Ultra Microfibers: Beyond Evolution

The term microdenier as it relates to synthetic fibers has been in general use in the United States for many years. Specifically, it has come to refer to synthetic fibers with denier per filament (dpf) of less than one; however, it is most often used for any fiber with a dpf between 0.5 and 1.5.

Initially, it was thought that fibers in this denier range would become a whole new product category of fibers, resulting in new markets and new profits. In some cases this happened; but for the most part, microfibers today are viewed as the low-denier extension of the natural broadening of fiber offerings.

Synthetic fiber spinning equipment and processes have improved rapidly since the early days when fiber producers had to develop their own in-house equipment and process technology. With time, this technology switched to large engineering firms and equipment manufacturers, and rapid advances were made. Similar advances took place in fabric processing equipment so that by the 1980's it became economically viable to spin

and process into fabric both filament and staple synthetic fibers with dpfs of less than one.

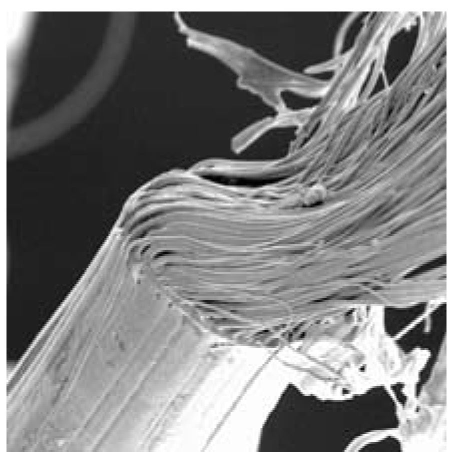
This description of microfibers generally refers only to homopolymer spinning and processing. Another type of microfiber spinning and processing technology has been in existence for more than 20 years; but until recently, has seen almost no application in the United States. This technology involves spinning and processing of bicomponent fibers in the range of 2 to 4 dpf, after which the fibers are split into smaller fibers with deniers of 0.1 or lower. Until recent technical advances, this type of product has been very expensive and has found greatest acceptance in the Far East.

Hills, Inc. has been one of the world leaders in bicomponent spinning technology and has seen great success in developing the technology required to make the spinning of bicomponent fibers to create microdenier fibers more economical and easier. With today's technology, a spinpack for bicomponent fibers is only slightly more expensive than a standard homopolymer pack, and the hole densities are usually the same. With bicomponent technology, a number of new approaches to making microfiber products have been developed and are discussed below.

Islands-In-The-Sea

A typical cross-section of an Island-In-The-Sea fiber is shown in Figure 1. This particular fiber contains 64 individual small fibers of one polymer spun inside of a matrix, or sea, of another fiber. The fiber shown has a denier of approximately three.

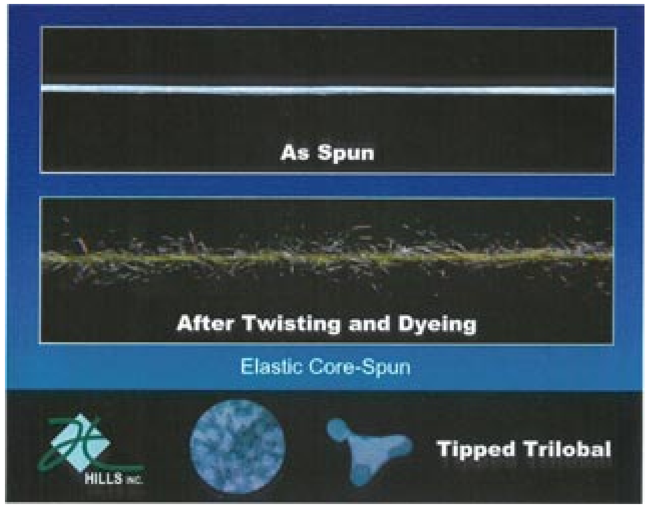
The islands compose approximately 80% of the fiber and the sea is approximately 20% of the fiber. Since the drawn denier per filament of the fiber as spun is three, the spinning and fabric formation processes are the same as the standard homopolymer fibers. This microdenier filaments are developed when the sea polymer is dissolved after the fabric has been woven or knit. As is obvious, there is an additive cost to processing these fibers; however, they have found an excellent market in ultra suede and other synthetic leather products. Furthermore, with the newest spinning technology, the spinnerette hole density and spinning yields are essentially the same as for homopolymer fibers, resulting in little or no additional cost in the extrusion process. Within the lat two years this technology has been greatly extended. In June of 1999, Hills developed a new method of pack builds that resulted in fibers with 240 islands-in-the-sea. These fibers were spun on commercial hole densities of approximately 6 mm hole centers and after drawing and dissolving of the sea polymer produced filaments with 0.7 micron diameter. Further work with our us Customers on a pilot line resulted in spinning 1 dpf fibers with 1120 islands in each filament. Commercial production with 600 islands-in-the-sea fibers (see figure 2) is presently being developed with an Asian customer.



Splittable Pies Another way to produce ultra microdenier fibers is called splittable pies (Figure 3) Using this concept, a 2 to 4 dpf bicomponent pie yarn is again spun and processed with standard techniques. Once in fabric form, a mild caustic solution is applied to the fabric causing the individual fibers to split apart from the main fiber. If a 32 segment pie of nylon/polyester as shown is used, the final dpf of the fibers are in the range of 0.1. Brushing and other type of finishing techniques can be used to enhance the effects.

Products with 12 to 16 segments are quite common in the Far East, and are used in both apparel fabrics and towels. Towels made using these fibers are unusually light and soft. Because the absorbent effect is due to the large surface area in the interstices of the fabric rather than adsorption, the towels dry very rapidly after use. Recently, Hills has shown that the pies can be split without the use of a caustic solution. Splittable, hollow fibers is one technique used in such applications (Figure 4). In this case, the polyester/polypropylene fiber pies shown stay together during spinning but come apart with various types of down-stream processing. The yarn shown in the photomicrographs consists of 198 three-denier filaments before drawing. After mechanical drawing, the yarn has 3,168 filaments with 0.2 dpf.

Splittable pies can also be used in bicomponent spunbond products to give an extremely soft feel to certain products. Combined with hydroentanglement techniques that break apart and mix the fibers, felt-like nonwovens are also being produced. Tipped Fibers An even newer concept is to make a bicomponent fiber where the second polymer is placed in small quantity on the tip on a trilobal or delta cross section fiber (Figure 5). In the fiber in the photograph, the core polymer is a melt-spinnable polyurethane and the tip polymer is polypropylene. The ratio of the two polymers is 70/30.



The yarn is made using a standard FOY spin/draw process with a dpf of approximately three. After spinning the fibers are twisted and then wet heat is applied (dyeing).The result also is shown in Figure 5. The polymer on the tops of the fibers break apart into microfibers of approximately 0.2 denier each and spiral around the polyurethane core that shrank during the heating process. The resulting yarn has over 100% elastic stretch and looks similar to a standard core/spun yarn, except the processing costs are substantially reduced and the fibers ringing the core are microdenier (<0.2 dpf).

Conclusion

With the use of modern bicomponent technology, microdenier fibers with a dpf of less than 0.2 can now be produced and processed economically and in large quantities. The industry is no longer limited in fiber dpf to the lowest homopolymer denier that can be spun or processed into fabric with reasonable yields. We are just now seeing what can be done when bicomponent technology is used to produce microdenier fibers. It is expected that exciting new products will be constantly discovered using this technology in the next decade.

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