

Jan. 30, 1968

TOYOKAZU MATSUMOTO ET AL

3,365,873

METHOD OF TREATING A COMPOSITE FILAMENT

Filed July 26, 1965

FIG. 1

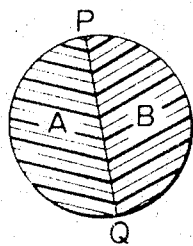


FIG. 2

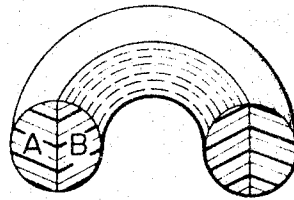


FIG. 3

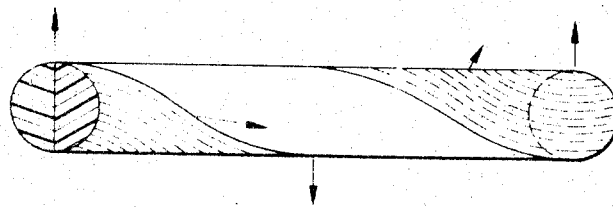
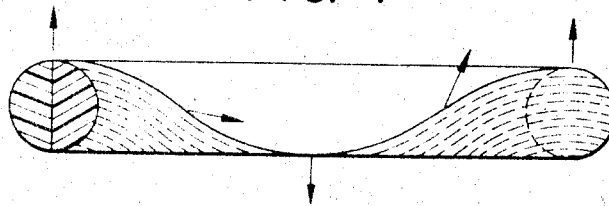


FIG. 4



1

2

3,365,873
**METHOD OF TREATING A COMPOSITE
 FILAMENT**

**Toyokazu Matsumoto, Osaka-shi, and Masao Matsui,
 Osaka-fu, Japan, assignors to Kanegafuchi Boseki
 Kabushiki Kaisha, Tokyo, Japan**

Filed July 26, 1965, Ser. No. 474,773
 Claims priority, application Japan, Sept. 26, 1964,
 39/55,372

12 Claims. (Cl. 57—157)

The present invention relates to a method of manufacturing knitted fabrics, and more specifically, to a method of manufacturing knitted fabrics having an excellent stretchability and an even surface appearance, which consists of imparting a twist or a false-twist to a composite filament comprising two adherent different components of synthetic thermoplastic linear polymer with different shrinkabilities disposed in a side-by-side or eccentric sheath-core relation with respect to each other in the cross-section of the filament and knitting fabrics from said filament.

It is well known that stretchable knitted fabrics are obtained by the use of crimped filaments. Likewise, knitted fabrics having a high stretchability may be obtained also by the steps: first manufacturing knitted fabric with fibers having potential crimpability and thereafter developing crimps in the fibers in said knitted fabric. For filaments with potential crimpability mentioned in the above, so-called composite filaments may be used. The composite filament is obtained by simultaneously, spinning through an orifice, two different polymers having different shrinkabilities. This filament develops crimps by the application of a suitable after-treatment, for instance, a swelling or heating treatment. When knitted fabrics are manufactured with composite filaments and by subsequent crimp development process, however, many of such fabrics, especially those made with monofilaments, present irregular or uneven stitches. This is a phenomenon which is caused by the shrinking of the filaments or by the development of crimps in filaments. This phenomenon is known in terms of "creping" or "wrinkling." Such development of creping greatly affects the aesthetic appearance of finished knitted fabrics.

In view of the foregoing problems in the knitted fabrics made from composite filaments, it is an object of the present invention to obtain knitted fabrics made from composite filaments which have an even and well-balanced superficial appearance as well as an excellent stretchability. More specifically, the present invention is characterized in that the composite filaments to be used are given a twist or a false-twist to such extent that the conjugate phase relative to the length of filaments necessary for forming a unit stitch (hereinafter to be referred to as unit stitch length) may be turned by at least 20 degrees, in average, and preferably 30 degrees or more around the axis of the filament, before the filaments are knit into fabrics.

The objects and advantages of the present invention may be more clearly understood by reference to the following detailed description including selected embodiments when considered with the drawings in which:

FIG. 1 is a cross-sectional view of a composite filament;

FIG. 2 shows a composite filament in crimped state; FIG. 3 is a side elevational view of a twisted composite filament; and

FIG. 4 is another side elevational view of a twisted composite filament.

The terms "conjugate phase" hereinabove used means the direction in which the two components forming a filament are disposed. In other words, in FIG. 1 of the drawings which shows a cross-section of a side-by-side

two-component filament having a circular cross-sectional configuration, the straight line P-Q represents the boundary line formed by the two components A and B. The direction of the said boundary line perpendicular to the axis of the filament is called the conjugate phase. For example, when the locations of the two components A and B in the cross-section of a composite filament are exchanged with each other, the phase has turned by 180 degrees. In the same way, the conjugate phases of various types of two-component filaments in which the two components are eccentrically disposed may be defined. When the shrinkability of the component B is greater than that of component A in FIG. 1, the filament will bend with the component B placed inside of the bends, by the application of heat-treatment, as shown in FIG. 2. If the conjugate phase of the said two-component filament was changed along the length of the filament, the filament would curl in a different direction with respect to the three-dimensional space. In other words, the direction in which the filament will curl may be regarded as the conjugate phase.

Now, if the composite filaments forming several stitches aligned in adjacent relationship either in a wale or in a course of a knitted fabric have the same conjugate phase, and especially when the plane of the surface of the knitted fabric lies in parallel with the boundary plane of two components in the side-by-side composite filaments, the filaments will invariably curl in the same direction, developing, as a result, a wavy contour on the surface of the knitted fabric. This phenomenon is more often noted of mono-filament fabrics as a matter of fact, but not often in multi-filament fabrics.

In order to accomplish the objects of the present invention, the filaments composing a knitted fabric have to be processed so that the conjugate phase of the filaments may be forcibly distributed with substantial uniformity in all directions in three-dimensional space by giving the filaments a twist, the angle of which is at least 20 degrees in average, and preferably 30 degrees or more per unit stitch length. If there is a change of 30 degrees in the conjugate phase of one unit stitch, the total amount of the changes in the phase for three adjacent stitches will be 90 degrees, and as a result, there will develop hardly any appreciable undulations of stitches in the knitted fabric. It is usually not necessary, however, to change the phase to an extent of more than 360 degrees per unit stitch length. In the present invention, the change of the conjugate phase of a filament is imparted by a twisting or false-twisting process. When a certain length of filament is turned or twisted by one complete revolution, the phase of the filament has been changed by 360 degrees. In the case of false-twisting, however, the number of twists given to a filament as a whole is zero, but the filament still carries twisted portions and reversely twisted portions locally thereof, and thus the filament is given a sufficient amount of change in phase. In the case of false-twisting, the amount of locally existing twists is calculated as a value per unit stitch length. Namely, in the case of false-twisting, the total amount of the changes in conjugate phase in the length of the filament, including S-twists and Z-twists, is obtained by aggregating the absolute values of changed phases. The mean may be obtained by dividing the total amount by the length of the filament.

FIG. 3 shows a composite filament after being twisted. FIG. 4 shows the same filament which has undergone false-twisting. Respective arrows show the progress of changes in the conjugate phase. As is obvious from the drawings, the twist in FIG. 3 and the false-twist in FIG. 4 may be considered to present the same effect. The amount of the changes in conjugate phase in both cases, which

is obtained according to the foregoing method, is 360 degrees respectively. Twists and false-twists need not be uniformly distributed throughout the length of the filament. The objects of the present invention may be attained by arranging the conjugate phase in such fashion that the phase may be reversed at every 3 to 4 stitches, and preferably at every two stitches or one stitch.

The size of the stitches in knitted fabrics for wear are usually restricted within a certain range. In many cases, the length of filaments constituting one unit stitch is in the range from 0.5 mm. to several millimeters. In seamless hosiery for ladies, for example, the unit stitch length is in the range of 0.5-3 mm., approximately. Therefore, the objects of the present invention may be accomplished by giving the filaments to be used an amount of twist of at least 50 t./m. (turns/meter).

A false-twist may be given to a filament by the following steps. Namely, the filament is first twisted. This twisted filament is treated with heat either by dry heating or wet heating to fix the twist therein. Then the processed filament is further given a reverse twist so that apparently the filament has been untwisted. By reason of the mutual actions between the primary fixed twist and the subsequent untwisting, the amount of local twist which was discussed above will be determined. Therefore, a highly effective local twist accruing from the twisting and false-twisting will be obtained by selecting the various conditions for twist-fixation as required. In general, the objects of the present invention may be attained by first twisting the filament to an extent of at least 100 t./m., subsequently fixing the twist, and then applying substantially equal amount of reverse twist to the filament. This false-twisting permits removal of residual torque in the filament, if any, by further heating the filament. The present invention is particularly effective for the manufacture of ladies' seamless stockings having even and uniform superficial appearances. The present invention is most effective for the manufacture of knitted fabrics with certain types of stitches which are: plain knitting of basic type and its modified types. The present invention is also effective for mesh knitting, run-proof knitting and other types of knitting, of which the surface conditions are highly improved.

Since the objects of the present invention are accomplished by distributing the conjugate phase of filaments in multiple directions in a knitted fabric or fabrics in such manner as has been described, the effect of this method is most remarkably displayed in fabrics knitted with mono-filaments. The surface of fabrics knit with multi-filaments is observed to be considerably even, because there is realized a distribution of conjugate phase in the multi-filaments themselves. In many cases, however, if the method of the present invention is used in knitting fabrics with multi-filaments, their uniformity in appearance will be further enhanced.

Now, some examples of the present invention will be described. In these examples, polyamide composite filaments are used. It is to be understood, however, that the present invention is not restricted only to such filaments. It should be obvious that composite filaments comprising any sort of polymers may be used in the method of the present invention so long as the filaments are of the type which can develop crimps.

EXAMPLE 1

Polycaproamide and a polymer obtained by polymerizing 15 parts of hexamethylene diammonium terephthalate and 85 parts of ϵ -caprolactam in an atmosphere of nitrogen gas at 260° C. were simultaneously spun together through an orifice to form a side-by-side type filament with the conjugation ratio of 1:1 by volume. The filament was then drawn at normal temperature to a length 4.4 times its original length, and thus a mono-filament of 15 deniers was obtained. A part of the filament thus obtained was given a twist of 20 turns per meter,

and another part of the filament was given a twist of 170 turns per meter. After fixing the twists in an oven at 70° C. for 10 minutes, the two parts of the filament were respectively placed on knitting machines to knit the leg portions for women's seamless hosiery. The superficial appearance of the stitches after knitting did not differ in any degree from that of ordinary nylon hosiery. These knitted specimens were treated with saturated steam at 110° C. for 5 minutes under relaxed conditions to develop crimps therein. After the fabrics were dyed, they were placed on ordinary aluminium boards, and were set at 120° C. for 45 seconds in saturated steam with subsequent drying and cooling. Thus, seamless hosiery having high stretchability were obtained. The unit stitch length was 1-2 mm. In the case of the fabric knit with filaments having a twist of 170 turns per meter, the changes of phase provided for said filaments were noted to be 60-120 degrees per unit stitch length, which showed that a satisfactory effect of the present invention was obtained.

EXAMPLE 2

A copolymer obtained by copolymerizing 4 parts of a salt of nylon 66 and 6 parts of a salt of nylon 610 and having an intrinsic viscosity of 0.94 in metacresol at 30° C. and nylon 66 with an intrinsic viscosity of 0.31 under the same conditions were simultaneously spun together through an orifice at the conjugation ratio of 1:1 by volume to form a unitary filament, and after drawing the obtained filament to a length 4.4 times the original length at 105° C., a mono-filament of 15.3 deniers was obtained. This filament was given a false-twist of 1,500 turns per meter at heater temperature of 140° C. at the first feeding rate of minus 3% on the CS-3 type false-twister manufactured by Ernest Scragg & Sons Limited, England, and then the filament was passed in contact with an aluminium plate heated at 120° C. for 0.3 second at the second feeding rate of minus 1% to erase the residual torque, and was wound up on a reel. The filament thus obtained was knit into a stocking in the same manner as mentioned in Example 1. The stocking so obtained was found to have excellent stitch formation, marvelous elastic properties and was wrinkle-free and superior to stockings made from composite filaments which were not given false-twists.

EXAMPLE 3

A copolyamide having an intrinsic viscosity of 1.29 was prepared by polymerizing a mixture of 90 parts of ϵ -caprolactam and 10 parts of hexamethylene diammonium terephthalate in an atmosphere of nitrogen gas at 270° C. for 6 hours. This copolyamide and nylon 6 having an intrinsic viscosity of 1.0 were simultaneously melt-spun together through a common orifice at the conjugation ratio of 1:1 by volume to form a side-by-side type composite filament. The spun filament was drawn to a length 3.9 times as long as the original length at room temperature, and a mono-filament of 15 deniers was obtained. The same filaments thus obtained were given twists of 20 t./m., 40 t./m., 60 t./m., 80 t./m., 100 t./m., 120 t./m., 150 t./m. and 220 t./m. respectively. These twisted filaments were wound up on aluminium bobbins respectively. After heating the filaments at 70° C. for 15 minutes to fix the twists thereof, leg portions of stockings were knit with these filaments respectively on a 400-needle Scott and Williams, hosiery knitting machine manufactured by the Scott and Williams, Inc., Laconia, N. H. The superficial appearances of the knitted fabrics were uniform and showed no difference from ordinary seamless stockings. The stocking fabrics thus knit were treated in saturated steam at 107° C. without tension for 15 minutes to develop crimps therein. After drying, the fabrics were placed on ordinary aluminium boards to be set in saturated steam at 118° C. for 45 seconds. After drying and cooling, the fabrics were removed from the boards, and thus stretchable stockings were obtained. Those fabrics made with filaments given twisting of more than 60 t./m. showed improved degree

of evenness of the surfaces, and that of 100 t./m. showed perfectly wrinkle-free surface. Those of 120 t./m. or more did not show an effect much superior to the fabric of 100 t./m. These findings are completely consistent with the theory of distribution of conjugate phase described previously in this specification.

EXAMPLE 4

A bundle of 5 mono-filaments of 15 deniers which were the same as those used in Example 3 was given a S-twist of 1,500 t./m. and was wound up on an aluminium bobbin. The bobbin was placed in saturated steam at 70° C. for 20 minutes to fix the twist of the filament. After drying, the bundle of filaments was given reverse twist (Z-twist) of 1,500 t./m. By fixing the reverse twists in the same manner, local twists were resulted in each filament. The bundle of the filaments were separated into five mono-filaments. These mono-filaments were knit into leg portions of seamless stockings in the same manner as was described in Example 3. The obtained stretchable stockings exhibited remarkably even superficial appearances.

What is claimed is:

1. A method comprising manufacturing stretchable knitted fabrics having an even surface appearance from composite filaments constituted of two different adherent components of synthetic thermoplastic linear polymers with different shrinkabilities, each filament having a tendency to curl and form a wavy contour along its length, said method including the steps of twisting said filaments prior to knitting therewith to produce at least a 20° turn of the conjugate phase of the filament per length of filament corresponding to the unit stitch length of the fabric to be knit to prevent curling of the filament, knitting the thus twisted filaments into fabric having the predetermined stitch length, and heating the thus knitted fabric to develop three dimensional crimps in the filaments thereof.

2. A method as claimed in claim 1 wherein the twist of the phase is periodically reversed.

3. A method as claimed in claim 1 wherein the twist of the phase is periodically reversed every 3 to 4 stitches.

4. A method as claimed in claim 1 wherein the twist of the phase is periodically reversed every one to two stitches.

5. A method comprising manufacturing stretchable knitted fabrics having an even surface appearance from composite filaments constituted of two different adherent components of synthetic thermoplastic linear polymers with different shrinkabilities, each filament having a tendency to curl and form a wavy contour along its length, said method including the steps of twisting said filaments prior to knitting therewith to produce at least 50 turns per meter of filament to prevent curling of the filament, knitting the thus twisted filaments into a fabric wherein the filaments have a unit stitch length between 0.5 mm. and 3 mm., and heating the thus knitted fabric to develop three dimensional crimps in the filaments thereof.

6. A method comprising manufacturing stretchable knitted fabrics having an even surface appearance from composite filaments constituted of two different adherent components of synthetic thermoplastic linear poly-

mers with different shrinkabilities, each filament having a tendency to curl and form a wavy contour along its length, said method including the steps of false twisting said filaments prior to knitting therewith to produce alternating twists in the conjugate phase of each filament, each said filament having a sum of the absolute values of the twists which is at least 20° per length of the filament corresponding to the unit stitch length of the fabric to be knit to prevent curling of the filament, knitting the thus false twisted filaments into fabric having the predetermined stitch length, and heating the thus knitted fabric to develop three dimensional crimps in the filaments thereof.

7. A method comprising manufacturing stretchable knitted fabrics having an even surface appearance from composite filaments constituted of two different adherent components of synthetic thermoplastic linear polymers with different shrinkabilities, each filament having a tendency to curl and form a wavy contour along its length, said method including the steps of imparting a twist to said filament of at least 100 turns per meter, heat-setting the twist of said filament, applying to the said filament substantially same amount of reverse twist as the first said twist to produce local turns of the conjugate phase of the said filament of which the sum of the absolute value of the twists is at least 20° per length of the filament corresponding to the unit stitch length of the fabric to be knit thereby to prevent curling of the filament, knitting the thus twisted filament into fabric having the predetermined stitch length and heating the thus knitted fabric to develop three-dimensional crimps in the filaments thereof.

8. A method comprising treating a composite filament to enable the filament to be knit into a fabric having an even surface appearance and substantial stretchability, said filament being composed of two adherent components of synthetic linear thermoplastic polymers having different shrinkabilities and joined along a conjugate phase, the filament having a tendency to curl and form a wavy contour along its length, said method including the steps of twisting the filament to orient the conjugate phase in differing directions along the length of the filament.

9. A method as claimed in claim 8 wherein said conjugate phase is continuously twisted in one direction.

10. A method as claimed in claim 9 wherein said conjugate phase is twisted in an amount about 50 turns per meter.

11. A method as claimed in claim 8 wherein said conjugate phase is alternately twisted in opposite directions.

12. A method as claimed in claim 11 wherein the sum of the absolute values of alternate twists is about 50 turns per meter.

References Cited

UNITED STATES PATENTS

2,881,504	4/1959	Billon.	
2,931,091	4/1960	Breen	28-72
3,009,312	11/1961	Seem et al.	57-157
3,192,295	6/1965	Settele	264-171
3,264,705	8/1966	Kovarik	28-72

LOUIS K. RIMRODT, *Primary Examiner.*