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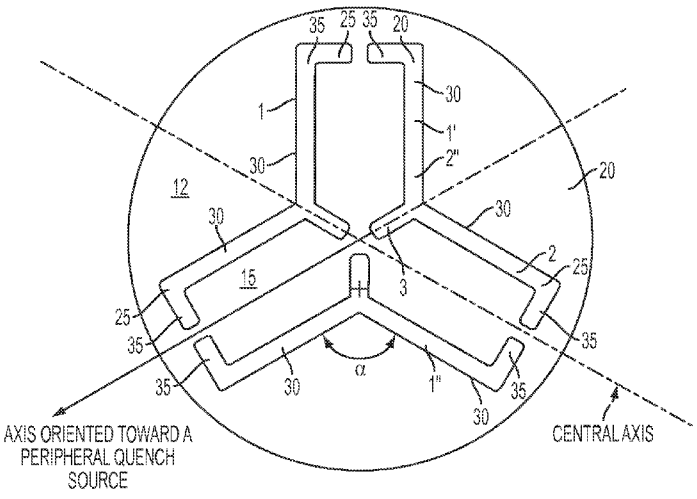

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FIG. 1

(57) Abstract: This invention relates to a trilobal filament having at least one axially extending void, preferably one elongated void in each lobe, wherein each lobe has a partial elliptical-shaped profile having a major axis to minor axis of between about 1.04 : 1 to about 1.12 : 1, the cross-section has a modification ratio of 1.7 to 2.2, and the total cross-sectional area is 7 to 13 percent void. In a further aspect, this invention is a spinnerette for producing a filament comprising at least one bore group. Each bore group having three leg sections that are divergent from each other by 100° to 130° and each leg section includes two substantially parallel long leg capillary sections extending to an end section having a shoulder that extends inwardly toward a central axis of the long leg capillary sections.

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YARN FILAMENT AND METHOD FOR MAKING SAME

Field of the Invention

[0001] The invention relates in general to synthetic polymeric fibrous materials. More particularly, this invention relates to a hollow trilobal cross-section filament for use as carpet yarn, and to a spinnerette for its manufacture.

Background of the Invention

[0002] For many uses of fibrous synthetic polymers, it is desirable to minimize the weight of fiber needed to spread over an area. This qualitative property of a fiber is known as "cover". Another quality of fibers for certain end uses (like for carpet yarn) is the fiber's ability to hide soil. While desireable to obtain high cover and good soil hiding, it is also desireable to control the degree of luster. For example, carpet yarns should provide the greatest cover and hide soil well, yet retain a desired degree of luster.

[0003] Trilobal fibers are known to provide cover superior to round cross-sections and it is known to make trilobal and pseudo-trilobal filaments (e.g., deltas, T-shapes). Exemplary are U.S. Pat. No. 3,981,948 to Phillips, U.S. Pat. No. 3,194,002 to Raynolds et at., U.S. Pat. No. 2,939,201 to Holland, U.S. Pat. No. 4,492,731 to Bankar et al. and Japanese Kokai 42-22574.

[0004] It is also known to provide voids in filaments and that many times these voids result in improved soiling hiding performance. U.S. Pat. No. 3,745,061 to Champaneria et al. and U.S. Pat. No. 4,407,889 to Gintis et al. show non-round filaments having one or more voids.

[0005] It is known also to provide trilobal or pseudo-trilobal fibers which have one or more voids. Exemplary are U.S. Pat. No. 3,095,258 to Scott, U.S. Pat. No. 3,357,048 to Cobb, Jr., U.S. Pat. No. 3,493,459 to McIntosh et al., U.S. Pat. No. 3,558,420 to Opfell, U.S. Pat. No. 4,279,053 to Payne et al., U.S. Pat. No. 4,364,996 to Sugiyama, U.S. Pat. No. 4,956,237 to Samuelsom and British Patent No. 843,179 to Siemer et al.

[0006] U.S. Pat. No. 4,648,830 to Peterson et al. discloses a spinneret for manufacturing hollow trilobal cross-section filaments. The filaments disclosed therein have one axially extending hole in each lobe.

[0007] Although the prior art hollow filaments are said to provide improved sparkle or luster and bulk when used as a carpet yarn, there exists a need for further improvement in these properties. In addition, it would be advantageous if hollow filaments could improve the cover of carpet yarns.

SUMMARY

[0008] The filament described herein has improved bulk, cover and resistance to a luster change as a result of wear. In one aspect, the filament comprises a trilobal filament having at least one axially extending void, preferably one axially extending void in each lobe. In one aspect, it is contemplated that each lobe can have a partial curved cross-sectional profile having a partial elliptical-shaped profile that has a major axis to minor axis ratio of between about 1.04 : 1 to about 1.12 : 1. It is also contemplated that each axially extending void will have an elliptical-shape having a major axis that is substantially co-axial with the major axis of the respective lobe. In other aspects, it is contemplated that the cross-section can have a modification ratio of 1.7 to 2.2 and the total cross-sectional area can be between about 7 to 13 percent void. The filament can be used as a carpet yarn.

[0009] In a further aspect, a spinnerette for producing such a filament can comprise at least one bore group, in which each bore group has three legs divergent from each other by 130° to 150°. In another aspect, each leg can include two substantially parallel capillary sections extending to an end section that has a shoulder that extends inwardly toward a central axis of the capillary sections.

[0010] Exemplary suitable synthetic polymers comprise polyamides, such as nylon 66 and nylon 6, polyesters, such as polyethylene terephthalate and polytrimethylene terephthalate, polyolefins, such as polypropylene, and polyacrylonitrile. Preferably, nylon-6 is used. In optional aspects, the filaments can be in the form of a continuous filament yarn, a crimped continuous filament yarn, a staple fiber yarn, or a crimped staple fiber yarn.

[0011] Accordingly, there is a need in the pertinent art for a filament for a carpet product that addresses the issues discussed above.

[0012] Additional advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate several aspects of the invention and together with the description, serve to explain the principles of the invention.

[0014] Figure 1 is an enlarged top view of a single spinneret capillary, showing at least one bore group, in which each bore group has three legs divergent from each other by 100° to 130°.

[0015] Figures 2A and 2B are cross-sectional views of exemplary filaments spun through a spinneret capillary of the type shown in Figure 1.

[0016] Figure 3 is a photograph showing the cross-sectional view of a plurality of filaments spun through a spinneret capillary of the type shown in Figure 1.

DETAILED DESCRIPTION

[0017] The present invention may be understood more readily by reference to the following detailed description, examples, drawings, and claims, and their previous and following description. However, before the present devices, systems, and/or methods are disclosed and described, it is to be understood that this invention is not limited to the specific devices, systems, and/or methods disclosed unless otherwise specified, as such can, of course, vary. It is also to be understood that the terminology used herein is for the purpose of describing particular aspects only and is not intended to be limiting.

[0018] The following description of the invention is provided as an enabling teaching of the invention in its best, currently known embodiment. To this end, those skilled in the relevant art will recognize and appreciate that many changes can be made to the various aspects of the invention described herein, while still obtaining the beneficial results of the present invention. It will also be apparent that some of the desired benefits of the present invention can be obtained by selecting some of the features of the present invention without utilizing other features. Accordingly, those who work in the art will recognize that many modifications and adaptations to the present invention are possible and can even be desirable in certain circumstances and are a part of the present invention. Thus, the following description is provided as illustrative of the principles of the present invention and not in limitation thereof.

[0019] As used throughout, the singular forms “a,” “an” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to “a void” can include two or more such voids unless the context indicates otherwise.

[0020] Ranges can be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another aspect includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another aspect. It will be further understood that the endpoints of each of the ranges are significant both in relation to the other endpoint, and independently of the other endpoint.

[0021] As used herein, the terms “optional” or “optionally” mean that the subsequently described event or circumstance may or may not occur, and that the description includes instances where said event or circumstance occurs and instances where it does not.

[0022] As used herein, "filament" includes a polymer or copolymer which has been formed into an article of a running or extremely long length and which is known conventionally as a continuous filament, or a polymer or copolymer which has been formed into an article of a running or extremely long length and then cut or chopped into shorter lengths, which is known conventionally as staple.

[0023] "Modification ratio" is a well known measure of the cross-section of a trilobal filament and is defined, for example, in U.S. Pat. No 4,492,731, incorporated

herein by reference, and Patent No. EP-A-0 516,119. As shown in Figure 2B, "modification ratio" means the ratio of the radius R_2 of the circumscribed circle to the radius R_1 of the inscribed circle. The cross-section of the filament of the present invention has a modification ratio of 1.5 to 2.4, preferably at least 2.0, and more preferably 1.7 to 2.2.

[0024] The present invention may be understood more readily by reference to the following detailed description of the invention and the examples included therein and to the Figures and their previous and following description.

[0025] The filaments 50 of this invention are generally prepared by conventional spinning molten polymer or polymer solutions through spinneret capillaries 10 which are designed to provide the desired cross-section of the filament. In optional aspects, it is contemplated that the filaments can be formed from synthetic, thermoplastic polymers that are melt-spinnable. These polymers can comprise, for example and without limitation, polyolefins such as polypropylene (PP), polyamides such as polyhexamethylenediamine adipamide (nylon 66) and polycaprolactam (nylon 6), polyesters such as polyethylene terephthalate (PET), polytrimethylene terephthalate (PTT), polybutylene terephthalate (PBT), and polyesters of other monomers, and acrylics such as poly(methyl methacrylate) (PMMA). As one skilled in the art will appreciate, copolymers, terpolymers, and melt blends of such polymers are also suitable. Polymers that form solutions, such as polyacrylonitrile, can also be optionally used. These polymer solutions can be conventionally dry-spun into filaments having the desired cross-section.

[0026] Generally, in a conventional melt spinning process, the molten polymer is extruded into air or other gas, or into a suitable liquid, where it is cooled and solidified. In another conventional aspect, suitable quenching gasses and liquids can include, for example and without limitation, air at room temperature, chilled air, and water. In another aspect, and in a conventional dry spinning process, the polymer solution can be extruded as a continuous stream into a heated chamber to remove the solvent and to thereby form a solid filament. It is recognized that the specific spinning conditions, *e.g.*, viscosity, rate of extrusion, quenching, etc. will vary depending upon the polymer used. In an optional aspect, it is contemplated that the polymer spinning dopes may also contain conventional additives, such as

antioxidants, dyes, pigments, antistatic agents, ultraviolet (UV) stabilizers, and the like.

[0027] Referring to Figure 1, an example of a suitable spinneret capillary 10 for forming the filaments of this invention is illustrated. In this example, a spinneret orifice 15 or bore group is defined in a planar member 12 that is suitable for melt spinning a filament-forming polymeric material therethrough. In one aspect, a spinnerette for producing a filament comprising at least one bore group20. In various aspects, it is contemplated that each bore group 20 can have three leg sections 25 that are divergent from each other an angle α that ranges from about 100° to about 130° and each leg section 25 can include two substantially parallel long leg capillary sections extending to an end section 30 having a shoulder capillary section 35 that extends inwardly toward a central axis of the long leg capillary sections.

[0028] As shown, each bore group can define three "Y" shaped holes 1, 1' and 1'', each Y shaped hole being defined by a pair of angularly opposed long legs 2, 2" (the "long leg capillary sections") and a short leg 3. The angle α between the pair of angularly opposed long legs 2, 2" is preferably about 120° and the angle between each of the angularly opposed long legs 2, 2" and the short leg is preferably about 120°. Each long leg 2 defines a shoulder capillary section at the distal end of the long leg that is positioned substantially transverse to the elongate axis of the leg. Thus, for each leg section of each bore group, the shoulder capillary sections of the two substantially parallel long leg capillary sections are positioned substantially co-axial to each other and extend inwardly toward a central axis of the long leg capillary sections.

[0029] Referring to Figures 2A -3, the described spinnerette 10 will produce a filament of fiber 50 comprising a trilobal cross-section and at least one elongated void 35. In one aspect, it is contemplated that each lobe 54 can have a partial curved cross-sectional profile having a partial elliptical-shaped that has a major axis to minor axis ratio of between about 1.04 : 1 to about 1.12 : 1. It is also contemplated that each elongated void 52 will have an elliptical-shape having a major axis that is oriented with respect to the major axis of the respective lobe. In other aspects, it is contemplated that the cross-section can have a modification ratio of 1.5 to 2.4, preferably at least 2.0, and more preferably 1.7 to 2.2 and the total cross-sectional area

can be between about 5 to 15 percent void, preferably about 6 to 14 percent void, and more preferably about 7 to 13 percent void.

[0030] In another aspect, it is contemplated that the filament will define three elliptical-shaped voids 52 having a major axis and a minor axis. In one aspect, the filament 50 can comprise one void 52 in each lobe 54. In a further aspect, it is contemplated that each lobe 54 has a pair of spaced foci and each axially extending void has a pair of spaced foci. In this aspect, in one embodiment, it is contemplated that one foci of the lobe and one foci of the axially extending void can be positioned in substantially the same cross-sectional position or, optionally, in close cross sectional position.

[0031] Referring to Figure 2B, it is also contemplated that the major axis of at least one of the elliptical-shaped voids 52 is oriented at an angle β with respect to the major axis of the respective lobe 54 in which the void is positioned. It is contemplated that the angle β can range from between about 0 degrees (substantially co-axial) to about 60 degrees, and preferably from between about 0 degrees to about 45 degrees. In another aspect, it is contemplated that each of the elliptical-shaped voids is oriented at an angle β with respect to the major axis of the respective lobe in which the void is positioned. In yet another aspect, it is contemplated that at least one or more of the angle β differ for each elongated void. For example, and without limitation, as shown in Figure 4, the angle β for all of the elongated voids are different.

[0032] As is apparent to one ordinarily skilled in the art, the filaments 50 can be prepared by known methods of spinning filaments. Molten polymer can be spun through spinneret orifices shaped to provide the desired void volume and filament cross-sections under spinning conditions which give the desired denier. Specific spinning conditions and spinneret orifices, shapes and dimensions will vary depending upon the particular polymer and filament product being spun.

[0033] In one exemplary aspect, although any filament count yarn can be manufactured, for this example, a spinnerette 10 can be drilled with multiple filament bore groups, in which the central axis of the long leg capillary sections of one leg section of each filament forming bore group as described in Figure 1 and above is oriented toward a peripheral quench source. For example, nylon 6 (polycaprolactam)

polymer can be extruded at normal conventional spinning conditions into a quench stack and drawn, taken up onto the package where it is further processed into typical carpet yarn. This carpet yarn is then tufted into a carpet using conventional tufting methods and the face yarn of the carpet is observed to have improved apparent bulk, soil hiding and reduced luster change with wear.

[0034] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. Other aspects of the invention will be apparent to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims

What is claimed is:

1. A filament comprising a trilobal cross-section and at least one elongated void, wherein each lobe has a partial elliptical-shaped profile having a major axis to minor axis of between about 1.04 : 1 to about 1.12 : 1, wherein each elongated void has an elliptical-shape having a major axis that is oriented at an angle β with respect to the major axis of the respective lobe, wherein the cross-section has a modification ratio of 1.7 to 2.2, and wherein the total cross-sectional area is between about 5 to 15 percent void.

2. The filament of Claim 1, wherein there are three elongated voids.

3. The filament of Claim 2, wherein there is one elongated void in each lobe.

4. The filament of Claim 1, wherein each lobe has a pair of spaced foci, wherein each void has a pair of spaced foci, and wherein one foci of the lobe and one foci of the void are positioned in substantially the same cross-sectional position.

5. The filament of Claim 3, wherein the angle β ranges from between about 0 degrees (substantially co-axial) to about 60 degrees.

6. The filament of Claim 3, wherein the angle β ranges from between about 0 degrees to about 45 degrees.

7. The filament of Claim 3, wherein at least one or more voids are oriented at a different β.

8. The filament of Claim 7, wherein the angle β for all of the elongated voids differ.

9. The filament of Claim 1, wherein the cross-section of the filament has a modification ratio of at least 2.0.

10. The filament of Claim 1, wherein the filament comprises a synthetic material selected from the group consisting of polyamide, polyester, polyolefin and acrylic.

11. The filament of Claim 10, wherein the synthetic material is selected from the group consisting of nylon 6 and nylon 66.

12. The filament of Claim 10, wherein the synthetic material is selected from the group consisting of polyethylene terephthalate (PET), polytrimethylene terephthalate (PTT), and polybutylene terephthalate (PBT).

13. A yarn comprising at least one filament comprising a trilobal cross-section and at least one elongate void, wherein each lobe has a elliptical-shaped profile having a major axis to minor axis of between about 1.04 : 1 to about 1.12 : 1, wherein each elongated void has an elliptical-shape having a major axis that is oriented at an angle β with respect to the major axis of the respective lobe, wherein the cross-section has a modification ratio of 1.7 to 2.2, and wherein the total cross-sectional area is between about 5 to 15 percent void.

14. The yarn of Claim 13, wherein there are three elongate voids.

15. The yarn of Claim 14, wherein there is one elongate void in each lobe.

16. The yarn of Claim 15, wherein each lobe has a pair of spaced foci, wherein each void has a pair of spaced foci, and wherein one foci of the lobe and one foci of the void are positioned in substantially the same in cross-section.

17. The yarn of Claim 15, wherein the angle β ranges from between about 0 degrees (substantially co-axial) to about 60 degrees.

18. The yarn of Claim 15, wherein the angle β ranges from between about 0 degrees to about 45 degrees.

19. The yarn of Claim 15, wherein at least one or more voids are oriented at a different β.

20. The yarn of Claim 18, wherein the angle β for all of the elongated voids differ.

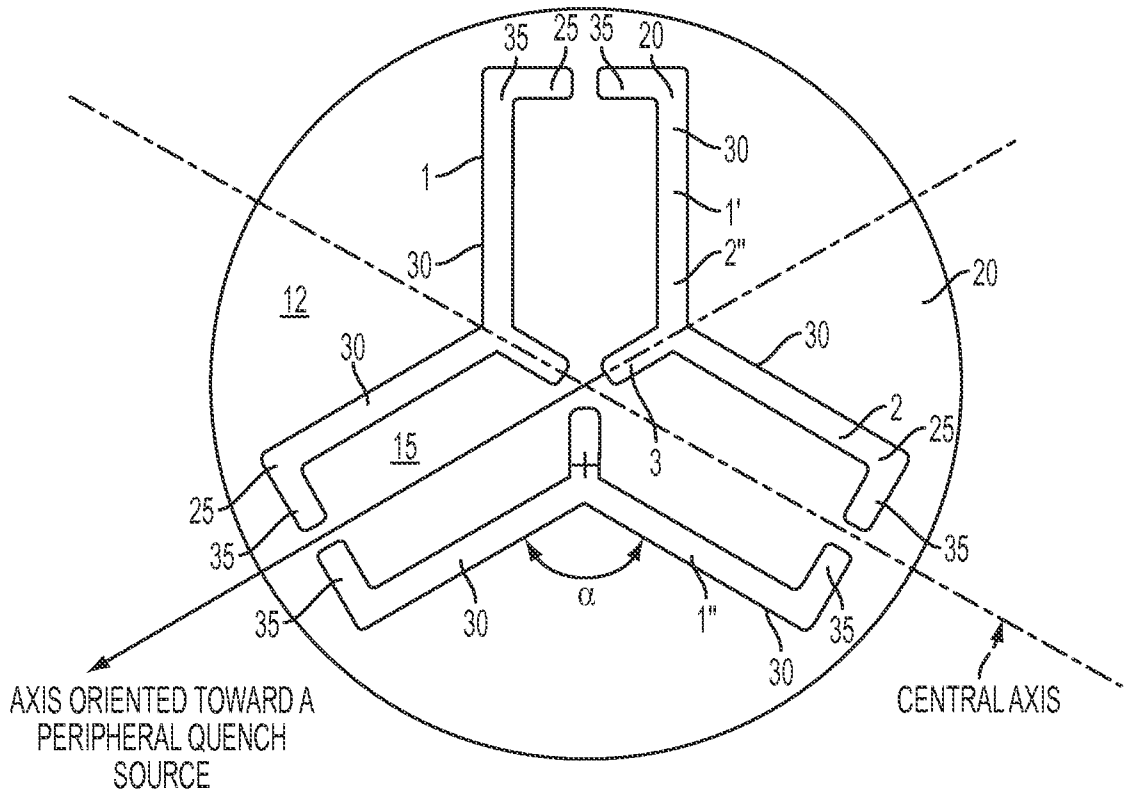

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FIG. 1

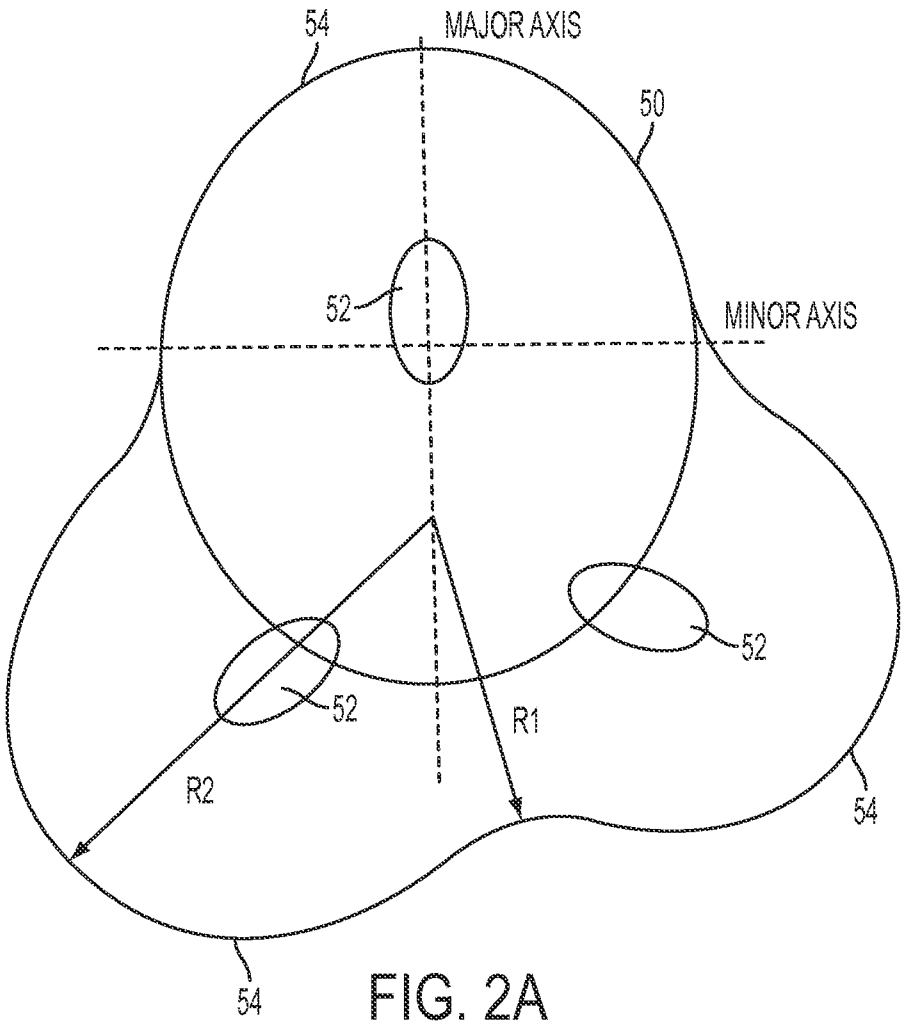

FIG. 2A

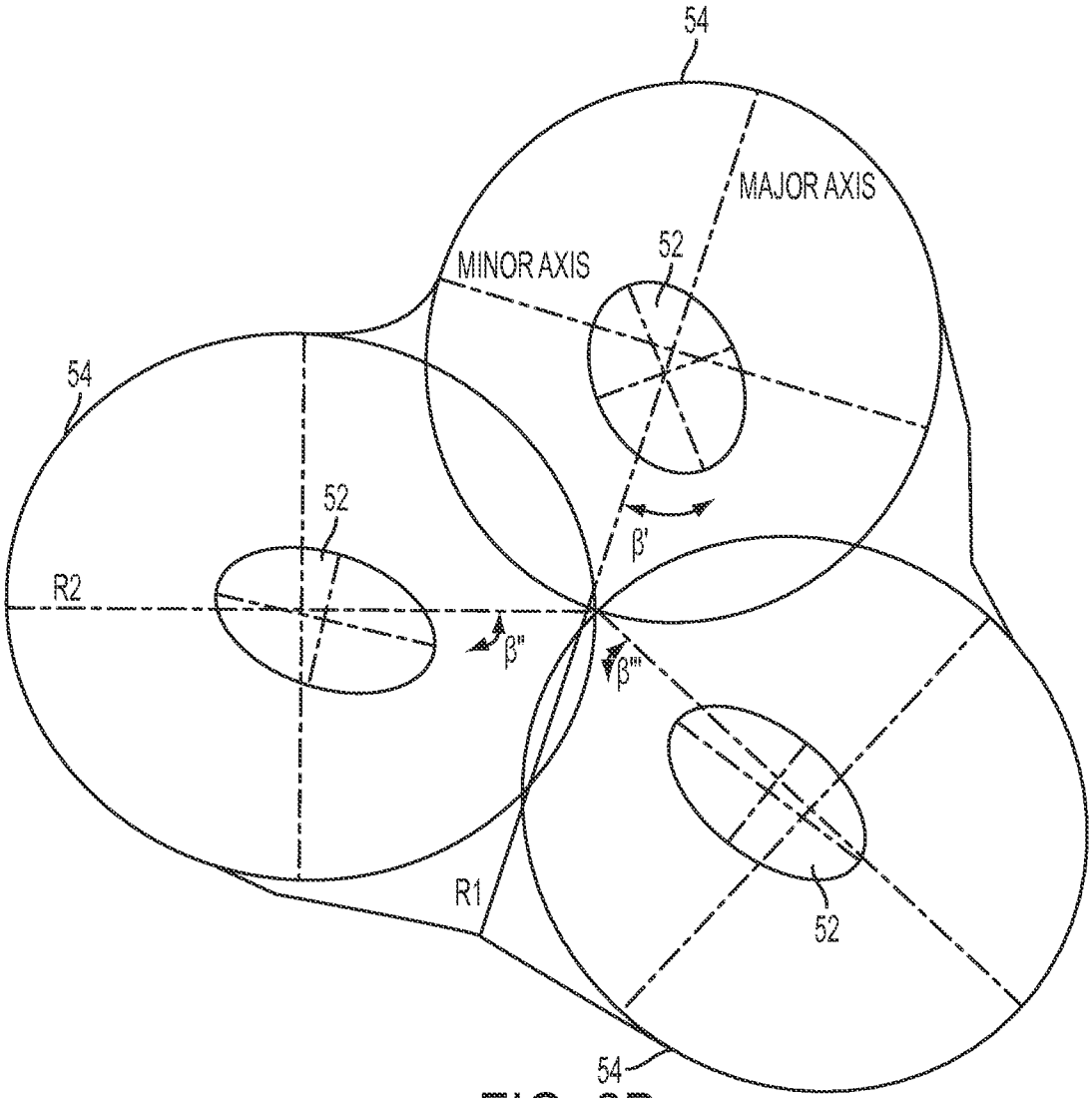

FIG. 2B

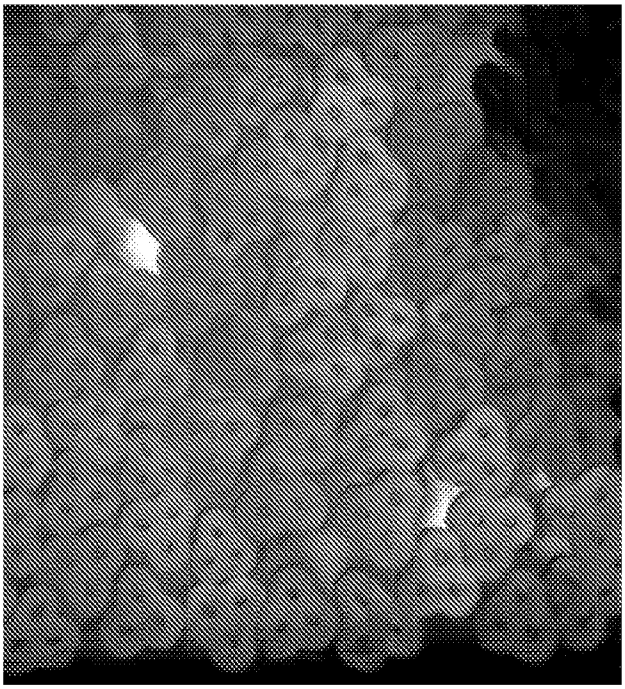

FIG. 3