Aug. 12, 1969 G. B. FEILD 3,460,337

SYNTHETIC YARN AND METHOD OF MAKING THE SAME

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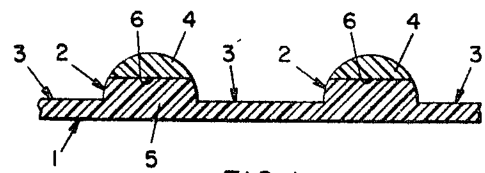

FIG. 1

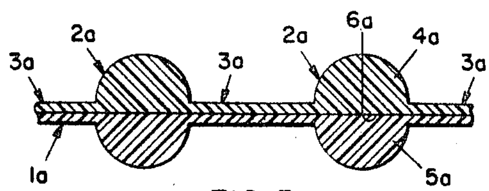

FIG. 5

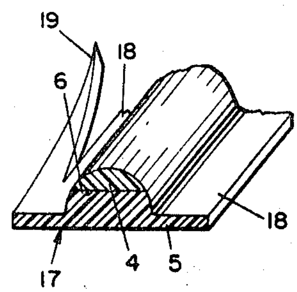

FIG. 4

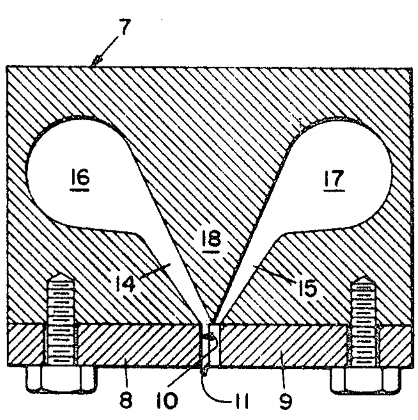

FIG. 2

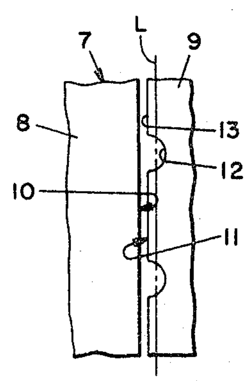

FIG. 3

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SYNTHETIC YARN AND METHOD OF MAKING THE SAME

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a synthetic yarn produced by the fibrillation of a conjugate striated plastic film, whereby the proportions of the two different materials in the film can be readily controlled to provide control of the bulk level obtained in the filaments and wherein the one material can be confined to strips disposed in spaced parallel relation along the striations and thus need not be split to effect fibrillation of the film. This material can therefore be one that is normally not fibrillatable but has other desired properties such as tensile strength, bulk, abrasion resistance, low melting point, etc.

The present invention relates to a composite synthetic yarn and to a method of making the same. More particularly, the present invention relates to a conjugate synthetic yarn, that is, one made of two components that are joined together at an interface, wherein the two components are formed of different polymers or of different forms of the same polymer.

Conjugate yarns have heretofore been produced, see for example the U.S. patent of Beck No. 2,901,770. These yarns have been produced by extrusion of the individual filaments through a single die orifice fed by separate sources of the two different polymers. In comparison with filaments produced by the fibrillation of film as noted below, the equipment for making conjugate filaments in this manner is relatively costly and difficult to operate and to maintain, and the filaments so produced are relatively expensive.

Fibrillation of films of plastic material by slitting, brushing, drawing, twisting, impingement of a fluid jet, or other mechanical expedients have also been known, see for example the patent of Wininger et al., No. 3,214,-899. There are also illustrations in the prior art of a yarn made by the fibrillation of a striated ribbon of thermoplastic material, see for example the patent of Gaston, No. 3,164,947, and the patent of Annesser, No. 2,728,950, and the pending application of Hall and Kim, Ser. No. 674,332, filed Oct. 10, 1967. With striated film, the valleys or grooves define lines of weakness along which fibrillation occurs so that in contrast to yarn produced by the fibrillation of flat or unstriated film, the individual filaments as well as the yarn itself are more uniform and the yarn is stronger and, because of the continuity of the filaments, does not require twist to develop its strength. It is known that continuous filaments produced from striated film may also be interconnected in a net-like structure or be made to include fibrils or side fins extending laterally from the filaments and imparting to the yarn a spun-like appearance and a soft hand, or increased cover, bulk, or resilience, and may also have a wide range of orientation levels to adapt the yarn for different uses.

Despite the fact that conjugate filaments and the fibrillation of striated films of plastic materials have been known, there have been no instances in the prior art in which conjugate filaments have been made by the fibrillation of a striated conjugate film. In accordance with this invention, it has been found that not only can conjugate filaments be made relatively simply and inexpensively in this manner, but they can also be formed with the relative proportions of the two polymers controlled and from polymers which, because of their inherent or induced properties such as tear resistance, could not otherwise be used.

The objects of this invention are to provide a conjugate filament and method of making it that are relatively inexpensive, but will provide continuous and thus strong filaments that are relatively fine and uniform and can be made with laterally projecting fibrils which, when a yarn of such filaments is processed into a fabric for example, will impart to the fabric a spun-like appearance and a soft hand. Further objects of this invention are to provide filaments formed by fibrillation of a film composed of a combination of two different plastic materials selected for specific properties or characteristics and one of which may normally be incapable of being fibrillated.

The above objects have been achieved by providing a yarn and a method of making it wherein the yarn is formed by the fibrillation of a striated film that is composed of two different plastic materials that are joined together in unmixed layers. With materials having different characteristics when heated to a shrink-inducing temperature, the filaments are self-crimping. By varying the relative proportions of the two different materials, different effects can be achieved, for example, by forming the web portion of the film, that is, the lateral interconnecting portion between adjacent filaments, entirely of one material that can be readily fibrillated, the other material can be selected for other desired physical properties such as low melting point, strength, toughness, bulk density, moisture absorption, dyeability, or fire-retardant properties; even though it may not be normally or readily fibrillatable. With a film that forms side fibrils upon fibrillation, the side fibrils may also be made self-bulking by making the lateral interconnection or webs between the adjacent filament of forming portion of the film of lamina of both materials.

Further objects of this invention will be evident from an understanding of the preferred embodiments hereinafter described in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary view in cross section of a conjugate film made in accordance with this invention.

FIG. 2 is a cross sectional view of a die in accordance with this invention and adapted to extrude the film of FIG. 1.

FIG. 3 is a fragmentary face view of the die opening at the bottom of the die of FIG. 2.

FIG. 4 is a view in perspective and in cross section illustrating a filament produced by the fibrillation of the film of FIG. 1.

FIG. 5 is a view similar to FIG. 1, but illustrating a conjugate film having a different configuration and in which the ratios of the two plastic materials is varied from that of the film of FIG. 1.

With reference to the drawings, there is disclosed in cross section in FIG. 1 a narrow section of a striated film **1** made in accordance with this invention. The film **1** comprises an alternating arrangement of ribs **2** that are disposed generally in spaced parallel relation and are interconnected laterally by webs **3**. The film **1** is formed of two different polymeric materials defining a minor component **4** at the top of the ribs **2** and a major component **5** that includes the remaining portion of the ribs **2** and the webs **3**, with interfaces **6** between the components.

The film **1** may be produced by the simultaneous extrusion of the two materials through a single film die **7** such as illustrated in cross section in FIG. 2. As illustrated, the die 7 comprises opposed die lips 8 and 9 having opposed die surfaces 10 and 11 that are shaped to define a die opening between them that conforms to the desired cross section of the extruded film. While the particular configuration of the die surfaces is not critical, the illustrated embodiment comprises grooves 12 (FIG. 3) in the die surface 11 that forms the ribs 2 of the film and flats 13 separating the grooves 12 and disposed in spaced parallel relation to the flat face of the die surface 10 to define a slot that forms the webs 3 of the film.

The molten polymeric materials are directed to the die opening by passages 14 and 15 from the headers 16 and 17. The passages 14 and 15 are separated by a divider 18 that tapers downwardly to a relatively sharp point at the top or input of the die opening, which point is represented by the line L in FIG. 3. The polymeric materials are metered positively in the desired proportions such as by a conventional metering pump (not shown) to provide a steady feed of the film from the die lips. By varying the feed ratios of the two materials, the relative proportions of the two materials in the film can be varied. The one material in the film may be only at the minor sections 4 of the ribs 2 as in FIG. 1, or may be substantially half of the film including both the ribs 2 and the webs 3 as illustrated in FIG. 5 wherein the film 1*a* has ribs 2*a* and webs 3*a* and wherein the two components of the film are designated 4*a* and 5*a* with the interface 6*a*. FIG. 5 also illustrates an alternative configuration for the film that is characterized by the ribs extending from both surfaces of the webs rather than from the one face as shown in FIG. 1.

After extrusion, the film 1 is melt drawn to reduce the thickness and the spacing of the ribs 2 and the width and thickness of the webs 3. The film 1 is then, in the usual manner, cooled to effect crystallization, reheated to its orientation temperature, and drawn to effect uniaxial orientation in the direction lengthwise of the ribs 2. Orientation improves the strength characteristics of the film in the direction of the axis of orientation and also reduces the tensile strength in the direction transverse to the axis of orientation so that the film can be readily fibrillated or split into individual filaments such as the filament 17 shown in FIG. 4. Since the webs 3 are generally weaker than the ribs 2, splitting occurs essentially in the webs 3 along the edges 18. Thus, upon fibrillation of the film 1, the resulting filaments are continuous and correspond generally to the ribs 2.

Fibrillation may be accomplished in any of the known methods of reducing a film to filaments such as by working the film mechanically, or by fluid jets, or ultrasonically, or spontaneously by drawing the same at a high ratio. In accordance with the invention of the above noted patent application of Hall and Kim, Ser. No. 674,332, fibrillation of a film having a web 3 such as shown in FIG. 1 can produce a plurality of short fibrils 19 formed from the webs 3 and extending laterally from the edges of the ribs 2.

When the filament 17 is heated to a temperature that will produce shrinkage of one of the components 4 or 5 of the filament 17 or a differential shrinkage of both components, it begins to curl and thus assumes a self-imposed crimp or bulk. The different materials to produce differential shrinkage may be for example a propylene homopolymer and a propylene/ethylene copolymer, or polypropylene of two different molecular weights.

In the same manner as the fibrillation of homogeneous striated film, the advantages of the present invention are that the filaments in accordance with this invention are less expensive to produce when compared with filaments that are extruded as individual strands, and are finer and more uniform when compared to filaments formed by the fibrillation of flat or non-striated film. In the same manner as conjugated filaments, because of the differential shrink characteristics, the filaments in accordance with this invention also have the advantage of self-crimping. In contrast to conjugate filaments formed by the extrusion of the filaments as individual strands, which requires a separate feed channel for each of the two materials to each of the spinnerette holes, the advantages in the cost and maintenance of the equipment and in achieving uniform high quality products is particularly significant.

In addition to the above advantages associated with the fibrillation of striated film and with conjugate filaments, the present invention has the additional advantages of providing for convenient control of the relative proportions of the two different materials. By adjustment of the feed ratios of the materials by adjustment or, when appropriate, by substitution of a different set of die lips for the die lips 8 and 9, which in effect laterally shifts the line L in FIG. 3, the two materials in the film can be readily varied between the ratios such as illustrated in FIGS. 1 and 5. With the ratio of FIG. 1, the component 4 constitutes only strips running along the crown of each of the ribs 2 so that, upon fibrillation of the film, the component 4 is not separated. Thus, the component 4 can be selected for some desired property such as tensile strength, bulk, or abrasion or frictional properties even though the material may be amorphous or for some other reason may not ordinarily be fibrillatable. The fibrils 19 in such an arrangement are all of the same material and thus are not self-crimping as the filament itself. On the other hand, with filaments formed from film as in FIG. 5, the fibrils are also self-crimping. In needle punched non-woven fabrics formed from staple fibers, the crimped side fibrils become entangled in the structure and greatly improve strength and tear resistance. Another effect that is obtainable in non-woven fabrics is that the section 4 may be, for example, an amorphous material with a low melting point, such as an ethylene/propylene copolymer, whereby the fabric may be bound into a coherent mass by subjecting the same to heat and pressure sufficient to bond the amorphous material at each crossing point. Control of the relative proportion of the two materials is also significant in color control where the two materials are colored differently to provide a color blend in the ultimate filament.

One of the most significant advantages obtained by the present invention is in the degree and uniformity of the crimp produced in the filaments. Crimping produced in conjugate filaments by differential shrinking of the two materials is helical in nature and, in any filaments in which the proportions of the two materials are constant, is a function of the moment of inertia of the filament. Conjugate filaments that are relatively large in cross-sectional area have minimum bulking characteristics and, as the area of cross-section is reduced, bulking increases. Uniform bulking is therefore dependent upon uniformity of cross-section areas of the filaments, both along the length of each individual filament and between the different filaments. In comparison with yarns produced by the fibrillation of flat film and which have significant variations in the width of the filaments and thus in the cross-sectional area of the filaments, those formed from striated film are essentially constant in cross-section between filaments and within each filament and, therefore, a more uniform bulk is obtained.

While the film mentioned above was produced by the simultaneous extrusion of the two polymeric materials through a common die for making a composite striated film, the film can be made by other processes. A composite striated film can also be produced for example by scoring or embossing a composite flat film that was formed by simultaneous extrusion, by coating one extruded film with another film from a solvent solution or water dispersion, by extrusion coating, by extruding the material in the form of strands onto a preformed film of the other material, or by laminating two films by heat or pressure or by an adhesive. With laminated films for example, the two different materials may comprise the same polymer but at different orientation levels.

The present disclosure deals primarily with continuous yarns. However, it will be obvious that the filaments may be chopped into staple fiber that is used for example in making staple yarn or non-woven fabrics.

What I claim and desire to protect by Letters Patent is:

1. A yarn consisting of a plurality of conjugate synthetic filaments formed by fibrillation of a striated uniaxially oriented ribbon having a plurality of laterally interconnected ribs extending in spaced parallel relation in the direction of the axis of orientation, said filaments corresponding substantially to a rib of the ribbon and having opposed side edges along which the filaments are separated from the adjacent filaments in the ribbon, said filaments having a transverse cross section that is substantially uniform along the length thereof and that has a minimum thickness at the opposed side edges and a maximum thickness intermediate the opposed side edges, said filaments being characterized in that it is formed of two plastic materials which, in the transverse cross section of the filament, are joined at an interface providing a first component formed of one of the materials at one face of the filaments and extending transversely of the filament continuously from one of the opposed side edges to the other and a second component formed of the other of the materials at the other face of the filament.

2. A yarn in accordance with claim 1 in which the filaments are interconnected by a plurality of fibrils to form a net-like structure.

3. A yarn in accordance with claim 1 in which the filaments are separated and have a plurality of protruding side fibrils.

4. A yarn in accordance with claim 1 in which said second component extends transversely of the filament continuously from one of the opposed side edges to the other.

5. A yarn in accordance with claim 1 in which said second component comprises an essentially non-crystalline polymeric material.

6. A yarn in accordance with claim 1 in which said second component has a relatively low melting point whereby a plurality of like filaments are adapted to be joined in a nonwoven fabric by adhesion of said second components.

7. A method of making conjugate continuous filaments of plastic material comprising providing a striated ribbon having a plurality of ribs disposed in spaced parallel relation and laterally interconnected by webs having reduced thickness relative to the ribs, uniaxially orienting the ribbon in the direction endwise of the ribs, fibrillating the ribbon by splitting the same along the webs to provide filaments corresponding to said ribs and having portions of the webs extending laterally from the ribs to side edges along which the filaments were separated from the adjacent filaments in the ribbon, said method being characterized in that the ribbon is formed from two components of different plastic materials, joined at an interface extending longitudinally of the filament, the first of said components being at one surface of the filament and extending transversely of the filaments continuously from one of said side edges to the other and the second of said components being at the other surface of the filament.

8. A method of making conjugate continuous filaments of plastic material in accordance with claim 7 in which said second component extends transversely of the filament continuously from one of the side edges to the other.

9. A method of making conjugate continuous filaments of plastic material in accordance with claim 7 in which said second component extends only along said ribs and said webs are formed only of said first component.

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JOHN PETRAKES, Primary Examiner

U.S. Cl. X.R.

28—72; 57—155, 157; 161—177, 168