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TETRALOBAL SYNTHETIC FILAMENT, PROCESS FOR PRODUCING THE SAME, AND ARTICLE MADE THEREFROM

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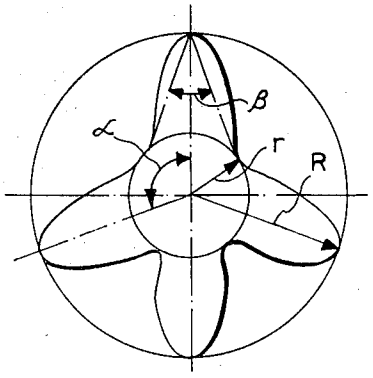

FIG.1

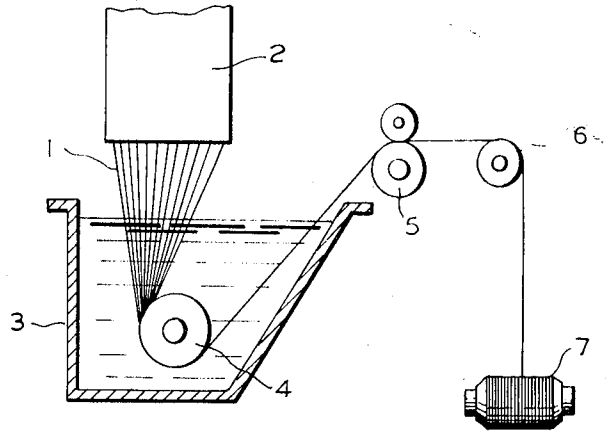

FIG.2

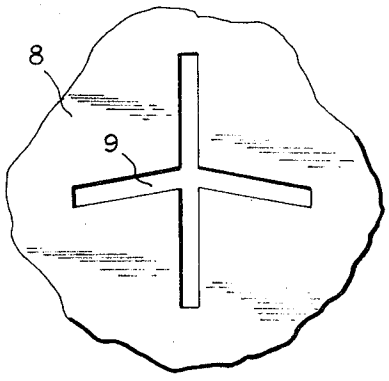

FIG.3

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TETRALOBAL SYNTHETIC FILAMENT, PROCESS FOR PRODUCING THE SAME, AND ARTICLE MADE THEREFROM

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ABSTRACT OF THE DISCLOSURE

A novel synthetic filament and articles produced therefrom wherein said filament has a tetralobal configuration, the filament and article produced therefrom possessing improved characteristics of rigidity and good covering power. Such filaments are characterized in that the ratio of the radius of the inscribed circle, i.e., the circle which passes through the connecting point of the lobes, to the radius of the circumscribed circle, i.e., the circle which passes by the apex of the lobes, is within the range of 0.25 and 0.42. The tetralobal configuration is further characterized in that two adjacent angles formed by the axes of the lobes are between greater than 90° to 120°.

The tetralobal synthetic filaments are prepared by extruding a thermoplastic polymer in a molten condition through a spinneret, the apertures of which are composed of four slits of substantially equal length forming a cross of two adjacent angles of between greater than 90° to 120°, the filaments being thereafter passed through a gaseous atmosphere and through a cooling bath maintained at a temperature lower than 100° C.

The present invention relates to novel synthetic filaments and articles produced therefrom, as well as a method for making the same wherein such synthetic filaments have a tetralobal cross-section; more particularly, the present invention is directed to such synthetic filaments with a tetralobal cross-section wherein the filaments and articles produced therefrom have improved physical properties, including in particular, a good rigidity, a nice hand, and very satisfactory esthetic qualities.

It is quite well known that fibers and filaments having various cross-sectional configurations have been prepared in the past for the purpose of adapting their properties and characteristics to certain types and fields of application, for example, in the field of floor covering, etc. In this regard, for example, filaments have been produced in the past having round, triangular or multi-lobal cross-sections, such filaments being used to produce textile materials having a variety of characteristics and properties associated with the particular cross-sectional configuration of the filaments. Thus, for example, depending upon the particular cross-sectional configuration of the filament, the fabrics produced therefrom can have improved elasticity, greater rigidity, improved optical properties, such as reflection, and many other properties or characteristics which are associated with the cross-sectional configuration of the filaments.

With regard to the above, it is well known that filaments having a round cross-section have many properties which are inferior to filaments having a multilobal cross-sectional configuration. This is particularly true wherein the filaments are used as fabrics for furnishings, in particular rugs, because yarns produced from filaments having a round cross-section do not have a sizeable bulk in view of their low covering power. Furthermore, such yarns produced from filaments having a round cross-section do not have the improved optical qualities which are imparted by multilobal cross-sectional filaments since the reflection of incident light on round cross-section yarns is considerably lower. Accordingly, while fibers and filaments of a round cross-section were of the first type produced, ever increasing demand for improved characteristics and properties has led to the recent development of a variety of cross-sections, including among others, fibers and filaments of a multilobal cross-sectional configuration.

Thus, for example, U.S. Pats. 2,939,201 and 2,939,202 are directed to trilobal textile filaments possessing allegedly improved optical and physical properties. Thus, as set forth in such patents, the filaments described of a trilobal cross-sectional configuration are specifically adapted for incorporation in apparel fabrics to provide a combination of luster highlight capability, resistance to soiling, covering power, and wrinkle resistance. Basically, the trilobal filaments set forth in the above United States Patents are of the type wherein the filament in cross-section is composed of three symmetrical lobes. Specifically, U.S. Pat. 2,939,202 describes such trilobal filaments wherein the aforementioned properties are associated with the fact that each lobe of the trilobal filament has a convex portion.

In addition to the foregoing trilobal filaments which have been found to be very satisfactory for a number of purposes, tetralobal filaments have been known and are illustrated, for example, in French Pat. 1,383,858 and U.S. Pat. 3,109,220. The fibers and filaments of such patents having specific tetralobal cross-sections while having good optical properties have a covering power and rigidity which are only slightly improved with respect to a yarn of a round cross-sectional configuration. This is due in part to the massive shape and slightly elongated lobes of the fibers and filaments. Accordingly, while such tetralobal cross-sectional fibers and filaments are advantageous for a number of purposes, the same do not have the enhanced characteristics and properties which are desirable for many applications.

In accordance with the present invention, however, it has been discovered that synthetic fibers and filaments of a tetralobal cross-section can be provided whereby the same have improved characteristics of rigidity and good covering power in addition to excellent optical qualities. Such characteristics of the present invention are associated with a tetralobal synthetic fiber or filament wherein the tetralobal cross-sectional configuration is such that the ratio of the radius of the inscribed circle, i.e., the circle which passes through the connecting point of the lobes to the radius of the circumscribed circle, i.e., the circle which passes by the apex of the lobes, is within the range of 0.25 and 0.42. In addition, such improved characteristics of the present invention are associated with the fact that two adjacent angles formed by the axes of the lobes are between greater than 90° to 120° and the angle of aperture, i.e., the angle formed by the segments joining the connecting points of the lobes to the apex of each lobe, is smaller than 50°.

Due to the improved characteristics of fibers and filaments having the aforenoted cross-sectional configuration the same find themselves to be eminently suited for a variety of applications, the same being particularly advantageous for the production of rugs and carpets. Such filaments of the present invention are prepared by extruding a molten thermoplastic polymer through a spinneret, the apertures of which are composed of four slits of substantially equal length forming a cross with two adjacent angles between greater than 90° and 120°. After extrusion, filaments are passed through a gaseous atmosphere and then through a cooling bath maintained at a temperature lower than 100° C.

Accordingly, it is a principal object of the present invention to provide a novel synthetic fiber or filament with a tetralobal cross-section, articles produced therefrom, and a method for producing the same wherein said fibers and filaments, articles, and method, eliminate the inherent deficiencies of previously described polylobal fibers and filaments, etc.

It is a further object of the present invention to produce such synthetic fibers and filaments having a tetralobal cross-section wherein such filaments have good rigidity, a nice hand, and excellent esthetic qualities, as well as good optical properties and covering power, such tetralobal fibers and filaments being characterized by a ratio of the radius of the inscribed circle to the radius of the circumscribed circle of between 0.25 and 0.42, two adjacent angles formed by the axes of the lobes being between greater than 90° to 120°, and the angle of aperture of each lobe being less than 50°.

It is yet a further object of the present invention to provide such tetralobal fibers and filaments and articles produced therefrom as well as a method of preparing such fibers and filaments comprising melt extruding the thermoplastic polymer through a spinneret characterized in that the same is composed of four slits of substantially equal lengths, forming a cross with two adjacent angles of between greater than 90° to 120°.

Further characteristics of the novel fibers and filaments, articles, and the process of the present invention will become more apparent from the following more detailed description thereof.

The foregoing objects and advantages of the novel filaments, articles produced therefrom, and method of production in accordance with the present invention are achieved through the provision of a tetralobal synthetic filament of a specifically defined cross-sectional configuration. Thus, the novel filaments of the present invention are characterized in that the ratio of the radius of the inscribed circle, i.e., the circle which passes through the connecting points of the lobes, to the radius of the circumscribed circle, i.e., the circle which passes by the apex of the lobes, is between 0.25 and 0.42. Additionally, such novel tetralobal synthetic filaments of the present invention are characterized in that two adjacent angles formed by the axes of the lobes are between greater than 90° to 120°. Similarly, such synthetic tetralobal filaments in accordance with the present invention are such that the angle of aperture of each lobe is smaller than 50°.

The yarns and filaments produced from the tetralobal synthetic filaments of the present invention have properties which are substantially improved with regard to round or trilobal cross-sectional filaments of the same or similar type. Thus, for example, where such yarns and filaments are subjected to crimping, the crimp induced in the tetralobal synthetic filaments and yarns of the present invention is characterized by a higher semi-uncurling power. This characteristic of the filaments and yarns in accordance with the present invention results in very interesting characteristics, i.e., the yarns and filaments are resistant to uncurling or uncrimping, a particularly advantageous characteristic for the production of rugs or carpets or similar articles.

As indicated previously, the filaments and yarns produced in accordance with the present invention are obtained by extrusion of a melted thermoplastic polymer through a spinneret, the apertures of which are formed by four slits having a substantially equal length, such slits forming a cross having two adjacent angles between greater than 90° to 120°. After extrusion through such spinneret, the filaments are passed into a gaseous atmosphere, then cooled in a bath maintained at a temperature lower than 100° C. Preferably the cooling bath is an aqueous bath.

The yarns produced in accordance with the present invention are composed of filaments which have a regular cross-sectional configuration from filament to filament,

having elongated lobes and a cut up shape. Accordingly, such yarns can be distinguished from any yarns heretofore known.

It is again pointed out that the filaments and yarns in accordance with the present invention have excellent characteristics of rigidity and improved optical properties, thereby making the same eminently suited for various applications, including among others, use in floor coverings. It is hypothesized in accordance with the present invention that the greater rigidity of the filaments and yarns produced in accordance with the present invention is associated with the fact that the tetralobal cross-sectional configuration of the filaments of the present invention is asymmetrical. In this regard, it is hypothesized that such asymmetrical tetralobal cross-sectional configuration brings about a greater rigidity in the filaments and yarns, which greater rigidity is not associated with other tetralobal or polylobal filaments of regular cross section. In addition, it is pointed out that the high covering power and good optical properties associated with the filaments and yarns of the present invention, in addition to the greater rigidity, provides for products which are vastly superior to known products for the production of carpeting and similar floor coverings. Accordingly, as employed throughout, the term "article" prepared from the novel filaments of the present invention is meant to embrace such yarns, specifically adapted for floor coverings, as well as the finished products per se.

The novel product and method of the present invention can be further illustrated by reference to the accompanying drawings wherein:

FIG. 1 is an enlarged view of a tetralobal filament in accordance with the present invention shown in cross section;

FIG. 2 is a diagrammatic view of the method employed in the production of the tetralobal synthetic filaments in accordance with the present invention; and

FIG. 3 is an enlarged view of a spinneret plate and aperture used to produce the filaments of the cross section of FIG. 1.

As seen in FIG. 1, the novel tetralobal filaments of the present invention are characterized by an asymmetric cross-section wherein each of the four lobes preferably has a single axes of symmetry. As seen in FIG. 1, the radius of the inscribed circle, i.e., the radius of the circle passing through the connecting point of the lobes is designated as r. Similarly, as seen in FIG. 1, the radius of the circumscribed circle, i.e., the circle which passes by the apex of the lobes is designated as R. As indicated previously, the ratio r/R of the radius of the inscribed circle to the radius of the circumscribed circle in accordance with the novel tetralobal filaments of the present invention is within the range of 0.25 to 0.42. When such ratio of r/R is within such range set forth above the tetralobal filaments have the outstanding optical properties, rigidity and covering power previously described.

Similarly, as seen in FIG. 1, the angle α, the angle between two adjacent axes of the lobes of the tetralobal filaments, is between greater than 90° to 120°. Here again, this a characteristic of the cross-sectional configuration of the tetralobal filaments of the present invention which provides for the outstanding optical properties, rigidity and covering power, allowing such filaments to be particularly suited for the production of floor covering, particularly rugs or carpets. In addition, as seen in FIG. 1, the angle β, i.e., the angle of aperture of each lobe, is smaller than 50°. In this regard, once such angle of aperture, i.e., the angle formed by the segments joining the connecting points of the lobes to the apex of each lobe, is less than 50°, the fibers and filaments having the tetralobal configuration of the present invention have the outstanding characteristics and properties described above.

Additionally, as seen in FIG. 1, it is preferred in accordance with the present invention, that the cross-sectional configuration of the tetralobal filament show a single

axis of symmetry. While such axis of symmetry preferably exists in accordance with the cross-sectional configuration of the tetralobal filaments of the present invention, it must be recognized that such filaments are asymmetrical in character and can, therefore, be distinguished from symmetrical tetralobal cross-sectional filaments such as shown, for example, in U.S. Pat. 3,109,220. This, of course, is due to the fact that the angle α formed by two adjacent axes of the lobes is an angle greater than 90° but less than or equal to 120°.

As indicated previously, FIG. 2 is a diagrammatic view of the process employed in accordance with the present invention to produce filaments and yarns of the tetralobal configuration such as set forth in FIG. 1. Thus, the filaments and yarns in accordance with the present invention, are prepared by extrusion of a melted thermoplastic polymer through a spinneret **2**. The melted thermoplastic polymer employed in the production of the tetralobal filaments and yarns of the present invention may include any conventional thermoplastic material normally prepared in round, trilobal, tetralobal or other cross-sectional configurations. Thus, for example, suitable thermoplastic polymers include the super polyamides, such as polyhexamethyleneadipamide (nylon 66) as well as other conventional super polyamides such as nylon 10, nylon 11, etc. Similarly, the thermoplastic polymer employed in the production of the tetralobal synthetic filaments and fibers can comprise a suitable polyester such as polyethyleneterephthalate. Accordingly, as used throughout, the term "thermoplastic polymer" is meant to embrace any and all such materials conventionally employed in the production of synthetic filaments and yarns.

The spinneret through which the molten thermoplastic polymer is spun is illustrated in FIG. 3. Such spinneret comprises a plate **8** and apertures **9**, such apertures forming four slits of substantially equal length, such slits forming a cross wherein two adjacent slits form an angle greater than 90° and less than or equal to 120°. The filaments **1** exiting from the spinneret **2** pass through a gaseous atmosphere prior to passing through a vat **3** containing a cooling liquid. The gaseous atmosphere can, of course, comprise ordinary air or the spinning apparatus can be encased so as to provide an inert gaseous atmosphere through which the filaments **1** pass after exiting the spinneret **2** and prior to entering the cooling vat **3**.

The cooling vat **3** in accordance with the present invention can comprise water or any other conventional cooling medium, generally used for the cooling of extruded synthetic thermoplastic filaments and yarns. Of course, the use of water as a cooling medium is preferred. After passing through the vat **3** containing a suitable cooling medium, e.g., water, the filaments **1** are wound on a suitable bobbin **7** after passing over and between the return rollers **4**, **5**, and **6**.

As indicated previously, the yarns and filaments of the present invention having a tetralobal cross-sectional configuration possess certain characteristics which are improved when compared to yarns and filaments having a round or trilobal cross-section or a tetralobal configuration not having those characteristics enumerated above. Thus, the yarns and filaments of the present invention are characterized by higher semi-uncurling powers after crimping, which characteristics result in very advantageous properties, making the yarns and filaments particularly suited for the production of rugs or carpets or similar floor coverings. Thus, the resistance of the yarns and filaments to uncurling or uncrimping makes the products of the present invention particularly suitable for a number of applications. In addition, as indicated previously the novel tetralobal filaments of the present invention are characterized by improved rigidity, improved optical qualities, and good covering power. These characteristics, of course, are in addition to the nice hand and exceptional esthetic qualities associated with tetralobal synthetic filaments of the present invention.

The novel filaments and method of producing the same will now be illustrated by reference to the following specific examples. It is to be understood, however, that such examples are presented for purposes of illustration only and the present invention is in no way to be deemed as limited thereto.

EXAMPLE 1

In the device illustrated in FIG. 2, polyhexamethyleneadipamide having a relative viscosity of 35 was extruded at 280° C. through a spinneret comprising 68 apertures composed of four slits arranged substantially in the shape of a cross and of equal lengths, having the following dimensions:

	Mm.
Length	0.28
Width	0.07

The polymer was fed to the spinneret at the rate of 2 g./mn./aperture.

The filaments issuing from three spinnerets were joined so as to form a yarn having a count of 3,520 dtex. (3,200 den.). This yarn was passed through a cooling vat containing water kept at a temperature of approximately 80° C. After a vertical trip of 70 cm. in said said bath, the yarn passed on a return roller and was removed from said bath at an angle of approximately 60° compared to quenching bath surface.

The yarn was then drawn at a rate of 3.4 at a speed of 425 m./mn.

The yarn was then subjected to a crimping treatment according to the process and device described in French Pat. 1,289,491 and its patents of addition.

The yarn obtained has the following characteristics:

Resistance in g./dtex. (g./den.)	3.5 (3.2)
Elongation (percent)	45
Stretchability	40
Semi-uncurling power in mg./dtex. (mg./den.)	3.9 (3.5)
Crimp (½ crimp/cm.)	15
Voluminosity cm.^{3}/g.	4.2

The cross section of the filaments was characterized by the following measurements: the ratio r/R was equal to 0.33, the angle formed by the axes of the lobes was 110°, and the angle of opening of the lobes was approximately 38°.

EXAMPLE 2

The same device as in Example 1 is used to extrude at 260° C. polycaproamide having a relative viscosity of 40.

The filaments coming out of the spinneret passed through an aqueous bath containing glycol kept at a temperature of approximately 25° C.

The filaments are joined so as to form a roving or slubbing which was cold drawn at a rate of 4.2 and at a speed of 100 m./mn., and then subjected to a crimping treatment.

The rovings or slubs obtained had the following characteristics:

Resistance in g./dtex. (g./den.)	3.3 (3)
Elongation (percent)	55
Crimp (½ crimp/cm.)	13
Voluminosity cm.^{3}/g.	4.2

The cross section of the filaments forming the roving have the following dimensions: the ratio r/R was equal to 0.40, the angle formed by the axes of the lobes was 100° and the angle of aperture of the lobes was 46°.

EXAMPLE 3

When Example 1 is repeated, except that the thermoplastic polymer is polyethyleneterephthalate, a product of similar properties is produced.

It can be seen from the foregoing that the present invention involves a distinct improvement in tetralobal synthetic filaments and methods of producing the same. In

this respect, while the present invention has been described primarily with regard to the foregoing exemplifications, it should be obvious that the present invention should in no way be deemed to be limited thereto but should be construed as broadly as any and all equivalents thereof.

What is claimed is:

1. Synthetic filaments of a thermoplastic polymer of a tetralobal cross-sectional configuration characterized by:

(a) the ratio of the radius of the inscribed circle (r) passing through the connecting points of the lobes to the radius of the circumscribed circle (R) passing by the apex of the lobes is within the range of 0.25 to 0.42;

(b) the angle of aperture of each lobe is less than 50°; and

(c) two adjacent angles formed by the axes of the lobes are between greater than 90° to 120° so that the tetralobal filament possesses an asymmetrical cross-sectional configuration.

2. The synthetic filaments of claim 2 wherein said thermoplastic polymer is a polyamide.

3. The synthetic filaments of claim 1 wherein said thermoplastic polymer is a polyester.

4. A yarn comprising a plurality of synthetic filaments of claim 1.

5. The yarn of claim 4 wherein said filaments have a substantially uniform cross-sectional configuration from filament to filament.

6. Articles produced from the yarn of claim 4.

7. Articles produced from the yarn of claim 5.

8. A method of producing the synthetic filaments of tetralobal configuration of claim 1 which comprises extruding a molten thermoplastic polymer through a spinneret, passing the extruded filaments through a gaseous atmosphere and thereafter passing the filaments through a cooling bath maintained at a temperature of less than 100° C., said method being characterized in that said spinneret comprises a plate having apertures in the shape of a cross comprising four slits of substantially equal length, said slits forming two adjacent angle of between greater than 90° to 120°.

9. The method of claim 8 wherein said thermoplastic polymer is a polyamide.

10. The method of claim 8 wherein said thermoplastic polymer is a polyester.

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