

A DOWN-LIKE FIBER

FIELD OF THE INVENTION

The present invention relates to a down-like fiber, particularly, to a down-like
5 fiber with a hollow stem and a plurality of shaped lobes.

BACKGROUND OF THE INVENTION

Natural feathers consist of vaned feathers and down feathers; the former has
hollow stems, and the latter does not. The arrangement of both vaned feathers and
10 down feathers forms irregular spaces, thereby trapping air to reduce heat dissipation
and thus can provide warm effect. However, the warm effect of natural feathers is
extremely decreased due to absorption of water.

In the prior art, fibers with different shaped lobes such as cross-shaped, Y-shaped
and W-shaped lobes have been disclosed. For example, U.S. patent No. 5,057,368
15 discloses a fiber comprising 3 or 4 T-shaped lobes. Although the above fibers have
capability of absorbing moisture and relieving sweat, the warm effect thereof is not
good enough. Contrarily, polyester fibers sold in the market have a hollow structure
and thus possess the warm effect, but the effects of absorbing moisture, relieving
sweat and a soft touch feeling are poor.

20 Therefore, it is highly desired to have a fiber that not only has good effect of
keeping warm but also possesses excellent effects of drainage and fast-drying, and a
lightened weight and a soft tough feeling can be achieved as well.

SUMMARY OF THE INVENTION

To solve the above problems, the present invention provides a down-like fiber which possesses an effect of keeping warm just like feathers, and presents an outstanding fast drying effect as well.

5 The present invention provides a down-like fiber which comprises a hollow stem and a plurality of shaped lobes arranged radially from the hollow stem as a center, wherein each of the shaped lobes comprises a bottom end and a head end opposite the bottom end. The bottom end connects to a surface of the hollow stem, and the head ends of two adjacent shaped lobes do not connect with one another to form an
10 opening.

According to one aspect of the present invention, the shaped lobes can be T-shaped, cross-shaped, Y-shaped, $\uparrow$ -shaped, φ -shaped, W-shaped, H-shaped, V-shaped or rectangular-shaped and the number of the shaped lobes can range from 2 to 6.

15 According to one aspect of the present invention, the down-like fiber stated above can be a filament or a staple.

The present invention also provides a spinneret for manufacturing the down-like fiber stated above. The spinneret comprises a plurality of slits of spinning nozzles. Each of the slits of spinning nozzles comprises an inner ring portion and an outer lobe
20 portion which has a bottom end and a head end opposite the bottom end wherein the bottom end connects to the inner ring portion. The inner ring portions of the plurality of slits of spinning nozzles are arranged in a circle at a regular interval, and the head ends of two adjacent outer lobe portions do not connect with one another to

form an opening.

According to one aspect of the present invention, the outer lobe portion can be T-shaped, cross-shaped, Y-shaped, $\uparrow$ -shaped, φ -shaped, W-shaped, H-shaped, V-shaped or rectangular-shaped. The number of the slits of spinning nozzles can
5 range from 2 to 6.

The present invention also provides a method for manufacturing the above down-like fiber, which comprises extruding a polyester polymer in melting form through the spinneret stated above.

The down-like fiber provided by the present invention has a hollow stem and
10 shaped lobes which imitates the structure of feathers, and thus can not only conserve heat dissipated from body but also lighten the weight of fiber, thereby providing a soft touch feeling. Moreover, since the head ends of adjacent shaped lobes do not connect with each other, the ditches formed therefrom can improve drainage functions. Accordingly, the effects of keeping warm and fast-drying can be achieved.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically shows the cross section of the down-like fiber having T-shaped lobes according to one embodiment of the present invention;

Figures 2A to 2H schematically show the cross sections of the down-like fibers
20 having different shaped lobes according to embodiments of the present invention;

Figure 3 shows a photograph of the cross section of physical samples of down-like fibers having T-shaped lobes;

Figure 4 schematically shows the arrangement of several down-like fibers having

T-shaped lobes according to one embodiment of the present invention;

Figure 5A schematically shows a spinneret used for manufacturing down-like fibers having T-shaped lobes according to one embodiment of the present invention;

Figure 5B schematically shows a spinneret used for manufacturing down-like
5 fibers having cross-shaped lobes according to one embodiment of the present invention; and

Figure 6 shows a bar graph of warm effect tests.

DETAILED DESCRIPTION OF THE INVENTION

10 Figure 1 schematically shows the cross section of the down-like fiber having T-shaped lobes according to one embodiment of the present invention. In Figure 1, the fiber 10 comprises a hollow stem 13 and four T-shaped lobes 11 which arrange radially from the hollow stem 13 as a center. Each of T-shaped lobes 11 comprises a head end 112 and a bottom end 111 wherein the bottom end 111 connects
15 to the surface of the hollow stem 13, and the head ends 112 of two adjacent T-shaped lobes 11 do not connect with one another to form an opening 12. The opening 12 can be used as a ditch to drain moisture.

Figures 2A to 2H schematically show the cross sections of the down-like fibers having different shaped lobes according to other embodiments of the present
20 invention. As shown in Figures 2A to 2H, the shaped lobes can be cross-shaped, Y-shaped, ↑ -shaped, ♀ -shaped, W-shaped, H-shaped, V-shaped or rectangular-shaped. The number of the shaped lobes is preferably from 2 to 6. That is because if the number of the shaped lobes is above 6, the design of spinning

nozzles will become more complicate and thus lead to increasing the cost; however, if the number of the shaped lobes is too few, the drainage function and warm effect of fibers will be affected.

Figure 3 shows a photograph of the cross section of physical samples of
5 down-like fibers having T-shaped lobes. According to Figure 3, due to the design of T-shaped lobes, those fibers can keep certain spaces to prevent from being tightly packed. Figure 4 schematically shows the arrangement of several down-like fibers having T-shaped lobes according to one embodiment of the present invention. In
10 Figure 4, since the head ends 112 of the adjacent T-shaped lobes 11 do not connect to each other, the opening 12 formed therefrom can be used as a ditch. Since water can be drained through the openings 12, the fabrics woven by the fiber 10 demonstrate an outstanding drying effect after absorbing moisture or sweat. Also, many air rooms formed by the arrangement of the head ends 112 of the T-shaped lobes 11, in combination with the closed hollow stems 13, can further conserve heat emitted from
15 a human body, thereby enhancing the warm effect.

Figure 5A schematically shows a spinneret for manufacturing a down-like fiber having T-shaped lobes according to one embodiment of the present invention. As shown in Figure 5A, a spinneret 20 comprises four “工” shaped slits of spinning nozzles 21. Each of slits of spinning nozzles 21 comprises an inner ring portion 211
20 and an outer lobe portion 213, wherein the outer lobe portion 213 has a bottom end 215 and a head end 217 opposite the bottom end 215, and the bottom end 215 connects to the inner ring portion 211. The inner ring portions 211 of the four slits of spinning nozzles 21 are arranged in a circle at a regular interval, and the head ends 217 of two adjacent outer lobe portions 213 do not connect with one another to form
25 an opening 22. A polymer is extruded from the slits of spinning nozzles 21 which

will further swell and connect at the inner ring portions 211 to form a hollow ring, thereby producing the fiber 10 shown in Figure 1.

Polymers suitable for manufacturing fibers of the present invention include but not limited to polyester, nylon, polyolefin, polyacrylonitrile or cellulose, wherein
5 polyester can be polyethylene terephthalate (PET), polybutylene terephthalate (PBT) or polypropylene terephthalate (PPT); nylon can be nylon 6 (N6) or nylon 66 (N66); and polyolefin can be polypropylene (PP) or polyethylene (PE). Besides, additives can be further added in the fibers of the present invention which include but not
10 anti-ultraviolet agents or far-infrared agent.

Figure 5B schematically shows a spinneret used for manufacturing down-like fibers of Figure 2A which have cross-shaped lobes according to one embodiment of the present invention. As shown in Figure 5B, the spinneret 30 comprises four
“±” shaped slits of spinning nozzles 31. The outer lobe portion 313 of the slit of
15 spinning nozzle 31 is “cross-shaped”. In other embodiments of the present invention, the outer lobe portion 313 can be Y-shaped, ↑ -shaped, ♀ -shaped, W-shaped, H-shaped, V-shaped or rectangular-shaped to manufacture down-like fibers having different shaped lobes shown in Figures 2B to 2H.

The following further describes manufacturing examples of down-like fibers of
20 the present invention and tests of effects.

Example 1: Manufacture of Down-Like Staples Having T-shaped Lobes

The polyester polymer in melting form is extruded through a spinneret as shown in Figure 5A at spinning temperature of 290°C; quenched by cooling air at a rate of 1.0 m/s; and spun at a spinning rate of 700 m/min. The filaments are drawn at a total

elongation of 2.89 times followed by thermosetting at 160°C, cooling, wrinkling, oiling, drying, cutting, and packaging steps. The down-like staples of 3d*51mm whose cross section is a hollow stem with four T-shaped lobes are thus obtained.

Example 2: Manufacture of Down-Like Staples having Cross-shaped Lobes

5 The polyester polymer in melting form is extruded through a spinneret as shown in Figure 5B at spinning temperature of 290°C; quenched by cooling air at a rate of 1.0 m/s; and spun at a spinning rate of 700 m/min. The filaments are drawn at a total elongation of 2.89 times followed by being thermosetting at 160°C, cooling, wrinkling, oiling, drying, cutting, and packaging steps. The down-like staples of 3d*51mm
10 whose cross section is a hollow stem with four cross-shaped lobes are thus obtained.

Example 3: Manufacture of Down-Like Filament Textured Yarn Having T-shaped Lobes

The polyester polymer in melting form is extruded through a spinneret as shown in Figure 5A at spinning temperature of 290°C; quenched by cooling air at a rate of
15 0.6 m/s; and winded at a spinning rate of 2500 m/min to produce 120/36 partially oriented yarns (POY). The yarns are drawn at a total elongation of 1.6 times followed by thermosetting at 160°C and winding steps. The 75/36 down-like filament textured yarns whose cross section is a hollow stem with four T-shaped lobes are thus obtained.

Example 4: Manufacture of Down-Like Filament Oriented Yarn Having T-shaped Lobes

The polyester polymer in melting form is extruded through a spinneret as shown in Figure 5A at spinning temperature of 290°C; quenched by cooling air at a rate of 0.6 m/s; and spun at a spinning rate of 4000 m/min. The yarns are drawn at a total

elongation of 2.0 times at the drawn temperature of 90°C followed by thermosetting at 130°C and winding steps. The 75/36 down-like filament oriented yarns whose cross section is a hollow stem with four T-shaped lobes are thus obtained.

Test 1: Evaporation Rate Test

5 The evaporation rate tests of fabrics woven by the down-like fibers having T-shaped lobes of the present invention, conventional hollow round polyester fibers, solid round polyester fibers and solid fibers having other shaped lobes are described below.

First, a sample of size 10×10 cm is placed in an environment of constant
10 temperature and humidity (23°C, 65%RH) for 24 hours and then moved onto a scale. A given amount of water (W1, unit: gram) is dripped from 1 centimeter above the fabric by using a volumetric pipet. After 5 minutes, the remaining amount of water (W2, unit: gram) in the fabric is recorded and the evaporation rate is calculated based on the following formula:

15
$$\text{Evaporation Rate} = (W1 - W2) / W1 \times 100\%$$

The test results are shown in Table 1. Sample 1 to 5 are double knit bird eye fabrics with a width of 36 inches*26 needles, which are respectively woven by staples having T-shaped lobes of the present invention, solid staples having 4T cross section, solid staples having cross cross section, solid round polyester fibers and hollow round
20 polyester fibers (the above products are obtained from Shinkong Synthetic Fibers Corporation, in which the solid staples having 4T cross section have been issued Taiwan Patent no. I374952).

Table 1

	1 (the present invention)	2 (comparative example)	3 (comparative example)	4 (comparative example)	5 (comparative example)
sample	down-like staples having T-shaped lobes	solid staples having 4T cross section	solid staples having cross cross section	solid round polyester fiber	hollow round polyester fiber
evaporation rate (%)	76.8	73.5	69.2	50.1	49.6

According to Table 1, the evaporation rate of the down-like fiber having T-shaped lobes provided by the present invention is around 76.8%, which is much better than 50.1% achieved by the solid round polyester fiber and 49.6% achieved by the hollow round polyester fiber. The test result demonstrates that since fibers of the present invention possess lobe structures as ditches, the fabric woven by fibers of the present invention can keep larger spaces between fibers, and thus facilitate drainage. The fibers of the present invention exhibit a fast drying effect compared with conventional hollow or solid round polyester fibers. Furthermore, the evaporation rate of fibers of the present invention is also higher than solid fibers having other cross sections (i.e. samples 2 and 3). This shows that compared with conventional solid fibers having 4T cross section or cross cross section, fibers of the present invention possess excellent drainage effect, and thus fabrics woven thereby can achieve fast drying effect without a muggy feeling.

Test 2: Warm-Keeping Test

The warm-keeping test of fabrics woven by down-like fibers having T-shaped lobes of the present invention is described below. The test is performed by AGEMA

Thermal vision 900 thermal conductivity meter. A 500W halogen lamp is used as a heat source to irradiate a sample for 10 minutes at a distance of 100 centimeters.

The temperature of the sample is measured before and after exposure to the light.

Samples 1 to 4 represent double knit bird eye fabrics with a width of 36 inches*26

- 5 needles which are respectively woven by four different fibers, including down-like fibers having T-shaped lobes of the present invention, conventional solid fibers having 4T cross section, solid round polyester fibers and hollow round polyester fibers

Table 2

Sample		Before Irradiation (°C)	After Irradiation (°C)	Differences of Temperatures
1	down-like fiber having T-shaped lobes (the present invention)	23.1	29.5	+6.4
2	solid fibers having 4T cross section (comparative example)	23.2	27.8	+4.6
3	solid round polyester fiber (comparative example)	23.1	25.6	+2.5
4	hollow round polyester fiber (comparative example)	23.2	26.3	+3.1

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Figure 6 shows a bar graph based on the results of warm-keeping test. According to Table 2 and Figure 6, the temperature of the fabric woven by fibers of the present invention is obviously raised after irradiation with a light source. The increase of

temperature is much greater than those of round polyester fibers (i.e. sample 3 and sample 4), and a better warm effect is also presented compared with conventional solid fibers having 4T cross section (i.e. sample 2).

According to the above, the hollow stem of the down-like fiber provided by the present invention, which is like a feather stem, not only reduces the weight of fiber but also provides effect of keeping warm. Moreover, the shaped lobes around the main stem provide several air rooms due to disconnection of adjacent head ends.

The ditch structures formed therefrom can further enhance the effects of heat conservation, and improve the effects of drainage and fast-drying. Accordingly, the down-like fibers provided by the present invention can overcome disadvantages of bird feathers, i.e. decrease in the effect of keeping warm as a result of moisture absorption, and of conventional fibers having shaped lobes which has a drainage function but a poor effect of keeping warm. Meanwhile, since the weight of fiber of the present invention has been reduced, a down-like touch feeling is reserved.

Exemplary embodiments have been described herein, but do not intend to limit the scope of the present invention. It will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the spirit and the scope encompassed by the appended claims. Therefore, the scope of the present invention is determined by the claims that follow.

WHAT IS CLAIMED IS:

1. A down-like fiber, comprising:

a hollow stem; and

5 a plurality of shaped lobes, each being T-shaped, cross-shaped, Y-shaped, ↑-shaped, ♀-shaped, W-shaped, H-shaped, or V-shaped, arranged radially from the hollow stem as a center, wherein each of the shaped lobes comprises a bottom end and a head end opposite the bottom end, and the bottom end connects to a surface of the hollow stem, and the head ends of two adjacent shaped lobes do not connect with one another to form an opening.

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2. The fiber of claim 1, wherein the number of the shaped lobes is from 2 to 6.

3. The fiber of claim 1, wherein the fiber is a filament or a staple.

- 15 4. A spinneret for use in manufacturing the down-like fiber of claim 1, comprising a plurality of slits of spinning nozzles, each of the slits of spinning nozzles comprising:

an inner ring portion; and

20 an outer lobe portion, each being T-shaped, cross-shaped, Y-shaped, ↑-shaped, ♀-shaped, W-shaped, H-shaped, or V-shaped, the outer lobe portion comprising a bottom end and a head end opposite the bottom end, wherein the bottom end connects to the inner ring portion;

wherein the inner ring portions of the plurality of slits of spinning nozzles are arranged in a circle at a regular interval, and the head ends of two adjacent outer lobe portions do not connect with one another to form an opening.

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5. The spinneret of claim 4, wherein the number of the slit of spinning nozzle is from 2 to 6.

6. A method for manufacturing the down-like fiber as claimed in claim 1,
10 comprising extruding a polyester polymer in melting form through the spinneret as claimed in any one of claims 4 to 5.