhesion promoters, antioxidants, antimicrobials, flame-

proofing agents, lubricants, and combinations thereof. Moreover, such additional additives may be added during various steps of the process as is known in the art. In a preferred embodiment, delustrants are added to the filaments of the present invention in an amount of 0%, more preferably, less than 0.4%, and most preferably, less than 0.2% by weight. If a delustrant is added, preferably it is titanium dioxide.

**[0028]** The filaments of the present invention are formed by any suitable spinning method and may vary based upon the type of polymer used; as is known in the art. Generally, the melt-spinnable polymer is melted and the molten polymer is extruded through a spinneret capillary orifice having a design corresponding to the desired lobe angle, number of lobes, modification ratio, and filament factor desired, according to the present invention. The extruded fibers are then quenched or solidified with a suitable medium, such as air, to remove the heat from the fibers leaving the capillary orifice. Any suitable quenching method may be used, such as cross-flow, radial, and pneumatic quenching.

**[0029]** Cross-flow quench, as disclose e.g., in U.S. Patent Nos. 4, 041, 689, 4, 529, 368, and 5, 288, 553, involves blowing cooling gas transversely across and from one side of the freshly extruded filamentary array. Much of this cross-flow air passes through and out the other side of the filament array. "Radial quench", as disclosed, e.g., in U.S. Patent Nos. 4, 156, 071, 5, 250, 245, and 5, 288, 553, involves directing cooling gas inwards through a quench screen system that surrounds the freshly extruded filamentary array. Such cooling gas normally leaves the quenching system by passing down with the filaments, out of the quenching apparatus. The type of quench may be selected or modified according to the desired application of the filaments and the type of polymers used. For example, a delay or anneal zone may be incorporated into the quenching system as is known in the art. Moreover, higher denier filaments may require a quenching method different from lower denier filaments. For example, laminar cross-flow quenching with a tubular delay has particularly been found useful for fine filaments having  $\leq 1$  dpf. Also, radially quenching has been found preferred for fine filaments below 1 dpf.

**[0030]** Pneumatic quenching and gas management quenching techniques have been discussed, for example, in U.S. Patent Nos. 4,687,610, 4,691,003, 5,141,700, 5,034,182, and 5,824,248. These patents describe processes whereby gas surrounds freshly extruded filaments to control their temperature and attenuation profiles.

**[0031]** The spinneret capillaries through which the molten polymer is extruded are cut to produce the desired cross-section of the present invention, as described above.

**[0032]** After quenching, the filaments are converged, interlaced, and wound as a multifilament bundle. Filaments of the invention, if sufficiently spin-oriented, can be used directly in fabric production. Alternatively, filaments of the invention can be drawn and/or heat set, e.g., to increase their orientation and/or crystallinity. Drawing and/or heat setting can be included in the drawing or texturing processes, for example, by draw warping, draw false-twist texturing or draw air-jet texturing the filaments and yarns of the invention. Texturing processes known in the art, such as air-jet texturing, false-twist texturing, and stuffer-box texturing, can be used. The multifilament bundles can be converted into fabrics using known methods such as weaving, weft knitting, or warp knitting. Filaments of the invention can alternatively be processed into nonwoven fibrous sheet structures. Fabrics produced using the as-spun, drawn, or textured filaments of the invention can be used to produce articles such as apparel and upholstery.

**[0033]** The filaments of the invention, whether in as-spun form or textured form, provide advantages to the multifilament bundles, fabrics and articles produced therefrom, such as a pleasing fabric luster essentially free of objectionable glitter. The highly-shaped filaments of the invention, even in very fine deniers including subdeniers, can be produced with tensile properties sufficient to withstand demanding textile processes such as draw false-twist texturing with low levels of broken filaments. The fine and subdenier filaments of the invention, in either as-spun or textured form, can be used to provide fabrics and articles therefrom having properties such as moisture transport that are especially advantageous to performance apparel applications. Accordingly, in one preferred embodiment, the filaments are spun as a direct-use yarn, which may be immediately used in manufacturing articles. Furthermore, as a result of the ability to use the present process to produce direct-use yarns via high speed spinning, it has been found that the process of the present invention is capable of generating an increased spinning productivity.

**[0034]** Optionally, however, the filaments of the present invention may be textured, also known as "bulked" or "scrimped," according to known methods. In one embodiment of the invention, the filaments may be spun as a partially oriented yarn and then textured by techniques, such as by draw false-twist texturing, air-jet texturing, gear-crimping, and the like.

**[0035]** Any false-twist texturing process may be used. For example, a continuous false-twisting process may be conducted, wherein 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 device, it accumulates a high degree of twist. Then, while the yarn is in a high degree of twist, it is passed through a heating zone and a permanent helical twist configuration is set in the yarn. As 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 crimps. The degree of crimping is dependent upon factors such as the torsion applied, amount of heat applied, frictional qualities of the twist-imparting device, and turns per inch of twist applied to the yarn.

**[0036]** An alternative draw-texturing process includes the simultaneous drawing and texturing of a partially oriented yarn as is known in the art. In one such process, the partially oriented yarn is passed through a nip roll or feed roll and

then over a hot plate (or through a heater), where it is drawn while in a twited configuration. The filaments in the yarn then pass from the hot plate (heater) through a cooling zone and to a spindle or twist-imparting device. As they exit the spindle, the filaments untwist and are passed over a second roller or draw roll. After the yarn exits from the draw roll, the tension is reduced as the yarn may be fed to a second heater and/or wound up.

**[0037]** The filaments of the invention can be processed into a multifilament fiber, yarn or tow having any desired filament count and any desired dpf. Moreover, the dpf may differ between a draw-false-twist textured yarn and a spin-oriented direct use yarn. The drawn or as-spun yarn of the present invention may be used, for example, in apparel fabrics, which can have a dpf of less than about 5.0 dpf, preferably less than about 2.2 dpf. Most preferably, the yarn is formed of filaments of less than about 1.0 dpf. Such subdenier yarns are also known as "microfibers." Typically, the lowest dpf attained is about 0.2. In one embodiment of the invention, the filaments are made up of polyester in which the denier per filament after draw-false-twist texturing is less than about 1 dpf. In another embodiment, the filaments are spin-oriented direct-use polyesters having a denier of about less than about 5.0 dpf, preferably less than about 3.0 dpf, and most preferably less than about 1.0 dpf. Other yarns may be useful in textiles and fabrics, such as in upholstery, garments, lingerie, and hosiery, and may have a dpf of about 0.2 to about 6 dpf., preferably about 0.2 to about 3.0 dpf. Finally, higher denier yarns are also contemplated for uses, for example, in carpets, having a dpf of about 6 to about 25 dpf.

**[0038]** The yarns of the present invention may further be formed from a plurality of different filaments having different dpf ranges. In such case, the yarns should be formed from at least have one filament having the multilobal cross-section of the present invention. Preferably, each filament of a yarn containing a plurality of different filaments, has the same or different dpf, and each dpf is from about 0.2 to about 5.

**[0039]** The synthetic polymer yarns may be used to form fabrics by known means including by weaving, warp knitting, circular knitting, or hosiery knitting, or a continuous filament or a staple product laid into a non-woven fabric.

**[0040]** The yarns formed from the filaments of the present invention have been found to provide fabrics having low glitter and subdued luster or shine. It is believed that the unique cross-section of the filament attributes to the reduced glitter. In particular, it has been found that as the filament factor is increased with cross-sections having low lobe angles, and  $\leq$  about  $15^\circ$ , the glitter effect is dramatically reduced, particularly in fine denier and subdenier filaments. This glitter effect is even more subdued in subdenier filaments with cross-sections having negative lobe angles.

**[0041]** Moreover, it has further been unexpectedly found that yarns having the filaments with filament factor of at least 2, with a low dpf in the fine range and sub- dpf (microfiber) range have a reduced glitter effect. The term "glitter" is reflection of light in instense beams from tiny areas of the filament or fabric, contrasting with the general background reflection. Glitter can occur from small flat areas on the fiber surface, which act as mirrors that reflect full spectrum (white) light. The areas are large enough such that the light reflections termed "glitter" are distinct and can be pinpointed by the eye. Glitter can be rated by a number of means such as rating low, medium, or high levels of glitter, or rating in terms of relative glitter. Both as- spun yarns and textured yarns of the present invention had low levels of glitter.

**[0042]** In addition, it has advantageously been found that the filaments of the present invention are able to absorb dyes, such as cationic dyes, and color. As the denier per filament is reduced in conventional filaments, especially to subdeniers, the fabric depth of color is generally reduced due to the increased fiber surface area and shorter within-fiber distances in which light and dye interactions can occur. It was surprisingly found that subdenier filaments of the invention, even though having greatly increased surface area due to the highly shaped filament exteriors, exhibited fabric coloration superior to prior-art multilobal filaments and approaching that of round cross-sections, in either as-spun or draw-textured configurations, as well as enhanced fabric performance such as moisture transport or wicking. The high coloration and wicking are benefits to the filaments of the present invention in addition to the added advantage of low glitter.

**[0043]** Further, the filaments of the present invention have high tensile properties enabling the filaments to be further processed in texturing and/or fabric formation processes with low levels of broken filaments. In particular, the subdenier multifilament bundles of the invention exhibited tenacity and elongation values, in as- spun and after draw false texturing, that were similar to those achieved with round subdenier filaments. This was surprising due to the much more rapid and non- uniform quenching that was expected when spinning highly- shaped subdenier filaments of the present invention.

**[0044]** As a result of the high tensile properties of the filaments of the present invention, the filaments are especially suited to high stress application including draw false-twist texturing, high speed spinning, and spinning of modified polymers. These findings were particularly found for the sub-dpf filaments of the present invention, which, when draw false-twist textured, exhibited high tensile strength and an orientation level similar to that of round sub-dpf filaments, resulting in low levels of broken filaments. Measurements relating to the orientation level of the spin-oriented filaments are tenacity at 7% elongation ( $T_7$ ), as set forth above, and draw tension (DT). The ability to essentially match the orientation level of the prior-art round fine and subdenier filaments was an advantage in enabling similar draw texturing processes to be used for filaments of the invention. The term "textured yarn broken filaments" (herein "TYBF") references "fray count" in number of frays (broken filaments) per unit length. As compared to its round cross-section counterparts, the sub-dpf filaments having the cross-sections of the present invention were capable of being subjected to the same types of texturing processes as round cross-section yarns, without the production of undesired glitter and high levels of broken filaments.

[0045] Moreover, the high tensile strength with low glitter of the filaments of the present invention have been found particularly suitable for fabric applications such as performance apparel and bottomweight- end uses such as slacks and suiting materials, and for blending with low- luster spun fibers such as cotton and wool.

[0046] For example, it has been found that the yarns of the present invention have increased cover, particularly relative to yarns having round cross-sections. In addition, the increased cover becomes even more dramatic for lesser denier filaments.

[0047] The fabrics of the present invention further have higher wicking rates than many other known cross-sections. Wicking refers to the capillary movement of water through or along the fibers. The ability of the fibers to wick, therefore, increases the ability of the fabric to absorb water and move it away from the body. It has been particularly found that the fabrics using microfibers of the present invention have higher wicking rates than fabric of round microfibers of comparable dpf.

[0048] The fabrics of the present invention do not require an external additive such as  $\text{TiO}_2$  or post-treatments such as described in the art to obtain low glitter. The amount of delustrant may be added in an amount of 0%, or less than about 0.1%, less than about 0.2%, or less than about 1% by weight of delustrant. This has been found particularly compelling for subdeniers, which typically require such delustrant additives or post-treatments to minimize glitter. However, these types of treatments may be used, if desired, for any of the fabrics of the present invention.

### Example XI

[0049] Bicomponent filaments having three lobes and filament factor  $> 2.0$  where produced by bicomponent spinning of polyethylene terephthalate and polytrimethylene terephthalate polymers. The polymers were located within the filaments in intimate adherence and in side- by- side configuration, and each polymer component extended longitudinally through the length of the filaments. Multiple filaments were simultaneously extruded from a spinneret, and the filaments were formed into multifilament bundles and wound. Bicomponent filaments having cross- section configurations according to the present invention may be bulked as result of their latent crimpability without the need to mechanically texture the filaments, as is described in the art (e.g., U.S. Patent No. 3, 454, 460) .

[0050] Those skilled in the art, having the benefit of the teachings of the present invention as hereinabove set forth, can effect numerous modifications thereto. These modifications are to be construed as being encompassed within the scope of the present invention as set forth in the appended claims.

### **Claims**

1. A multilobal bicomponent filament comprising a first component and a second component,  
**characterised in that** the filament has a multilobal cross-section with at least 3 lobes, a tip ratio of  $\geq 0.2$ , the tip ratio being defined as the average lobe radius divided with the radius of a circle circumscribed about the tips of the lobes, a lobe angle of  $\leq 15^\circ$ , the lobe angle being defined as the angle of two tangent lines laid at the point of inflection of curvature of each side of the lobe, and a denier of less than about 5 dpf.
2. The filament of claim 1, having a denier of less than about 2.2.
3. The filament of claim 1, having a denier of less than about 1.0.
4. The filament of claim 1, wherein the first component is selected from the group consisting of poly(ethylene terephthalate) and copolymers thereof and the second component is selected from the group consisting of poly(trimethylene terephthalate) and copolymers thereof, the two components beeing present in a weight ratio of 95:5 to 5:95.
5. The filament of claim 4, wherein the first component is a copolymer of poly(ethylene terephthalate), wherein a comonomer used to prepare the copolymer is selected from the group consisting of isophthalic acid, pentanedioic acid, hexanedioic acid, 1,3-propane diol, and 1,4-butane diol.
6. A garment or fabric formed at least in part from a filament of claim 1.
7. Use of multifilament yarns comprising multilobal filaments for forming a fabric  
**characterised in that** at least a portion of the filaments of the yarn are bicomponent filaments comprising a first component and a second component, the filaments having a multilobal cross-section with at least 3 lobes, a tip ratio of  $\geq 0.2$ , the tip ratio being defined as the average lobe radius divided with the radius of a circle circumscribed about the tips of the lobes, a dpf less than 5, and a lobe angle less than  $15^\circ$ , the lobe angle being defined as the angle of



two tangent lines laid at the point of inflection of curvature of each side of the lobe.

## Patentansprüche

1. Multilobales Zweikomponentenfilament, eine erste Komponente und eine zweite Komponente umfassend, **dadurch gekennzeichnet, dass** das Filament einen multilobalen Querschnitt mit mindestens drei Flügeln aufweist, ein Spitzenverhältnis von  $\geq 0,2$ , wobei das Spitzenverhältnis als durchschnittlicher Flügelradius geteilt durch den Radius eines Kreises, der um die Spitzen der Flügel gezogen ist, definiert ist, einen Flügelwinkel von  $\leq 15^\circ$ , wobei der Flügelwinkel als der Winkel von zwei tangentialen Linien definiert ist, die am Anfangspunkt der Krümmung jeder Seite des Flügels liegen, und eine Feinheit von etwa 5 dpf (Denier pro Filament).
2. Filament nach Anspruch 1, eine Feinheit von weniger als etwa 2,2 den aufweisend.
3. Filament nach Anspruch 1, eine Feinheit von weniger als etwa 1,0 den aufweisend.
4. Filament nach Anspruch 1, wobei die erste Komponente aus der Gruppe ausgewählt ist, die aus Poly(ethylenterephthalat) und Copolymeren davon besteht, und die zweite Komponente aus der Gruppe ausgewählt ist, die aus Poly(trimethylenterephthalat) und Copolymeren davon besteht, wobei die zwei Komponenten in einem Gewichtsverhältnis von 95:5 bis 5:95 vorhanden sind.
5. Filament nach Anspruch 4, wobei die erste Komponente ein Copolymer von Poly(ethylenterephthalat) ist, wobei ein Comonomer, das verwendet wird, um das Copolymer herzustellen, aus der Gruppe ausgewählt ist, die aus Isophthalsäure, Glutarsäure, Adipinsäure, 1,3-Propandiol und 1,4-Butandiol besteht.
6. Kleidungsstück oder Textilie, zumindest teilweise aus einem Filament nach Anspruch 1 gebildet.
7. Verwendung eines Multifilamentgarns, das multilobale Filamente umfasst, zum Bilden einer Textilie, **dadurch gekennzeichnet, dass** mindestens ein Teil der Filamente des Garns Zweikomponentenfilamente sind, die eine erste Komponente und eine zweite Komponente umfassen, wobei die Filamente einen multilobalen Querschnitt mit mindestens drei Flügeln aufweisen, ein Spitzenverhältnis von  $\geq 0,2$ , wobei das Spitzenverhältnis als durchschnittlicher Flügelradius geteilt durch den Radius eines Kreises, der um die Spitzen der Flügel gezogen ist, definiert ist, eine Feinheit von etwa 5 dpf und einen Flügelwinkel von weniger als  $15^\circ$ , wobei der Flügelwinkel als der Winkel von zwei tangentialen Linien definiert ist, die am Anfangspunkt der Krümmung jeder Seite des Flügels liegen.

## Revendications

1. Filament bicomposant multilobé comprenant un premier composant et un second composant, **caractérisé en ce que** le filament a une section transversale multilobée dotée d'au moins 3 lobes, un ratio de pointe  $\geq 0,2$ , le ratio de pointe étant défini comme le rayon moyen du lobe divisé par le rayon d'un cercle circonscrit autour des pointes des lobes, un angle de lobe  $\leq 15^\circ$ , l'angle de lobe étant défini comme l'angle de deux lignes tangentes tirées au point d'inflexion de la courbure de chaque face du lobe et un denier inférieur à environ 5 dpf.
2. Filament selon la revendication 1, ayant un denier inférieur à environ 2,2.
3. Filament selon la revendication 1, ayant un denier inférieur à environ 1,0.
4. Filament selon la revendication 1, dans lequel le premier composant est sélectionné dans le groupe composé du poly(éthylène téréphtalate) et ses copolymères et le second composant est sélectionné dans le groupe composé du poly(triméthylène téréphtalate) et ses copolymères, les deux composants étant présents dans un ratio de poids de 95:5 à 5:95.
5. Filament selon la revendication 4, dans lequel le premier composant est un copolymère de poly(éthylène téréphtalate), un comonomère utilisé pour préparer le copolymère est sélectionné dans le groupe composé de l'acide isophthalique, l'acide pentanedioïque, l'acide hexanedioïque, du 1,3-propane diol et du 1,4-butane diol.
6. Vêtement ou tissu formé au moins en partie d'un filament selon la revendication 1.

7. Utilisation de fils multifilaments contenant des filaments multilobés pour former un tissu, **caractérisée en ce qu'**au moins une partie des filaments du fil sont des filaments bicomposants comprenant un premier composant et un second composant, les filaments ayant une section transversale multilobée dotée d'au moins 3 lobes, un ratio de pointe  $\geq 0,2$ , le ratio de pointe étant défini comme le rayon moyen du lobe divisé par le rayon d'un cercle circonscrit autour des pointes des lobes, un dpf inférieur à 5 et un angle de lobe inférieur à  $15^\circ$ , l'angle de lobe étant défini comme l'angle de deux lignes tangentes tirées au point d'inflexion de la courbure de chaque face du lobe.

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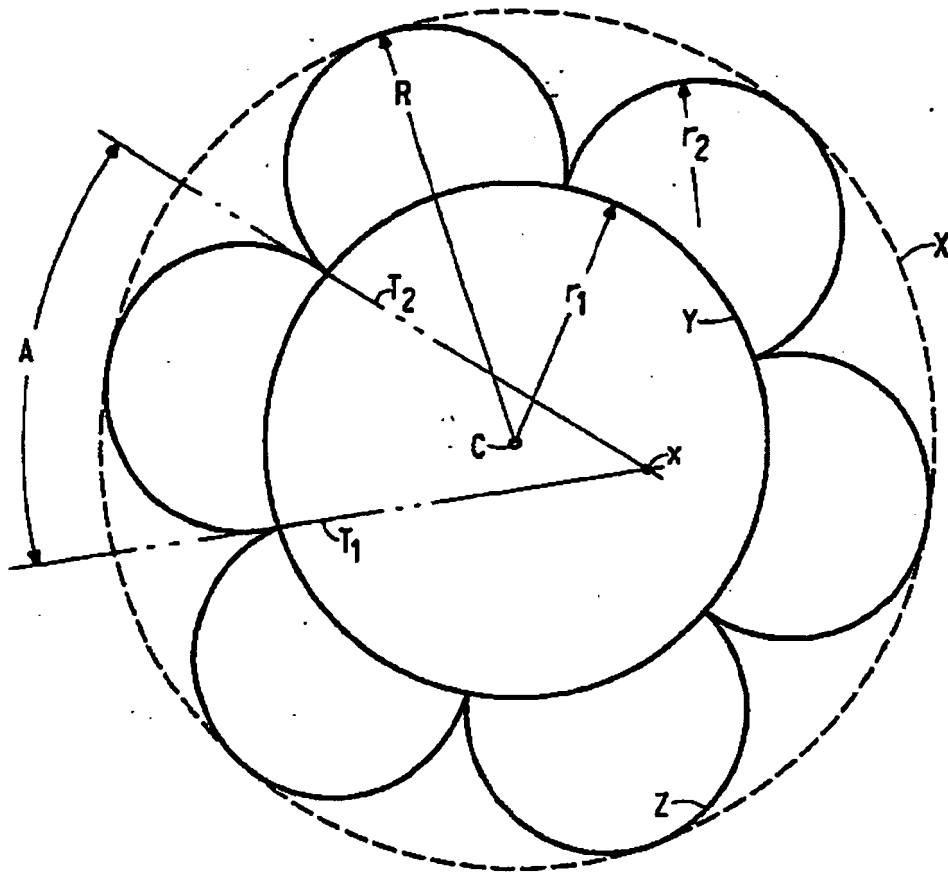


FIG. 1

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- US 5108838 A [0003]
- US 5176926 A [0003]
- US 5208106 A [0003]
- US 4041689 A [0004] [0029]
- US 3691749 A [0004]
- US 3994122 A [0007]
- US 5948528 A [0007]
- US 5288553 A [0023] [0029]
- US 5607765 A [0023]
- US 4529368 A [0029]
- US 4156071 A [0029]
- US 5250245 A [0029]
- US 4687610 A [0030]
- US 4691003 A [0030]
- US 5141700 A [0030]
- US 5034182 A [0030]
- US 5824248 A [0030]
- US 3454460 A [0049]