TEXTILE YARN HAVING MOISTURE WICKING AND ANTI-MICROTBIAL PROPERTIES

Inventors: Joe O'Mara JR., Haverford, PA (US); Keith Reece, Hickory, NC (US); Franco Tajana, Gaffney, SC (US); Gangadharu Thulahalli, Hickory, NC (US)

Correspondence Address:
ALSTON & BIRD LLP
BANK OF AMERICA PLAZA
101 SOUTH TRYON STREET, SUITE 4000
CHARLOTTE, NC 28280-4000 (US)

Publication Classification

Int. Cl.
D02G 3/00 (2006.01)

U.S. Cl. .................................................. 428/364

ABSTRACT

A polymeric textile yarn having both moisture wicking and anti-microbial properties, and wherein the yarn is produced by a melt spinning process where an anti-microbial agent, and possibly also a colorant, are intimately admixed with the resin in the extruder. Also, the spinneret used in the spinning process includes a large number of minute cross-shaped openings which act to impart a non-regular cross section to the extruded filaments. The non-regular cross section causes voids to be formed between adjacent filaments when the filaments are gathered together to form a yarn, and the voids serve to wick moisture from the body of a wearer when the yarn is incorporated in a body garment. The yarn may include elastic filaments which are intermingled with the extruded filaments.
TEXTILE YARN HAVING MOISTURE WICKING AND ANTI-MICROBIAL PROPERTIES

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to a yarn having moisture wicking and anti-microbial properties and which is useful in the production of body garments, such as athletic socks and underwear, which come into direct contact with the body of the wearer.

[0002] In the production of such garments, numerous yarn constructions have been proposed which are designed to wick moisture away from the skin of the wearer to thereby cool the body and provide improved comfort during either normal wear or athletic performance. DuPont’s Coolmax® polyester fiber yarn is one example of a commercially available yarn which achieves this function. Specifically, the fibers of the Coolmax® yarn have four longitudinal grooves along the length of each fiber which serve to move water moisture along the fibers and away from the skin of a wearer by capillary action, note FIGS. 2 and 3 of U.S. Pat. No. 5,152,014 which illustrate the configuration of a Coolmax® fiber.

[0003] It has also been proposed to topically apply an anti-microbial agent to a yarn, or to a finished body garment, with the agent being formulated to kill bacteria and eliminate odor, note for example U.S. Pat. No. 5,416,929.

[0004] It is an object of the present invention to provide an improved yarn construction, and to a method of fabricating the same, which serves to effectively wick moisture from the body of a wearer, and which also incorporates an anti-microbial agent which effectively kills bacteria and minimizes odor.

[0005] It is also an object of the invention to provide a yarn having both wicking and anti-microbial properties, and which also has sufficient bulk to impart a desirable degree of softness to a body garment which incorporates the yarn.

[0006] It is still another object of the invention to provide a yarn having highly stable anti-microbial properties, and which may also incorporate a highly stable colorant.

SUMMARY OF THE INVENTION

[0007] The above and other objects and advantages of the invention are achieved by the provision of a yarn which is fabricated by a melt spinning process which includes extruding a polymeric melt through a spinneret having a plurality of openings, and so as to form a plurality of downwardly advancing filaments. The openings in the spinneret having a cross section which is configured to impart a non-regular cross sectional configuration to the advancing filaments.

[0008] The advancing filaments are gathered together to form an advancing multi-filament yarn, and with the non-regular cross section of the filaments serving to cause voids to be formed between adjacent filaments which serves to wick moisture from the body of a wearer when the yarn is incorporated in a body garment. The advancing yarn is then wound into a package.

[0009] The melt comprises a mixture of a polymer or a copolymer and an anti-microbial agent, and may also include a colorant. Thus both the anti-microbial agent and the colorant are intimately mixed in the polymeric melt prior to the extrusion step, and this results in the ingredients being dispersed and held within the interior of the extruded filaments of the yarn. This in turn provides the resulting yarn with a greatly improved stability of both ingredients, as compared to a yarn which has the ingredients topically applied.

[0010] To improve the bulk of the yarn and thus the softness of the fabric into which it is incorporated, the yarn may be subjected to a texturing process, such as a friction false twisting texturing operation. During such friction texturing operation, the operating parameters should be controlled so as to not distort the unique non-regular cross section of the filaments. Specifically, the heater temperature, the tension ratio across the friction unit, and the draw elongation, should all be controlled as further described below.

[0011] Also, in order to provide improved wicking properties, it is desirable to design the openings in the spinneret so as to extrude filaments in the range of 2 dpf (denier per filament) or less.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Some of the objects and advantages of the present invention having been stated above, others will appear as the description proceeds, when considered in conjunction with the accompanying schematic drawings, wherein

[0013] FIG. 1 illustrates a melt spinning operation which may be utilized in the practice of the invention;

[0014] FIG. 2 is a highly enlarged view of one of the openings in one of the spinnerets illustrated in FIG. 1;

[0015] FIG. 3 is a highly enlarged cross sectional view of a filament after having been extruded through the opening of FIG. 2, and shown after the filament has “blossomed” to form four outwardly directed bulbous protrusions;

[0016] FIG. 4 is an enlarged cross sectional view of the filaments after they have been gathered to form a yarn;

[0017] FIG. 5 illustrates a friction false twist operation which may be utilized in the practice of the invention;

[0018] FIG. 6 is a schematic representation of a process for achieving a two color heather effect in the finished yarn; and

[0019] FIG. 7 is a view of an athletic sock of the type adapted to incorporate the yarn of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] FIG. 1 of the drawings schematically illustrates a melt spinning operation which may be employed in the practice of the present invention. As illustrated, a polymeric resin, such as a polyester or a nylon resin, or a copolymer, is delivered to a heated extruder where it is melted and mixed with an anti-microbial agent. A particularly satisfactory anti-microbial agent is sold under the trademark Alphasan® by Milliken & Company of New York, and comprises a silver based agent. The amount of the agent added to the resin is preferably in a range above at least about 1% by weight.
A conventional pigment based colorant is added to the extruder so as to produce solution dyed filaments. As will be apparent, the colorant may be any one of a wide variety of colors, depending on the end use for the yarn being produced.

In the embodiment illustrated in FIG. 1, the extruder feeds two spin pumps, and each spin pump feeds three spin packs. Each spin pack includes a spinneret which has a plurality of openings there-through and so as to form a plurality of downwardly advancing filaments which pass through an annealing zone and then a quench zone where the initially molten filaments are subjected to a transverse cooling airstream and solidify.

The annealing zone, which is sometimes referred to as the delay quench zone, comprises the area immediately below each spinneret and extending to the quench zone. Thus the filaments are not subjected to any appreciable cooling airstream in the annealing zone. Also, the annealing zone should extend only a short distance in the case of the present invention, so as to maintain the cross sectional shape of the filaments as further described below. As a specific example, the annealing zone should extend not more than about 6 inches below the spinneret.

In one embodiment of the invention, sufficient tension is applied to the filaments as they advance through the quench zone, to partially orient the polymer before it solidifies to form a partially oriented yarn (POY), which typically has a residual elongation of 115% to 145%.

The filaments are then gathered to form an advancing yarn, and a finish is applied at the roller. Each yarn is then wound to a package via an industry standard traversing mechanism which is indicated by the double arrows in FIG. 1. As is conventional, the yarn may be air entangled before it is wound, for the purpose of facilitating further processing.

FIG. 2 illustrates a preferred configuration for the openings in each spinneret. Each opening has the general configuration of a cross, with each leg of the cross being in the form of an arrow. In one specific embodiment, each spinneret has 136 such openings, and each side of the outline of the opening as indicated by the letter A in FIG. 2 measures about 0.59 mm. The width B of each leg is about 0.047 mm. The length C of each side of the head of each arrow measures 0.17 mm, and the width D of each side of the arrow measures about 0.05 mm.

With the openings of a size and configuration as described above, it is possible to extrude filaments which are in the fiber weight range of 2 dpf or less. Such fine filaments provide improved wicking properties in the finished fabric or garment in which the yarn of the invention is incorporated.

Prior to the solidification of the filaments in the quench zone, the melt tends to “blossom” into the clover-like configuration illustrated schematically in FIG. 3. More particularly, each leg of the cross-shaped initial configuration tends to expand into an outwardly extending bulbous protrusion. The result is a non-regular outline which is defined by four such protrusions.

When the filaments are gathered to form the yarn as schematically indicated in FIG. 4, the bulbous protrusions form voids between adjacent filaments of the yarn, which effectively serve to wick moisture from the body of the wearer when the yarn is incorporated in a body garment which is worn next to the skin.

In order to maintain the configuration of the filament cross section as described above during the melt spinning process, the following parameters are desirable, with the values within the indicated ranges depending upon the particular polymer or copolymer being processed. The spinning speed, i.e., the speed of the winding operation, should range between about 2500-3500 m/min. The spinning temperature in the extruder should be about 300 to 50°C above the melt point of the polymer or copolymer being processed. The transverse air flow in the quench zone should be between about 0.15 to 1.15 m/sec.

The POY yarn produced in the manner described above achieves the objects of the present invention for many end uses. However, in order to increase the bulk of the yarn, and thus the softness of the fabric which incorporates the yarn, the POY yarn packages may be heat treated in a texturing operation, such as the friction false twist texturing process shown schematically in FIG. 5. In the illustrated process, the POY yarn is withdrawn from the package and guided across a first feed shaft, then serially through a heater, along a cooling plate, and then through a friction unit. From the friction unit the yarn is guided by a second feed shaft, so as to define a draw zone between the first and second feed shafts, which is controlled by the relative rotational speeds at which the shafts are driven.

The friction unit may be of the type illustrated in U.S. Pat. No. 6,212,867, the disclosure of which is incorporated by reference, and it typically comprises three parallel shafts mounted at the corners of an equilateral triangle, with each shaft mounting one or more friction discs which engage the advancing yarn. In the case of the present invention, the number of friction discs should be as few as possible so as to maintain the cross sectional configuration of the yarn by minimizing the amount of twist. The use of a total of 3 to 6 friction discs in the unit has been found to be suitable for this purpose.

Optionally, the yarn next passes through an air jet nozzle, which serves to intermingle the filaments and which is useful in the case of certain two component yarns as described below or warp yarns. The yarn is then advanced by a third feed shaft which is used in association with the air jet nozzle to control the tension in the nozzle. The yarn then advances through a set heater, and from the heater, the yarn is advanced to a take up station where it is wound into a package in a conventional manner.

As schematically illustrated in FIG. 5, a second yarn, such as the elastic polyurethane fiber yarn sold under the designation Lycra®, optionally can be introduced upstream of the second feed shaft so that the elastic yarn and the primary yarn are intermingled in the air jet nozzle to form a two component yarn.

It has been discovered that certain operating parameters should be maintained in the described false twist texturing operation in order to maintain the unique non-regular cross sectional configuration of the filaments.
Specifically, the number of friction discs 41 in the friction unit 38 should be limited as indicated above. Further, it has been found that the draw imparted to the advancing yarn in the draw zone should be sufficient to impart an elongation of between about 30% and 36%. Also, the heater 35 should be controlled or have a length so as to not heat the advancing yarn to a temperature above about 180°C, and the tension ratio measured across the friction unit should be about 1.0 or greater.

In the melt spinning process as shown in FIG. 1, a single extruder 10 delivers the melt to both spin pumps 12, 13 so that all of the yarns are of a uniform color and composition. If it should be desired to simultaneously produce yarns of different colors or compositions, it would be possible to feed each of the two spin pumps from a separate extruder, with the extruders being supplied with different colors or other ingredients.

FIG. 6 illustrates a process where yarns of different colors are plied together, with the plied yarn being textured for example by a process as shown in FIG. 5. A heather-like yarn may thus be produced, which is composed of a blend of the two colors.

FIG. 7 illustrates an athletic sock 54, which can advantageously incorporate the yarn of the present invention. For example, the yarn of the invention may be knitted to form 100% of the sole portion of the sock, or the yarn of the invention may be knit together with a conventional yarn to form the sole portion, with the conventional yarn being in an amount and composition which does not interfere with the wicking capabilities of the yarn of the invention. As will be apparent, the yarn of the invention may be advantageously incorporated in many other body garments, such as underwear.

The following is a specific example of the process of the present invention and the resulting yarn.

The melt supplied by the extruder 10 comprised a polyester resin, to which was added Alphasan™ anti-microbial agent in an amount equal to about 1% by weight. A conventional pigment based colorant was added in an amount equal to about 1.5% by weight. The melt was extruded and processed to form a 270/150/136 POY yarn, which was wound into a package 26.

The openings 18 in the spinneret 16 were of the configuration and size as described above with respect to FIG. 2, and the cross section of the filaments 19, when viewed under a microscope, exhibited a non-regular, bulbous outline very similar to that as shown in FIG. 3. Also, the filaments 19 were in the micro fiber range, having a weight of about 1 denier per filament.

The POY yarn 24 was then withdrawn from the package 26, and textured in a process as indicated in FIG. 5 (without introducing a second yarn), with the parameters of the process being maintained within the limits described above.

The resulting yarn was then conventionally knit to form 100% of the sole portion of an athletic sock, which exhibited the desired wicking and anti-microbial properties, and a desirable softness.

As an alternative to producing a POY yarn by the process and apparatus described above with respect to FIG.

1, a flat yarn, which is also commonly called a fully oriented yarn (FOY) or a spin draw yarn (SDY), may be fabricated so as to embody the invention. Such a flat yarn is typically made in a single or multi-stage process, and is defined as having a residual elongation of between about 10% and 75%. Also, the apparatus of FIG. 1 could be employed to produce such a yarn by adding several pairs of godet draw rolls so as to be positioned immediately upstream of the traversing mechanism. Heat may be applied to cause the yarn to have a temperature from ambient to about 180°C, such as by heating the godet draw rolls or utilizing a separate heating tube, and while maintaining a spinning speed of 3800 to 6500 m/min. The resulting flat yarn can achieve the benefits of the present invention without subsequent texturing or bulking in the case of certain end uses.

Many other modifications and embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains, having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A method of producing a yarn having anti-microbial and moisture wicking properties and which is particularly useful in the fabrication of body garments, comprising the steps of

   providing a polymeric melt which comprises a mixture of a polymer or copolymer and an anti-microbial agent,

   extruding the polymeric melt through a spinneret having a plurality of openings therethrough and so as to form a plurality of downwardly advancing filaments, and

   with said openings having a cross section which is configured to impart a non-regular cross sectional configuration to the advancing filaments, and

   gathering the advancing filaments together to form an advancing multi-filament yarn, and with the non-regular cross section of the filaments serving to form voids between adjacent filaments which serve to wick moisture from the body of a wearer of a body garment which incorporates the yarn.

2. The method of claim 1 wherein the non-regular cross section of the filaments is characterized by a plurality of outwardly directed bulbous protrusions formed about the periphery of each filament.

3. The method of claim 2 wherein the cross section of the openings in the spinneret have the general configuration of a cross, and so as to form four of said bulbous protrusions on each of the filaments.

4. The method of claim 1 comprising the further subsequent step of winding the advancing yarn into a package.

5. The method of claim 4 comprising the further step of applying sufficient tension to the downwardly advancing filaments to partially orient the polymer or copolymer and so as to have a residual elongation of between about 115% to 145%.

6. The method of claim 4 comprising the further step of drawing the yarn at a location immediately prior to the
winding step so as to produce a flat yarn which has a residual elongation of between about 10% and 75%.

7. The method of claim 1 wherein the polymeric melt further comprises a colorant.

8. The method of claim 1 comprising the further subsequent step of texturing the yarn so as to increase the bulk thereof.

9. The method of claim 8 wherein the texturing step includes advancing the yarn serially across a heater and a cooling plate, and then through a friction twisting unit, while drawing the yarn.

10. The method of claim 9 wherein the drawing step imparts an elongation of between about 30% and 36% to the yarn.

11. The method of claim 10 wherein the texturing step further includes heating the yarn in the heater to a temperature not above 180°C, while maintaining a tension ratio in the yarn greater than about 1.0 on opposite sides of the friction twisting unit.

12. The method of claim 11 wherein the friction twisting unit comprises a plurality of friction discs positioned on parallel shafts which are mounted at the corners of an equilateral triangle, and wherein the total number of friction discs is between 3 and 6.

13. The method of claim 9 wherein the texturing step further comprises introducing an elastic yarn to the textured yarn downstream of the friction twisting unit and then intermingling the yarns in an air jet nozzle to form a composite yarn.

14. The method of claim 1 wherein the filaments are extruded to be of 2 dpf or less.

15. The method of claim 1 wherein the anti-microbial agent is silver based.

16. A method of producing a yarn having anti-microbial and moisture wicking properties and which is particularly useful in the fabrication of body garments, comprising the steps of:

1. providing a polymeric melt which comprises a mixture of a polymer or copolymer, an anti-microbial agent, and a colorant,

2. extruding the polymeric melt through a spinneret having a plurality of openings therethrough and so as to form a plurality of downwardly advancing filaments, and with said openings having a cross section which is configured to impart a non-regular cross sectional configuration to the advancing filaments, while cooling the downwardly advancing filaments in a quench zone so as to solidify the polymer or copolymer, and while applying sufficient tension to the filaments to partially orient the polymer or copolymer,

3. gathering the advancing filaments together to form an advancing multi-filament yarn, and with the non-regular cross section of the filaments serving to form voids between adjacent filaments which serve to wick moisture from the body of a wearer of a body garment which incorporates the yarn, winding the advancing yarn into a package, and withdrawing the yarn from the yarn package and texturing the withdrawn yarn so as to increase the bulk thereof.

17. The method of claim 16 wherein the texturing step includes advancing the yarn serially across a heater and a cooling plate, and then through a friction twisting unit, while drawing the yarn so as to impart a residual elongation of between about 30% and 36% to the yarn.

18. The method of claim 17, wherein the friction twisting unit comprises a plurality of friction discs positioned on parallel shafts which are mounted at the corners of an equilateral triangle, and wherein the total number of friction discs is between 3 and 6.

19. The method of claim 17 wherein the texturing step further includes heating the yarn in the heater to a temperature not above 180°C, while maintaining a tension ratio in the yarn greater than about 1.0 on opposite sides of the friction twisting unit.

20. The method of claim 19 wherein the texturing step further comprises introducing an elastic yarn to the textured yarn downstream of the friction twisting unit and then intermingling the yarns in an air jet nozzle to form a composite yarn.

21. The method of claim 16 wherein the cooling step includes passing a cooling airstream transversely across the downwardly advancing filaments in the quench zone, and wherein the filaments initially advance through an annealing zone positioned between the spinneret and the quench zone where the filaments are not subjected to any appreciable cooling airstream.

22. The method of claim 21 wherein the annealing zone is not more than about 6 inches in length between the spinneret and the quench zone.

23. A multi-filament polymeric yarn useful in the fabrication of body garments and comprising a plurality of gathered together polymeric continuous filaments, with at least some of the filaments having a non-regular cross sectional configuration which serves to form voids between adjacent filaments which aid to wick moisture from the body of a wearer of a body garment which incorporates the yarn, and with said at least some of the filaments comprising a co-extruded mixture of a polymer or copolymer and an anti-microbial agent in an amount sufficient to impart anti-microbial properties to the yarn.

24. The polymeric yarn of claim 23 wherein the yarn is textured to provide enhanced bulk to the yarn.

25. The polymeric yarn of claim 24 wherein said at least some of the filaments are of 2 dpf or less.

26. The polymeric yarn of claim 25 wherein said at least some of the filaments are solution dyed with a colorant.

27. The polymeric yarn of claim 23 wherein the anti-microbial agent is silver based.

28. The polymeric yarn of claim 23 wherein the yarn further comprises a plurality of elastic filaments intermingled with said at least some of the filaments.

* * * * *