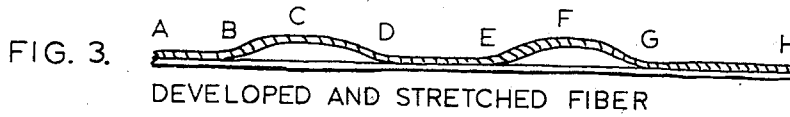
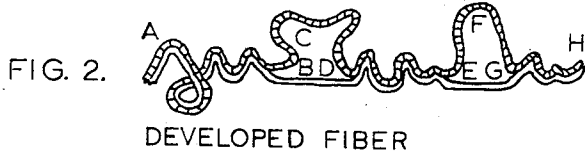
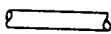


Sept. 17, 1968

J. P. KNUDSEN ET AL
BI-COMPONENT NON-ELASTIC FILAMENT, CAPABLE
OF PARTIAL SEPARATION
Filed May 21, 1964

3,402,097



HARD
POLYMER 
ELASTOMER 

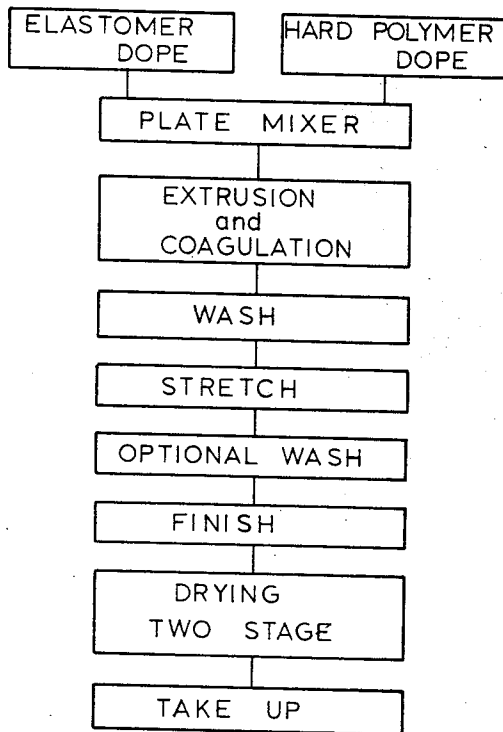


FIG. 4.

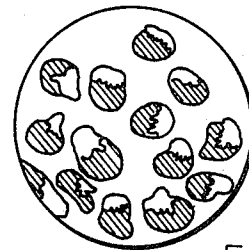
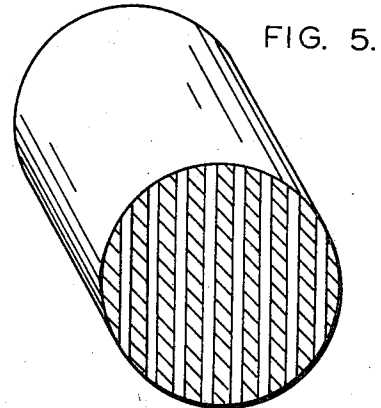
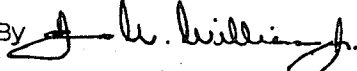


FIG. 6.

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3,402,097

BI-COMPONENT NON-ELASTIC FILAMENT CAPABLE OF PARTIAL SEPARATION

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8 Claims. (Cl. 161-177)

ABSTRACT OF THE DISCLOSURE

A composite filamentary structure of side-by-side components of hard inelastic polymeric material and an elastomer is able to retain from about 25 to 75 percent of the side-by-side structure upon subsequent treatment. Yarns and fabrics are made from the composite structure.

This invention relates to partially composite elastic fibers and filaments. The invention further relates to non-elastic staple fibers and to non-elastic continuous filaments. Included in this invention are blended staple fibers and continuous filament yarns and woven, non-woven and knitted fabrics which may be manufactured according to conventional procedures, employing conventional equipment to provide fabrics possessed of permanent elasticity and a high degree of bulkiness.

Fabrics derived from staple blends of elastomeric and hard inelastic fibers are known in the art. However, processing such a mixture or physical blend requires special procedures and equipment at almost every stage in the manufacture of yarns and fabrics. Moreover, when fabrics derived from such staple mixtures undergo repeated stretching the ends of the elastic fibers have a tendency to work out of the fabric. Thus, where repeatedly stretched and relaxed the arrangement of the elastic and hard fibers is altered with respect to one another, the result being that the fabric loses much of its original texture and elasticity. Another approach to the preparation of elastic fabrics resides in the extrusion of continuous bicomponent fibers which wholly separate into individual elastic and hard components to provide a continuous filament yarn characterized by separate inelastic filaments randomly looped and entangled about essentially straight elastomeric filaments. The continuous bicomponent filaments described in the art suffer the disadvantage that they tend to separate into their elastomeric and inelastic components when drawn. Such separation causes processing difficulties and migration of the elastomeric filaments.

A principal object of this invention is to provide a novel elastic fiber structure which retains permanent elasticity and bulk.

A further object is to provide essentially non-elastic composite fibers in both staple and continuous filament form which have a high elastic and bulk potential and which may be processed and made into fabrics using conventional methods and equipment.

Another important object of this invention resides in providing blends of the undeveloped composite fibers of this invention with other inelastic fibers commonly employed in the textile manufacturing art.

These and other objects are achieved by providing a laminated liquid structure comprising at least three alternating layers of two different synthetic fiber forming polymers one of which is a synthetic elastomeric polymer and the other of which is a non-elastomeric or hard polymer. Every polymer layer has at least one common interface with a different polymer layer. The liquid laminated polymer structure is extruded through the holes of a conventional spinnerette to provide a non-elastic filamentary

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composite or bicomponent structure comprised of at least two continuous polymeric components arranged in a continuous side-by-side relationship to one another. This structure possesses the property of permanently retaining from about 25 percent to about 75 percent of the composite or bicomponent structure upon being treated in a tensionless condition with a hot aqueous medium. When so treated a partially composite filamentary elastic structure is formed comprising at least one continuous elastic component and at least one continuous hard inelastic component wherein the elastic and inelastic components are permanently interlocked or fused in a side-by-side relationship to one another in at least two short recurring segments of the overall filamentary structure. The interlocked or fused segments are separated by short recurring segments wherein the continuous polymer components are divided or separated from one another, there being at least one separated or divided segment and at least two fused segments per staple fiber length. The cumulative length of the recurring fused segments comprise from about 25 to about 75 percent of the overall length of the elastic partially composite structure. Staple fiber and continuous filament yarns of the described filamentary structures may be blended with other staple fiber and continuous filament yarns and used in the manufacture of elastic fabrics.

By extrusion of the laminated liquid polymer structure a non-elastic composite fiber comprised of an elastomeric component and a non-elastomeric or hard component is formed which when heated in a relaxed condition provides a new and different fibrous structure developed by partial splitting of the elastomeric and inelastic components and further characterized by having short, helically crimped non-elastic fused composite segments alternating with short elastic segments where the elastomeric fiber component is separated from the inelastic component. The latter separation provides a segment of divided fiber structure wherein the length of inelastic fiber is greater than the length of the elastomeric fiber. While the development of the unique fiber structure of this invention is normally reserved until the fiber is in fabric form, it is the unique fiber structure which imparts the elastic properties to the finished product.

FIGURE 1 depicts the as-spun composite fiber of this invention in the form in which it is spun, stretched, washed, dried and otherwise processed into fabric or other end use. The as-spun fiber is characterized as a truly composite structure in that the side-by-side relationship of elastic and inelastic components and the adhesion of components along the length of the fiber have a uniform appearance.

The fiber is essentially straight, non-elastic and assumes the characteristics of a fiber spun from an inelastic polymer alone. It has been discovered that the as-spun fiber may be drawn or stretched in a hot medium such as steam or boiling water and cooled while still under tension without undergoing separation or development of elastic properties. However, after stretching if the fiber is placed in steam or boiling water for example in a relaxed or untensioned condition and then flexed a striking development occurs in the basic fiber structure. This development is depicted by the differences between FIGURES 1 and 2. The latter figure depicts a typical segment of the novel elastic fiber structure of this invention which is derived from a fiber such as that of FIGURE 1 by steam or hot water treatment in a relaxed or untensioned position. Thus, a given length of the fiber AH is no longer a straight true composite structure. Instead, the fiber length AH is comprised of truly composite, non-elastic segments such as AB, DE, and GH which possess considerable helical crimp, and in which the elastic and inelastic components remain permanently adhered or fused to each other in a side-by-

side relationship. The latter non-elastic truly composite segments alternate with segments of the overall fiber length where there is a complete separation of composite components into individual elastomeric fiber segments (BD and EG) and non-elastomeric or hard fiber segments (BCD and EFG). The fiber component segments BD and EG are highly elastic whereas the fiber component segments such as BCD and EFG provide a high degree of bulk and are essentially inelastic. When point H is pulled away from point A the fiber AH may be stretched to assume the structure such as that depicted by FIGURE 3 wherein the elastic component segments BD and EG approach the length of the inelastic component segments BCD and EFG. Then too, the crimp in the truly composite segments AB, DE and GH somewhat enhances the degree of stretch. When the tension on the fiber depicted by FIGURE 3 is released the fiber snaps back to the structure indicated in FIGURE 2.

The cumulative degree of component separation in the partially composite structure may be varied between about 25 percent and about 75 percent of the fiber length. However, cumulative separation of about 50 percent of the fiber length appears to provide the optimum characteristics in terms of degree of elasticity, permanence of elasticity and bulkiness. It is essential that there are recurring segments of component separation and truly composite segments such that there are at least two truly non-elastic composite segments per staple fiber length and at least one elastic separated segment per staple fiber length. In actual practice it has been found that the fibers of this invention normally occur with several alternating non-elastic truly composite segments and separated elastic segments per staple length. The optimum structure requires short alternating segments whether the end use requires continuous filaments of staple fiber lengths. Staple fibers of this invention have a length of from about 0.5 to 4 inches and may comprise two or more truly composite segments and at least one divided segment. The partially composite elastic fibers of this invention can be tailored to provide reversible elastic stretch of from about 50 to about 150 percent of their relaxed length. Where spandex polymers are employed as elastic components of the instant invention the degree of stretch is usually limited by the degree of separation of the hard and elastic components and the degree of shrinkage occurring during development of the fiber elastic properties. In another sense, the degree of stretch when using highly elastic polymers of the spandex type is limited to the point at which the separated spandex or elastic member is stretched to equal the length of the separated hard fiber member. This is where BD equals the length of BCD in FIGURES II and III.

In a typical case an acrylic-spandex as-spun bicomponent filament which has been given a 4X orientation stretch will shrink about 60 percent of the oriented length when the elastic properties are developed. By flexing the fiber as soon as its elastic properties are developed an initial non-elastic increase in length of about five percent occurs after which the fiber has a completely reversible stretch of about 100 percent when the cumulative degree of separation along the length of the fiber is about fifty percent.

The partially composite fiber structures of this invention are produced by extrusion of a multilayered liquid polymer structure through the orifices of a conventional spinnerette. The extruded filaments have a truly composite structure. That is, the filaments are comprised of continuous elastic and inelastic components adhered to one another in a side-by-side relationship along the length of the fiber. After coagulation the as-spun fiber may be washed to remove the traces of solvent, stretched, given a conventional finish application, then dried and taken up on rolls as depicted in the flow diagram of FIGURE IV. Throughout the initial processing there appears to be no tendency for separation of elastic and inelastic components of the as-spun composite. A composite fiber which is spun from laminated dope structure comprising an acrylic dope and an elasto-

mer dope, for example, assumes the general characteristics of an acril-nylon fiber. After the fiber is drawn or given an orientation stretch it can be treated in a hot medium in a relaxed or untensioned condition to develop the elastic partially composite structure depicted in FIGURE II. However, development of the elastic potential in commercial operation is reserved until the fiber has been fully processed to its end use. For example, a fabric comprising the undeveloped fibers of this invention might be developed in a terminal dyeing stage or at some other late stage of manufacture where the requisite conditions to develop elasticity are inherent. Thus, from a production and manufacturing point of view this invention provides a fiber which can replace or be blended with conventional staple or continuous filament yarns and processed to provide permanently elastic fabrics in the absence of special processing considerations normally found from the face of the spinnerette to the finished fabric when elastomeric fibers have been employed heretofore in the art. Such blends of the as-spun fibers with other fibers are more particularly described below.

An essential feature in the production of the novel fiber structures of this invention resides in spinning the fiber from a liquid laminated polymer structure comprising at least three alternating liquid layers of hard or inelastic polymer and elastic polymer. The liquid multilayered polymer stream can be formed in a plate mixer device such as that described in copending application Serial No. 204,707, filed June 25, 1962, now abandoned. The plate mixer device comprises two inlets through which separate streams of elastic and hard polymer are pumped. The device is further comprised of a plurality of plates through which the polymer streams flow. The multiple alternating plates contain passages through which portions of the hard polymer, for example, are fed to a mainstream in a confined passage or zone leading to the inner face of a spinnerette. From a multiplicity of other alternating plates, portions of the other polymer stream are fed into the same mainstream so that each alternating plate provides the source of a different polymer solution to the mainstream. The mainstream is formed by that portion of polymer fed from the first plate and it assumes a laminar structure as the next and succeeding plates provide additional portions of different polymer solutions. The number of alternating polymer layers is determined by the number of plates in the device. As the mainstream passes the terminal plate of the mixer device it approaches the inner face of the spinnerette through a confined passage at which stage it has a cross-section such as that depicted in FIGURE VI wherein each polymer layer has at least one common interface with a different polymer layer. The laminated structure of the liquid polymer stream formed in a plate mixer device has been determined at several points between the terminal plate of the mixer and the inner face of the spinnerette both by sectional freezing and coagulation of the mainstream wherein one of the layered solutions contained a contrasting dye. Conventionally, bicomponent fibers have been spun using a conjugate spinnerette wherein different dope solutions are separated until they reach the inner face of the spinnerette at which point both solutions are pumped through a single orifice. Conjugate spinning of this type is expensive and troublesome and it is further limited by practical consideration to spinning small fiber tows, usually less than about 500 filaments per conjugate spinnerette. The laminated polymer structures of this invention have been extruded through the orifices of conventional spinnerettes to provide from 15, for example, up to 20,000 filaments per bundle from a single spinnerette. Thus, the liquid laminated structure comprising alternating layers of elastic and inelastic polymers provides a means of greatly increasing production and ease of spinning potentially elastic bicomponent filaments not heretofore available.

Filaments ranging from about 2 to about 20 denier may

be spun by the process of this invention. Of course, the particular denier will depend on the end use as will the number of filaments per bundle.

The laminated polymer structure is usually patterned to suit the geometric arrangement of the holes in the spinnerette used. As a general rule, where the holes in the spinnerette are arranged in several concentric circles, a multi-layered or laminated dope stream comprising a number of layers equal to twice the number of circles is employed. Precise correlation of the number of dope layers to the geometric arrangement of the holes is not essential so long as a random distribution of bicomponent filaments is extruded. Accordingly, other patterns may be devised in a particular case by increasing or decreasing the number of plates in the mixer device.

In the preparation of the polymers to be used in this invention care should be taken that the solvent used for one polymer does not coagulate the other polymer. Otherwise, conventional solutions using the same solvent or solvents which are miscible in one another can be used. For example, when an acrylic polymer is used, dimethylacetamide may be used as a solvent in the preparation of dopes for both elastic and inelastic polymers. On the other hand, different solvents such as dimethylacetamide and dimethylformamide or dimethylsulfoxide may be employed. Selection of suitable solvents will depend on the nature of the particular hard and elastic polymers used in a given case and may be determined readily by those skilled in the art. If desired, different spinning conditions may be employed. For example, a spandex component may be melt spun while the hard component is dry spun.

Coagulation of the extruded bicomponent filaments can be accomplished by conventional wet or dry spinning means and will depend on the method best suited for the particular composite fiber in a given case, the number of filaments spun, the spinning speeds and other such considerations known to those skilled in the art. For example, where the fiber contains an acrylic component the filament may be extruded into an aqueous bath containing up to 80 percent of the solvent or extrusion may be made in a bath of polyethylene glycol having a molecular weight of around 1000. It has been found that where elastic and inelastic bicomponent fibers are spun there is a distinct tendency, particularly in large filament bundles and in high denier filaments, for the individual bicomponent filaments to marry or become cemented together. In this respect care should be taken to provide thorough coagulation followed by washing to remove residual solvents. After washing, the coagulated filaments are given an orientation stretch of from about two to about six times the length of the washed fiber. After stretching the bicomponent filaments they may be optionally subjected to a washing with water.

It has been found highly desirable to apply a conventional textile lubricant or finish of the type described in Canadian Patent No. 573,234. The application of about two percent of such finish composition not only lubricates the filaments, but also gives them a soft hand and antistatic properties. Before taking up, the filaments should be dried by passing them over a heated roll or by other means. It has been discovered that marrying or cementation of the individual bicomponent filaments is appreciably lessened if they are dried under tension in two stages, the first stage being conducted at a temperature of from about 75° to about 110° C. and a second stage immediately following the first stage at from about 115° to about 145° C. The dried filaments, usually in the form of a multifilament tow, are wound on take-up rolls to await further use.

It will be recognized that the treatment of the as-spun fiber of this invention as above described is wholly conventional with the exception of two stage drying to lessen cementation of individual bicomponent filaments. However, because of the elastic potential of the bicomponent fiber of this invention, care should be taken that it is not

subjected to conditions which promote development of elasticity during the early processing as above described.

While the hard and elastic distribution in a multifilament bundle spun according to the invention corresponds precisely to the amounts of hard and elastic polymers fed to the plate mixer device, there is a random weight distribution and spatial arrangement of components from fiber to fiber in a given bundle. This random distribution and spatial arrangement of elastic and hard polymer components is in contrast to the uniform distribution characteristic of components prepared using conventional conjugate spinning techniques. To provide an elastic multifilament bundle the overall elastic polymer content should be from about 5 to 70 percent by weight of the total polymer content. However, it is preferred to employ the elastic polymer in concentrations of from about 25 percent to about 35 percent of the overall polymer weight. Notwithstanding the random weight distribution of elastic and hard polymer in the fibers of a multifilament bundle, a large number of fibers will contain a weight distribution which is rather closely related to the overall weight distribution so that the significance of the overall weight ratio is not lost because of the wide variation in weight ratio from fiber to fiber.

It has been noted that the interface between polymer components of filaments spun by the method of this invention is irregular as depicted in FIGURE VI and while it is not intended that this invention be founded on, or limited by, any particular theory of operation it is believed that the permanent, recurring fused segments found in the developed fiber of this invention may result at least in part from the recurring influx of alternating polymer solutions as the mainstream passes the multiplicity of plates in the mixer device coupled with an almost imperceptible blending or fusion of the different polymer dopes at their common interfaces prior to reaching the inner face of the spinnerette. Theories relating to the dope structure as a source for the unique developed structure of this invention have been considered because bicomponent fibers spun using a conventional conjugate spinning system and otherwise processed under the same conditions as described herein do not exhibit the ability or property to permanently retain a partially fused structure. On the contrary, conjugate spun elastic-hard bicomponent filaments tend to split completely along the length of the filament even in the drawing or stretching stage.

As previously indicated the as-spun fibers of this invention assume the characteristics of a fiber spun from the hard fiber alone. They have essentially no reversible stretch and they are not crimped. As in the case of conventional hard fibers it is frequently desirable to impart a degree of mechanical crimp to enhance processability. The as-spun non-elastic filaments are readily converted to staple by conventional cutting means.

The straight or mechanically crimped non-elastic, bicomponent, staple fibers may be readily blended with conventional textile fibers such as acrylic, nylon, polyester, rayon, cotton, wool, and the like to provide elastic potential to fabrics manufactured from such blends. The amount of the novel staple fiber blended will, of course, depend on the stretch potential of the bicomponent fiber and also upon the degree of stretch desired in the fabric. For example, a stretch fabric to be used in a garment wherein 30 to 35 percent reversible stretch is desired may be woven from a yarn which is a blend comprising about 30 percent by weight of the as-spun staple fiber which has been tailored to provide about 50 percent separation when developed and about 70 percent by weight of a fiber prepared from a co-polymer of acrylonitrile. In the manufacture of a woven fabric, the potentially elastic fiber of this invention may be employed in warp or fill, or both warp and fill, in the same or different concentrations to provide the type and degree of stretch desired in each direction.

The versatility in use of the novel structures extends to knitted, woven and non-woven articles.

The terms "hard" or "inelastic" and "elastic" or "elastomeric" as applied to polymers, fibers and fiber components are given their art recognized meaning as described in U.S. Patent 3,111,805.

For example, a "hard" fiber is defined herein as one which possesses less than about 10 percent reversible elongation and an "elastic" fiber is intended to include those elastic fibers which possess greater than about 75 percent reversible elongation. Thus, the hard fibers of this invention may be selected from conventional inelastic synthetic fiber forming polymers including condensation polymers and addition polymers well known for textile fiber application such as polyamides, polyesters, polyester amides, polyurethanes, and polyureas, as well as addition polymers such as polyolefins, polyethers and polymers of acrylonitrile. The preferred hard fibers are those prepared from polymers comprising at least 85% acrylonitrile and up to 15% olefinic comonomers such as vinyl acetate, vinyl pyridine, vinyl benzene, sulfonic acids, methyl acrylate, methyl methacrylate, vinyl chloride, vinyl-idene chloride, vinyl bromide and the like. The spandex type elastomers comprise the preferred elastic materials for use as the elastic component in the manufacture of the novel structures of this invention. These materials are well known in the art and exemplified in U.S. Patent No. 3,097,192, U.S. Patent No. 3,115,384, U.S. Patent No. 3,111,805 and copending application Ser. No. 410,709, now abandoned. Other useful elastic materials may be selected from acrylate elastomers or the synthetic rubber type polymers well known in the art.

The choice of polymers selected for hard and elastic components can be determined by the physical characteristics of their fibers and while the novel structure here includes a broad variety of hard and elastic polymers, the use of the spandex-acrylic combination is preferred because of their excellent fiber forming characteristics as are well recognized in the art.

The following examples illustrate several specific embodiments of the described processes employed in the preparation of the novel fibers, yarns and fabrics. Proportions are by weight unless otherwise indicated.

EXAMPLE I

A spandex elastomer designated Elastomer A was prepared in a two-step process by reacting 254 parts of methylene diphenyl diisocyanate in 416 parts of dimethylformamide (DMF) solvent with 1000 parts of a copolyesterdiol, derived from a mixture comprising 80% caprolactone and 20% methyl caprolactone, having a molecular weight of approximately 2000 (mole ratio of diisocyanate to diol being 2:1) to form a "prepolymer" condensation product terminated with isocyanate groups. The thus formed prepolymer in solution was added to a solution of 11.9 parts of hydrazine hydrate in 1750 parts of DMF to provide a solution of Elastomer A having a viscosity of 10,600 cps. at 25°C.

A copolymer prepared by polymerization of 93 parts of acrylonitrile and 7 parts of vinyl acetate in the presence of a redox catalyst was dissolved in dimethylacetamide (DMAc) to provide a 25% solution of copolymer. This solution of copolymer and the solution of Elastomer A were separately metered through Zenith pumps to a plate mixer device so that 3 parts of copolymer were fed to the device for every part of Elastomer A. At the terminal plate of the plate mixer device the laminated mainstream of liquid polymers comprised 18 layers of acrylonitrile copolymer, each of which was separated by a layer of Elastomer A solution. The laminated mainstream was pumped to a 1,000 hole/3.5 mil spinnerette and extruded into a coagulation bath wherein the filaments were coagulated at 35°C. in water containing 40% DMAc. The coagulated filament bundle was washed, given an orientation stretch of 4X in boiling

water, washed again and then passed through a finish bath. The drawn fiber was then dried on steam-heated rolls at 120°C. and wound on bobbins.

Composition of the 1000-filament tow as a whole was 75% hard copolymer and 25% Elastomer A by weight. The yarn as-spun was straight and non-elastic much like conventional acrylic fiber. Physical properties of the tow (1000 filament, 3 d.p.f.) were: tenacity approximately 1.9 grams per denier, elongation 11 to 12%.

A 100 cm. length of the as-spun yarn was relaxed under tensionless conditions in boiling water for 60 seconds. The bicomponent filaments became highly crimped upon exposure to hot water. After being dried, the boiled-off yarn was pulled out manually to approximately 90% of its original length and tension was then released. This procedure produced a very bulky elastic yarn which was found to be reversibly extensible to about 1.9 times its untensioned length.

A 25-pound quantity of the undeveloped as-spun bicomponent tow was given a light mechanical crimp and then was fed into a high-speed rotary cutter to produce 3½-inch staple fiber. This operation was performed without difficulty and staple of uniform length was obtained without premature separation of the spandex and acrylic components in the filaments. The staple was suitable for textile processing into spun yarn.

The undeveloped bicomponent fiber in staple form was combined with 3 d.p.f. staple prepared from a copolymer of acrylonitrile and vinyl acetate in a 30:70 bicomponent to copolymer fiber weight ratio to give a blend containing 7.5% of the elastomeric polymer component. The staple blend was then processed into worsted yarn through the steps of carding, gilling, roving, and spinning. Processability of the staple blend was satisfactory at all stages without modification of procedures or equipment normally employed for all-acrylic yarns.

The staple yarns obtained by worsted spinning are described in Table I. Before development the yarns had conventional appearance and properties; they were inelastic and had no tendency to bulk. After being relaxed in boiling water, each yarn was transformed into a moderately elastic structure which could be reversibly stretched.

TABLE I

Property	Spun Yarn		
	1	2	3
Worsted yarn number.....	1/45	1/45	1/45
Twist, turns per inch.....	18	14	13
Tenacity, grams/denier.....	1.0	1.1	1.1
Breaking elongation before development, percent.....	11.0	11.1	11.4
Elongation after development:			
Reversible (elastic), percent.....	17	12	15
Total (at break), percent.....	36	22	21

The yarns described in Table I were used (before being developed) to prepare fabrics of various types, both woven and knitted.

A 2/1 twill fabric of open construction was woven using Yarn 1 in the warp and Yarn 2 in the filling, the thread count on the loom being 40 warp ends x 30 picks per inch. This twill fabric was non-elastic as it was taken from the loom. Its latent stretch properties were readily developed by shrinking the fabric in boiling water; a stretchable fabric was obtained having good covering power, a soft hand, and reversible elongation of 25% in the warp and filling directions.

A plain-weave fabric was woven using Yarns 1 and 2 in the warp and filling, respectively, the thread count on the loom being 40 ends x 60 picks per inch. As in the case of the twill woven fabric, the greige taken from the loom exhibited no elastic stretch. However, after development in boiling water, a stretchable fabric was obtained having stretch potential of about 25% in both directions.

Twenty-cut jersey fabric was knitted from Yarn 3. The

fabric after dyeing and finishing (including a napping process), possessed not only good stretchability, but also exhibited excellent stretch recovery properties, both characteristics being superior to those found in a conventional all-acrylic knitted fabric.

EXAMPLE II

A spandex elastomer designated Elastomer B was prepared in a two stage process by reacting 254 parts of methylene diphenyl diisocyanate in 416 parts of DMAc with 1000 parts of a co-polyester diol derived from a mixture comprising 80 percent caprolactone and 20 percent methyl caprolactone having a molecular weight of approximately 2000 (mole ratio of diisocyanate to diol being 2:1) to form a "prepolymer" condensation product terminated with isocyanate groups. The thus formed solution was then reacted with 31.8 parts of carbodihydrazide in 2,490 parts of DMAc to yield a solution of Elastomer B having a viscosity of 85,000 cps. at 25° C.

The solution of Elastomer B and the solution of the copolymer of Example I were then spun and processed following the procedure given in Example I including a single stage drying step. To compare the effect of a two-stage drying step a portion of the laminated polymer dope was spun and the filaments were processed according to Example I through the application of the finish after which the filaments were passed over a first set of steam heated Godet rolls at 90° C. and then passed over a second set of heated rolls at 130° C. to dry the filaments. The filament tow dried under two-stage conditions was observed to contain considerably fewer marred or cemented filaments than the tow dried in a single stage. Fiber samples prepared according to the preferred technique of this example had a tenacity of 1.9 grams per denier and an elongation of 17 to 18%. When treated with boiling water without tension and flexed the fibers became highly crimped and partially split along their length to provide a bulky elastic structure.

EXAMPLE III

Example II was repeated using the two-stage drying step with the exception that Elastomer B was co-spun as in Example I with a hard copolymer blend comprising equal parts of a copolymer of acrylonitrile and vinyl acetate and a copolymer of acrylonitrile and methylvinylpyridine to give a fiber with a tenacity of 1.8 grams per denier and an elongation of 9 to 11%.

EXAMPLE IV

Example II was repeated with two stage drying except the elastomer B was co-spun with a hard terpolymer comprising acrylonitrile, vinyl acetate and p-methallyloxy benzene sulfonic acid as in Example I to give a fiber with a tenacity of 1.9 grams per denier and an elongation of 17 to 18%.

EXAMPLE V

Example II was repeated employing the two stage drying step with the exception that 1000 parts of a copolymeric polyesterdiol, derived from a mixture of 80% caprolactone and 20% methyl caprolactone, have a molecular weight of approximately 2000 was reacted with 365 parts of methylene diphenyl diisocyanate in 341 parts of DMAc solution (mole ratio of diisocyanate to diol being 3:1) to give a "prepolymer" solution terminated with isocyanate groups. This prepolymer solution was added to a solution of 64.3 parts of carbodihydrazide in 2,925 parts of DMAc to give an elastomer solution (designated elastomer C) having a viscosity of 60,000 cps. at 25° C.

Elastomer C and the terpolymer of Example IV were co-spun as in Example I to give a fiber with a tenacity of 1.90 grams per denier and an elongation of 18 to 20%.

EXAMPLE VI

Example II was repeated with two stage drying except that 1000 parts of a polyesterdiol derived from caprolactone and having a molecular weight of approximately 2800 was reacted with 220 parts of methylene diphenyl diisocyanate in 590 parts of DMAc (mole ratio of diisocyanate to diol of 2.5:1) to give a "prepolymer" solution terminated with isocyanate groups. This "prepolymer" solution was added to a solution of 26.3 parts of carbodihydrazide in 2740 parts of DMAc to give an elastomer solution (designated Elastomer D) having a viscosity of 97,000 cps. at 25° C.

Elastomer D and the terpolymer of Example IV were co-spun as in Example I to give a fiber with a tenacity of 1.50 grams per denier and an elongation of 15 to 16%.

EXAMPLE VII

Example VI was repeated using the preferred drying step with the exception that 17 grams of ethylene diamine was substituted for the carbodihydrazide used in Example VI and 2730 grams of DMAc was employed to give an elastomer solution (designated elastomer E) having a viscosity of 64,000 cps. at 25° C.

Elastomer E and the terpolymer blend of Example IV were co-spun as in Example I to give a fiber with a tenacity of 1.8 grams per denier and an elongation of 11 to 15%.

EXAMPLE VIII

Example VII was repeated with the exception that a homopolymeric polyesterdiol derived from caprolactone with a molecular weight of approximately 1400 was employed instead of the 2800 molecular weight homopolymer employed in Example VI. This polyesterdiol was reacted with 440 parts of methylene diphenyl diisocyanate in 776 parts of DMAc (mole ratio of diisocyanate to diol of 2.5:1) to give a "prepolymer" solution terminated with isocyanate groups. This prepolymer was added to a solution of 72.6 parts of carbodihydrazide in 3400 parts of DMAc to give an elastomer solution (designated elastomer F) having a viscosity of 50,000 cps. at 25° C.

Elastomer F and the terpolymer blend of Example IV were co-spun as in Example I and dried in two stages to give a fiber with a tenacity of 1.7 grams per denier and an elongation of 15 to 17%.

Yarns prepared from the fibers prepared in each of Examples II-VIII showed no signs of premature component splitting during processing. Upon development excellent partial separations were achieved to provide bulky highly elastic yarns.

The fibers of this invention may be used in the manufacture of lightweight stretch fabrics possessing a wide variety of stretch properties. Useful application of the stretched fabrics include foundation garments, underwear, suits, dresses, ski pants, gloves, half-hose, sweaters, garters, belts and the like. Other such specific uses will readily occur to those skilled in the art and the above description is not intended to limit the invention beyond the scope of the claims.

We claim:

1. A non-elastic filamentary composite structure comprised of at least two continuous polymeric components adhered in a continuous side-by-side relationship to one another, one of said components being a synthetic polymer capable of forming a hard inelastic fiber, the other of said components being a fiber forming elastomer having a reversible elongation of greater than 75 percent, said structure having the property for permanently retaining from about 25 percent to about 75 percent of the composite side-by-side structure upon being treated under tensionless conditions in a hot medium.

2. A non-elastic staple fiber yarn comprising the structure of claim 1 in staple fiber lengths.

3. A non-elastic continuous filament yarn comprising the structure of claim 1 as a continuous filament.

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4. An elastic partially composite filamentary structure comprised of at least two continuous polymer components one of said polymer components being an elastomer having a reversible elongation of greater than 75 percent, the other of said components being a hard inelastic polymer, said elastomer and said hard inelastic polymer components being permanently fused in side-by-side relationship to one another in at least two short recurring segments of the overall filamentary structure, said fused segments being separated by short recurring segments wherein said continuous polymer components are separated from one another, there being at least one separated segment and at least two fused segments per staple fiber length, the cumulative length of said recurring fused segments comprising from about 25 percent to about 75 percent of the overall length of said elastic partially composite filamentary structure.

5. The structure of claim 4 wherein the weight of the

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elastomer component comprises from about 5 to about 70 percent of the total weight of the structure.

6. The structure of claim 5 wherein the hard inelastic component is a polymer containing acrylonitrile.

7. An elastic yarn comprising the structure of claim 4 in staple fiber lengths.

8. A continuous filament elastic yarn comprising the structure of claim 4.

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