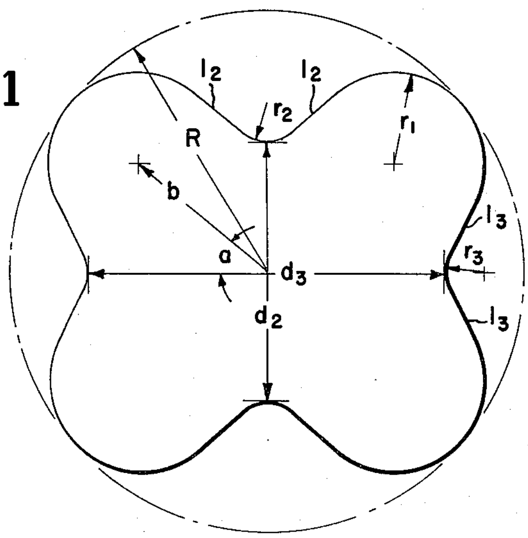
Nov. 5, 1963 A. H. McKINNEY ETAL 3,109,220

TETRALOBAL CROSS-SECTIONED FILAMENTS

Filed Aug. 19, 1960 3 Sheets-Sheet 1

FIG. 1



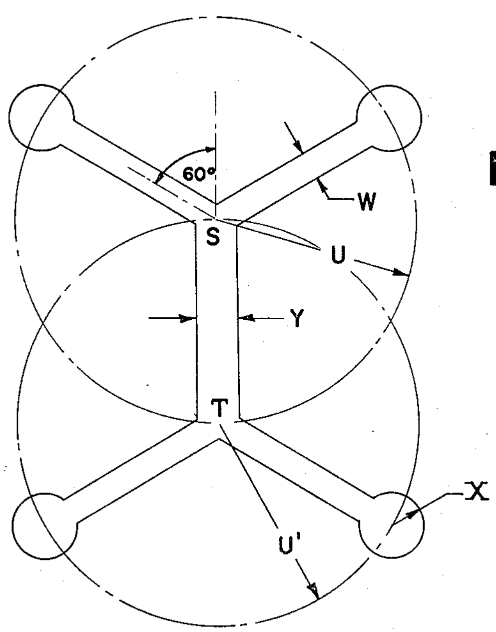


FIG. 2

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FIG. 4

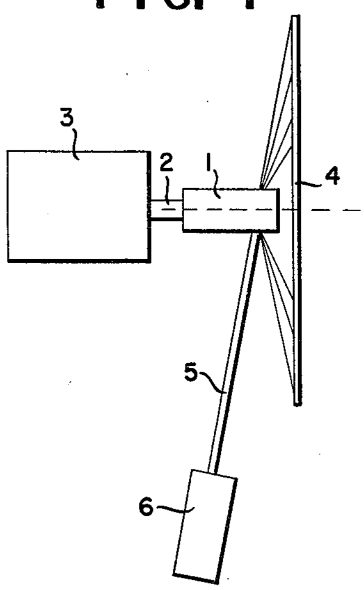


FIG. 5

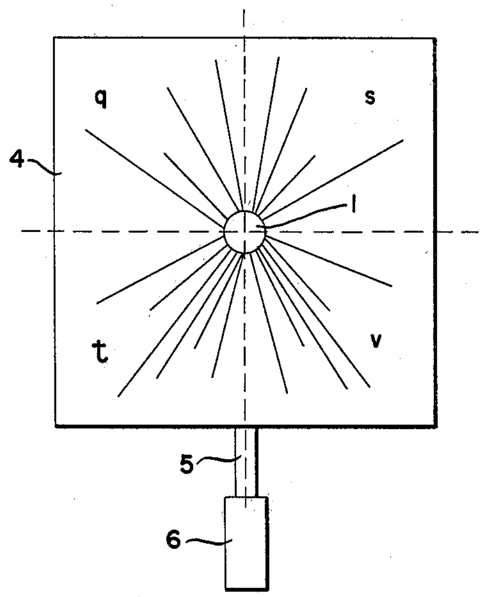
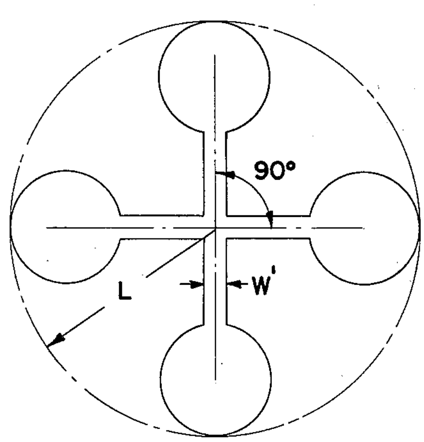


FIG. 3



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TETRALOBAL CROSS-SECTIONED FILAMENTS

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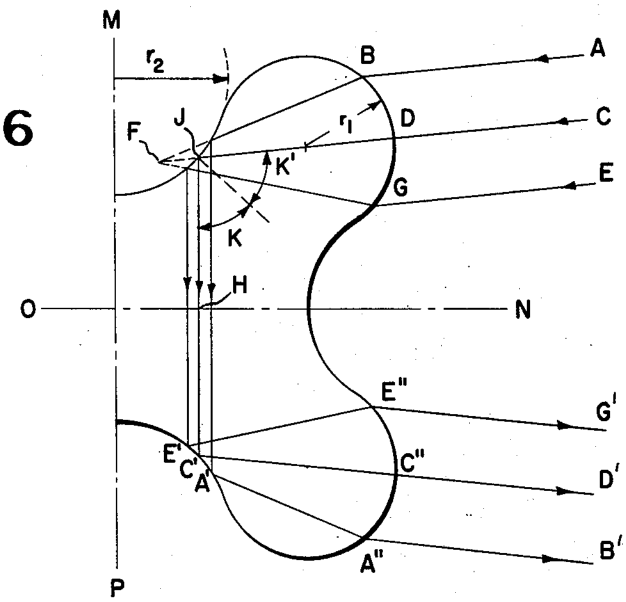
FIG. 6



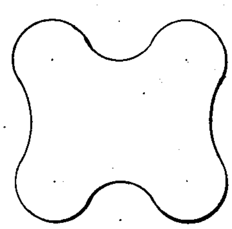


FIG. 9

FIG. 7

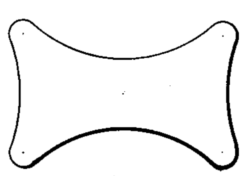
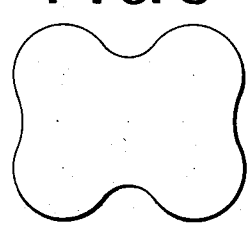


FIG. 8



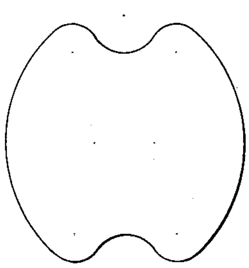


FIG. 11

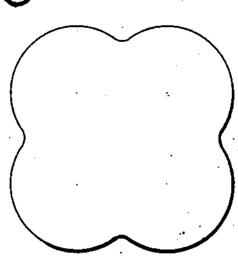


FIG. 10

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United States Patent Office

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Patented Nov. 5, 1963

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TETRALOBAL CROSS-SECTIONED FILAMENTS

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Filed Aug. 19, 1960, Ser. No. 50,725
13 Claims. (Cl. 139—420)

This invention relates to novel synthetic fibers and filaments having a tetralobal cross-sectional configuration. More particularly, this invention relates to textiles prepared from said fibers and filaments which have a combination of pleasing optical properties and improved aesthetics.

Fibers having various cross-sectional configurations have been prepared in the past to achieve certain specific properties when incorporated in textile materials. For example, it is known that fibers having a Y-cross section exhibit improved bulk when made into fabrics. Also, fibers have been made with cross sections simulating ribbons, dog bones, cruciform, and the like, to achieve specific property improvements in textiles made from these fibers. However, none of these prior art cross sections exhibit a combination of substantially all of the properties desirable for textiles in certain end uses.

It is, therefore, an object of this invention to provide novel fibers and filaments adapted for use in woven and knitted apparel fabrics, carpets, and hosiery. Another object is to provide novel synthetic fibers and filaments which when made into textiles exhibit a combination of high sparkle, high total light reflectance, high resistance to deformation and crushability, and high resistance to soiling. Another object is to provide synthetic fibers and filaments which when made into textiles exhibit a combination of good soil hiding power, pleasing optical properties and good covering power. A further object is to produce textiles from synthetic fibers and filaments which textiles will exhibit a combination of low sparkle, high total light reflectance, high covering power, a high degree of snag resistance, and a dry hand. Other objects will appear hereinafter.

The objects of this invention are accomplished by providing filaments having essentially tetralobal cross sections along their length. While filaments having a four-lobed cross section have been previously prepared, it is those filaments which are described in the following detailed description and accompanying drawings which provide the combination of properties heretofore mentioned. In the drawings:

FIGURE 1 is an enlarged representation of a cross section of a filament on which the dimension lines used in defining the cross sections of this invention have been superimposed;

FIGURES 2 and 3 are enlarged views of spinneret orifices useful in spinning the filaments of this invention;

FIGURE 4 is a diagrammatic side view of apparatus used in measuring the optical properties of models of filaments of this invention;

FIGURE 5 is a front view of the apparatus of FIGURE 4;

FIGURE 6 is an enlarged representation of a portion of a cross section of a filament of this invention illustrating the path of a light beam entering and emerging from the cross section; and

FIGURES 7 to 11 are enlarged representations of other filament cross sections of the invention.

Referring now to FIG. 1, the filaments of the invention may be defined in terms of the relationship of the following dimensions:

(*a*) The radius r_1 of a circle, an arc of which defines the tips of the lobes of the cross section;

2

(*b*) The radius R of a circle which circumscribes the tips of the lobes;

(*c*) A pair of intersecting perpendicular lines d_2 and d_3 which bisect the cross section; and

(*d*) The lobe angle *a* which lies between line d_3 and a line *b* which connects the center of the cross section to the center of an adjacent lobe tip.

The filaments of the present invention are those which meet the following requirements: The cross section must have a tip radius ratio r_1/R in the range from 0.05 to 0.80, the lobe angle *a* must be in the range from 25° to 65°, the ratio of

$$\frac{d_2}{2}\Big/R$$

which will be referred to herein as the minor lobe factor, and

$$\frac{d_3}{2}\Big/R$$

which will be referred to herein as the major lobe factor, must be in the range from 0.3 to 0.9, providing, however, that when the tip radius ratio is in the range from 0.05 to 0.45 the minor lobe factor is in the range from 0.3 to 0.75 and the major lobe factor is at least equal to

$$\left(\frac{d_2}{2}\Big/R+0.15\right)$$

but not greater than 0.9, and when the tip radius ratio is in the range from 0.45 to 0.80 the minor and major lobe factors are both in the range from 0.3 to 0.9.

Filaments having cross sections within the above definition exhibit a high total light reflection, high bulk, high resistance to deformation and crushability, and a pleasing sparkle which makes them particularly suitable for textile uses. When the tip radius ratio is in the range from 0.05 to 0.45, the minor lobe factor is from 0.3 to 0.75, and the major lobe factor is at least 0.15 greater than the minor lobe factor, the filaments exhibit a low to medium sparkle. Such filaments are particularly desirable for carpets, hosiery, and woven flat fabrics. When it is desired to have a very low sparkle, the tip radius ratio is maintained within the lower portion of the range, i.e., 0.05 to 0.25. Filaments having a high tip radius ratio, i.e., 0.45 to 0.80, and a major and minor lobe factor in the range from 0.3 to 0.9, exhibit a high light reflectance as well as a very high sparkle. Such filaments are particularly suitable for novelty hosiery, knitted fabrics such as tricot, and woven flat fabrics.

As previously mentioned, FIGURES 1 and 7–11 are enlarged representations of filament cross sections within the scope of the present invention. The tip radius ratio, lobe angle, and the minor and major lobe factors for these filaments are set forth in the following table:

TABLE 1

Figure	$\frac{r_1}{R}$	Lobe angle	$\frac{d_2}{2}/R$	$\frac{d_3}{2}/R$
1	0.35	40	0.50	0.70
7	0.10	30	0.30	0.80
8	0.40	35	0.50	0.80
9	0.30	43	0.47	0.69
10	0.50	45	0.75	0.75
11	0.20	60	0.70	0.90

Referring again to FIG. 1, the periphery of the filament cross section is comprised of the arcs of the four tip circles generated by the radius r_1 and the lines connecting these arcs. The connecting lines may be either curved, e.g., an arc of a circle, a straight line, two straight lines joined by an arc, or a combination of straight and curved lines. In FIG. 1, straight lines 1_2 are connected by radius r_2 and straight lines l_3 by radius r_3. As illustrated in FIG. 11, one part of the connecting lines may be concave while the other is convex. Various modifications of the configuration of cross sections are also shown in FIGS. 7 to 10.

In general, the filaments of this invention may be prepared by extruding molten polymer or a solution of the polymer through orifices having configurations which will provide the tetralobal structure. FIGS. 2 and 3 are illustrative of such orifices. In FIG. 2 the spinneret orifice consists of four arms extending radially from centers S and T. The radii U and U' extending from centers S and T, respectively, have a length of about 15 mils. Each of the arms have a width W of 2 mils with a circular tip having a radius X of about 2 mils. The slot Y connecting the respective arms has a length of 15 mils and a width of 2.5 mils. Referring now to FIG. 3, the arms of the orifice each have a length L of 32 mils, a width W' of 3.3 mils, and a tip diameter of 9 mils. Various modifications of these configurations may be utilized in preparing the filaments of this invention.

In spinning filaments of this invention, the spinning conditions, e.g., viscosity, rate of extrusion, quenching, windup speed, and the like, must, of course, be varied, depending on the particular synthetic polymer being spun. These conditions should be controlled to give filaments which have a substantially uniform cross-sectional shape along their length. Although the cross-sectional shape of the filament must remain generally as tetralobal with minor deviations permissable as previously described, slight variations in the parameters of the cross section may occur along the length of the filament or from filament-to-filament in a bundle without adversely affecting their unique properties. The denier of the filaments may vary within wide limits, e.g., to 200 or more, with the optimum denier which is selected depending on the intended end use of the finished fabric or textile material.

In order to provide tetralobal filaments having a particular combination of optical properties, it must first be noted that light beams which fall upon the surface of these filaments may be reflected from an outer surface, may be transmitted completely through the filament, or may be reflected from an inner surface. They may also be reflected from pigment particles within the filament. The preferred filaments prepared according to the present invention which may contain from 0% to about 0.05% of a pigment such as titanium dioxide are relatively clear, at which level the amount of pigment is not great enough to cut off any major portion of light transmission through the filament. For some uses, however, the filaments of this invention may contain up to about 3% of the pigment. It has been long recognized that the outer surface of the filament may reflect light and therefore affect the optical properties of filaments. However, it has now been found that by utilizing cross sectional configurations of this invention inner surfaces of certain configurations reflect an even greater amount of light. The relative importance of light reflected from an inner surface of a filament may be demonstrated with a single tetralobal filament of this invention or with an enlarged, clear plastic model of the filament. The filament or model is partially immersed in a tray of water with the axis of the filament or model at a horizontal position. The filament is illuminated from above by a single light source and is observed, first in air as it is held parallel to the water surface and again as it is partially immersed. By visual or photoelectric techniques, it is observed that the amount of light reflected is greatly reduced by immersing one side of the filament or model in the water, indicating that prior to immersion a large proportion of the reflected light is being reflected from the inner surface of the filament. With the refractive index of the filament or model and water being essentially the same and substantially more than that of air, almost no light can be reflected from the immersed surface of the filament. On

the other hand, a great amount of light can be reflected when the filament is surrounded by air.

The optical properties of multilobed filaments will be fully understood by referring to FIGURE 6 which shows a portion of the cross section of a filament of the present invention having a plane of symmetry ON and a line MP which defines a boundary of the portion shown. Radius r_1 is the radius of the circle which defines the periphery of the lobes of the filament cross section, and radius r_2 is the radius of the circle which defines the arcuate portion of the filament cross section adjoining one side of the lobes. A beam of parallel light represented by the area bounded by lines AB, CD and EG strikes the surface of the lobe between points B and G. This beam which would theoretically focus at point F, if not reflected by an internal surface is, however, reflected when it strikes the arcuate surface generated by radius r_2. The beam is in turn reflected from a second internal arcuate surface E'C'A' and emerges from the filament cross section as a parallel beam bounded by the lines A''B', C''D' and E''G'.

In FIGURE 6 the letter H designates the point at which the center line JC' of the beam intersects the plane of symmetry ON. DJ is the distance between the point at which the center line CDJ of the beam enters the filament cross section and the point at which it strikes the first internal surface. JH is the distance between the point at which the center line of the beam strikes the first internal surface and the point at which it crosses the plane of symmetry ON.

It has been determined that a high return of light in essentially parallel beams providing sparkle or glitter results from inner surface reflections from multilobed shapes of the type herein described and, in the more general case, from multilobed shapes formed by any combination of a number of curved or flat surfaces so constructed that a plane or planes of symmetry may be drawn between the reflecting elements or lobes when, with reference to FIGURE 6, the conditions set forth in any one of the three following equations are satisfied and when equal angles K and K' shown in FIGURE 6 are greater than the critical angle (with respect to air) and when JC' crosses the plane of symmetry ON at or very nearly at right angles. There is no limitation on the angle at which the center line of the light beam enters or leaves the cross section with respect to the axis ON provided these conditions are met. In these equations the mathematical sign of the radius r_2 is designated as negative when the arcuate surface it generates is concave and as positive when the arcuate surface generated is convex. The equations are

$$(1) \qquad \frac{4r_1 - r_2}{2(DJ)} \rightarrow 1$$

$$(2) \qquad (2r_1 - DJ)(2/r_2 - 1/JH) \rightarrow 1$$

$$(3) \qquad (2r_1 - DJ)(1/JH - 1/r_2) \rightarrow 1$$

Equation 1 applies when the mathematical sign of r_2 is negative and the internal light crosses the line of symmetry as an essentially parallel beam.

Equation 2 applies when r_2 is negative and the internal light is focused at or very nearly at point H.

Equation 3 applies when r_2 is positive.

In the foregoing discussion it will be apparent that the critical angle will depend on the particular composition of the essentially transparent polymeric material from which the filament is prepared.

The following examples illustrate various embodiments of the present invention.

Example 1

Tetralobal nylon filaments for use in carpet yarns are prepared by melt spinning polyhexamethylene adipamide through a spinneret having 34 orifices of the type shown in FIG. 2. The polymer melt temperature is about

290° C. The filaments are quenched in an air flow of about 250 cubic feet per minute at a temperature of 5° C. and are wound up at a speed of about 600 yards per minute. The yarns contain 0.02% titanium dioxide. After drawing the yarn about four times its original length, the yarn has a total denier of about 500, and the individual filaments have a denier of 15. The filaments have a cross section similar to that shown in FIG. 7 and have the following dimensions:

Lobe angle	30°
$\frac{r_1}{R}$	0.10
$\frac{d_2}{2}/R$	0.30
$\frac{d_3}{2}/R$	0.80

The yarn is converted to a crimped and bulky form by simultaneously passing two ends of the 500-denier yarn through a steam jet as described in Breen et al. U.S. application Serial No. 698,103. The bulked yarn has a total denier of about 1300 when measured under tension with a 0.1 gram per denier load.

Three (3) ends of the bulked yarn are then plied and twisted to give a yarn of a denier of about 3900. This yarn is tufted into a woven jute backing to give a carpet having a pile weight of twenty-four ounces per square yard. This carpet shows excellent soil hiding qualities even though only about 0.02% titanium dioxide is utilized. Comparative data shows that round filaments require about 0.3% titanium dioxide to obtain the same soil hiding qualities. The tetralobal filaments show a superior brightness of color as well as higher total light reflectance than the round fibers.

Example 2

Example 1 is repeated except that the polymer contains 0.1% titanium dioxide as a delusterant. A 15-denier monofilament, having the dimensions described in Example 1, is knit on a 60-gauge, 4-position Reiner hosiery knitting machine. Two ends of the yarn are combined for the welt fabric and for the splicing. After knitting, the hosiery is seamed, preboarded for five minutes at 27 pounds per square inch, scoured, dyed to a beige shade, finished, and postboarded dry at 200° F. using conventional procedures. The resultant beige-colored hosiery is bright in color and has high covering power without chalkiness. A control hosiery prepared from round monofilaments of polyhexamethylene adipamide containing 0.3% titanium dioxide is dull and chalky in appearance. When the titanium dioxide content of the round filaments is reduced, the covering-power is also reduced. The hosiery prepared from the tetralobal filaments exhibit twice the snag resistance of the round filament hosiery and develops about ⅛ as many picks as an equal weight of round filament hosiery.

Example 3

Hosiery having a very high pleasing sparkle is prepared from 15-denier tetralobal monofilaments having the following cross-sectional dimensions:

Lobe angle	45°
$\frac{r_1}{R}$	0.5
$\frac{d_2}{2}/R$	0.7
$\frac{d_3}{2}/R$	0.7

The cross section is similar to that shown in FIG. 8 and is spun from a spinneret similar to that shown in FIG. 3 using a polyhexamethylene adipamide polymer containing 0.02% titanium dioxide. The hosiery is knit and finished as described in Example 2 except that it is dyed a gold shade. This finished hosiery exhibits an exceptionally high sparkle. A comparative 15-denier monofilament hosiery prepared from a similar polyhexamethylene adipamide yarn having a round cross section in which 0.02% titanium dioxide is included in the polymer has little, if any, sparkle.

Example 4

A low luster flat fabric is prepared from a 70-denier multifilament yarn having 34 filaments of the shape shown in FIG. 7, which is spun in accordance with Example 1. The amount of titanium dioxide contained in the filaments was 0.3%. The tetralobal yarn is woven in uncrimped form to provide a plain weave fabric having a finished construction of 115 ends and 90 picks per inch. The fabric weighs approximately 2.2 ounces per square yard. The fabric, when compared with a similar fabric of filaments having a round cross section, exhibits increased covering power, greater stiffness, improved resistance to soiling, greater dryness of hand, higher bulk, and a faster rate of dyeing. The fabric, while free from luster highlights, exhibits a clarity of color that is superior to a fabric prepared from pigmented filaments of round cross section.

Example 5

A flat fabric is prepared from yarn having a cross section similar to that described in Example 3 except that the filaments contain 0.3% titanium dioxide. The filaments have a denier of about 2 and the fabric prepared has a construction similar to that of Example 4. The fabric exhibits a high sparkle and when compared with a similar fabric prepared from round filaments exhibits superior light reflectance and sparkle.

Example 6

A tetralobal monofilament of polyhexamethylene adipamide containing 0.02% titanium dioxide is spun from a spinneret having an orifice of the configuration and dimensions of that shown in FIG. 3. The polymer, which has a relative viscosity of 38, is extruded through the spinneret orifice at 461 yards per minute at a temperature of 292° C. The filament is quenched in the spinning chimney with air at 70° C. which is delivered at a rate of 150 cubic feet per minute. The filament which has a denier of 62 is drawn 4.35 times its original length over a ceramic pin 3/16 of an inch in diameter. The filament has a cross section having the following dimensions:

Lobe angle	45°
$\frac{r_1}{R}$	0.46
$\frac{d_2}{2}/R$	0.56
$\frac{d_3}{2}/R$	0.56

The monofilament yarn is knitted into hosiery using a single feed Scott & Williams seamless knitting machine. The resulting hosiery exhibits an exceptionally high reflectance and high sparkle.

Examples 7–22

A number of plastic models are prepared from polymethylmethacrylate rods two inches in diameter. The dimensions of the models are given in Table 2, which follows. The ends of the tetralobal models were cut square and the surfaces were given a high polish. The models were evaluated using the apparatus shown in FIG. 4.

Referring to FIGS. 4 and 5, a model 1 is attached to the shaft 2 of a variable speed motor 3. A ground glass screen 4 is placed in front of the model. A beam of collimated light 5, about 1.5 inch in diameter, is directed from a light source 6 at the screen 4 at an angle of 10°.

The model 1 is interposed between the light source and screen so that all of the beam strikes the side of the model, there being essentially no light falling directly on the screen. The axis of the light beam intercepts the axis of the model at a point approximately 1.25 inches from the end of the model adjacent to the screen. The light patterns on the glass screen are observed by the experimenter who is situated on the opposite side of the screen relative to the model. The patterns are subjectively rated by five experimenters and the average of the rating recorded. The light emitting from source 6 is either transmitted through the model to the screen or reflected from one of the surfaces of the model onto the screen. Most of the reflected light is reflected from the various inside surfaces of the models. Light which is transmitted through the model falls upon the screen in quadrants *q* and *s* away from the incident light as shown in FIG. 5. For the purpose of simplification, it is assumed that all of the transmitted light falls in quadrants *q* and *s* and that all of the reflected light falls in quadrants *t* and *v*. When the model is rotated at high speed a constant pattern of light falls on the screen. When testing the tetralobal cross section models, light falls in all four quadrants. On the other hand, when using a round cross section model, practically all of the light is transmitted through the model and very little falls in quadrants *t* and *v*.

The readings for reflectance were based on a scale from 1 to 10, with 1 representing almost no reflectance, as in a round cross section model, and 10 representing the highest reflectance believed to be possible. In rating sparkle, "sparkle" is defined as the contrast between the intensity of the brightest reflected beams and the average intensity of reflected light. A rating of 1 indicates that the reflected light was completely diffused with no obvious bright rays and a rating of 10 indicates that the reflected light forms very intense beams with little reflected light outside of the intense beams. Intermediate levels of sparkle are indicated by numbers between 1 and 10.

TABLE 2

Example	$\frac{r_1}{R}$	Lobe angle	$\frac{d_2}{R}$	$\frac{d_3}{R}$	Total reflectance rating	Sparkle rating
7	.50	45	.70	.70	8.0	9.0
8	.40	45	.42	.65	8.8	8.4
9	.50	40	.65	.85	8.8	8.4
10	.40	45	.55	.71	8.1	7.9
11	.45	45	.70	.80	8.1	7.7
12	.40	31	.65	.80	7.7	6.9
13	.40	42	.62	.80	8.2	6.2
14	.30	43	.47	.69	6.0	5.8
15	.30	40	.33	.61	5.9	5.3
16	.30	29	.30	.80	7.9	5.2
17	.30	30	.41	.85	7.2	4.8
18	.30	31	.35	.60	6.5	3.3
19	.30	30	.48	.68	7.3	3.2
20	.30	45	.36	.55	6.8	2.3
21	.10	46	.45	.61	4.6	2.0
22	Round Cross Section				1.0	1.0

As demonstrated in the foregoing examples, the total reflectance and sparkle both increased with increasing tip radius ratio. With still higher values of tip radius ratio, up to about 0.8, the amount of sparkle and reflectance drops off with values above about 0.8 being not significantly different from those of round fibers which have a tip radius ratio equal to 1.

The present invention may be used to prepare either staple fibers or continuous filaments from a variety of synthetic polymers. Among the most important polymers are the polyamides such as polyhexamethylene adipamide, polyhexamethylene sebacamide, polycaproamide, polyxylylene azelamide, polyoctamethylene oxalamide, polypyrrolidone, polymetaphenylene isophthalamide, polymetaphenylene adipamide; copolyamides, and irradiation grafted polyamides, and the polyesters and copolyesters such as the condensation products of ethylene glycol with terephthalic acid, ethylene glycol with a 98/2 mixture of terephthalic/(5-sodium sulfo)isophthalic acids, ethylene glycol with a 90/10 mixture of terephthalic and isophthalic acids, polyesters derived from 2,2-bis(4-hydroxyphenyl) propane, and trans-p-hexahydroxylylene glycol with terephthalic acid; acrylonitrile polymers and copolymers such as polyacrylonitrile, copolymers of acrylonitrile with vinyl pyridine, vinylidene chloride, vinyl chloride, or methyl acrylate; vinyl chloride polymers and copolymers, vinylidene chloride polymers and copolymers; polyurethanes, e.g., those described in French Patent 1,172,566, polyesteramides, polyethylenes, linear polypropylene, polycarbonates such as those derived from 2,2-bis(4-hydroxyphenyl) propane, polyoxymethylenes, fluorinated ethylene polymers and copolymers such as polymers of tetrafluoroethylene, hexafluoropropene, and monochloroetrifluoroethylene; composite filaments such as, for example, a sheath of polyamides around a core of polyester as described in the application of Breen Serial No. 771,676, filed November 3, 1958, and now U.S. Patent No. 3,038,236, and two acrylonitrile polymers differing in ionizable group content spun as a sheath and core as described in the application of Taylor Serial No. 771,677, filed November 3, 1958, and now U.S. Patent No. 3,038,237; cellulose acetate, regenerated cellulose, and the like. Mixtures of the above fibers as well as blends containing a major proportion of the synthetic fibers of this invention with a minor proportion of natural fibers may be used to prepare fabrics. The filaments may be spun in the form of tow, monofilament yarn, multifilament yarn, or the like.

The fibers and filaments may be crimped, drawn, bulked, and twisted if desired. The filaments of this invention are particularly useful in bulked form. Bulking may be conveniently achieved by a number of methods. For example, a particularly desirable bulking process is described in the copending application of Breen & Lauterbach, Serial No. 698,103, filed November 22, 1957. The filaments of this invention may also be treated according to the process described in the copending application of Breen & Sussman, Serial No. 810,671, filed May 4, 1959, to provide desirable products.

Obviously, slight variations in the configuration of the filaments of this invention may be present without impairing their desirable properties. Slight distortions may be introduced in the filament when it is spun or during the processing operations such as drawing, crimping, twisting, dyeing, bulking, and the like.

The chief advantage of this invention is that it provides fibers, filaments, yarns, and fabrics having a combination of pleasing optical properties and improved aesthetics. In particular, it is possible to prepare hosiery having either high or low luster and better snag resistance than hosiery made from prior art fibers. It is also possible to prepare carpets having improved optical properties, better soil hiding power, and better ability to resist crushing in use. Still another advantage of this invention is that it permits the preparation of flat fabrics which have a combination of higher luster, less tendency to entrap soil, a drier hand, and improved aesthetics.

The novel fibers and filaments of this invention may be employed to produce a wide variety of different types of woven, knitted and non-woven fabrics, including both apparel and industrial textile products. Specific examples of these products include shirtings, suitings, dress and blouse fabrics, hosiery, sheeting, lingerie, taffetas, georgettes, sand-crepes, tissue-failles, foulards, broadcloths, batistes, rainwear, surah, tricot, tulles, circular knitted goods, satins, chiffons, sheers, wash-wear fabrics, crepes, casement fabrics, upholstery, filter cloths, ducks, beltings, webbing, braids, cordage and twine, fiber-reinforced laminates, tire cord, coated fabrics, pile fabrics, stuffing materials, floor covering, and tiles.

As many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that this invention is not to be limited to the specific embodiments thereof except as defined in the appended claims.

We claim:

1. A textile filament prepared from a synthetic polymer having an essentially solid tetralobal cross section along its length, said cross section having a tip radius ratio r_1/R in the range from 0.05 to 0.80 and a lobe angle from 25° to 65°, said cross section being symmetrical about two perpendicular lines d_2 and d_3 which bisect said cross section, the ratios of

$$\frac{d_2}{2}\Big/R \text{ and } \frac{d_3}{2}\Big/R$$

being in the range from 0.3 to 0.9, with the proviso that when r_1/R is in the range from 0.05 to 0.45,

$$\frac{d_2}{2}\Big/R$$

is in the range from 0.30 to 0.75 and

$$\frac{d_3}{2}\Big/R$$

is at least equal to

$$\left(\frac{d_2}{2}\Big/R+0.15\right)$$

but not greater than 0.9, and when r_1/R is in the range from 0.45 to 0.80,

$$\frac{d_2}{2}\Big/R \text{ and } \frac{d_3}{2}\Big/R$$

are both in the range from 0.3 to 0.9.

2. The filament of claim 1 wherein said synthetic polymer is a polyamide.

3. A textile yarn prepared from the filaments of claim 1.

4. A textile fabric prepared from the filaments of claim 1.

5. A textile filament prepared from a synthetic polymer having an essentially solid tetralobal cross section along its length, said cross section having a tip radius ratio r_1/R in the range from 0.05 to 0.45 and a lobe angle from 25° to 65°, said cross section being rotationally asymmetric about the intersection of two perpendicular lines d_2 and d_3 which bisect said cross section, the ratio of

$$\frac{d_2}{2}\Big/R$$

being in the range from 0.30 to 0.75 and the ratio of

$$\frac{d_3}{2}\Big/R$$

being at least equal to

$$\left(\frac{d_2}{2}\Big/R+0.15\right)$$

but not greater than 0.9.

6. A textile filament of claim 5 wherein said synthetic polymer is a polyamide.

7. A textile yarn prepared from the filaments of claim 5.

8. A textile fabric prepared from the filaments of claim 5.

9. A textile filament of claim 5 wherein r_1/R is in the range from 0.05 to 0.25.

10. A textile filament prepared from a synthetic polymer having an essentially solid tetralobal cross section along its length, said cross section having a tip radius ratio r_1/R in the range from 0.45 to 0.80 and a lobe angle from 25° to 65°, said cross section being symmetrical about two perpendicular lines d_2 and d_3 which bisect said cross section, the ratio of

$$\frac{d_2}{2}\Big/R \text{ and } \frac{d_3}{2}\Big/R$$

being in the range from 0.3 to 0.9.

11. A textile filament of claim 10 wherein said synthetic polymer is a polyamide.

12. A textile yarn prepared from the filament of claim 10.

13. A textile fabric prepared from the filaments of claim 10.

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