Splitting Bicomponent Fibers in Spunbond Fabrics

Introduction

Splittable bicomponent fibers have been commercial for many years, mostly in Asia. With these types of fibers, filament deniers as low as 0.1 are commonly produced. Generally, these fibers are spun in a standard FDY or POY process as continous bicomponent filaments of 2 to 3 denier with 16 or 32 segments (Figure 1).

The fibers are woven or knitted into fabric using standard techniques after which a mild caustic solution is used to swell and split the fibers. Some type of mechanical process such as combing or brushing is then used to fully separate the tiny fibers. (Figure 2). These same type of fibers can be spun in a staple form. In this case they are needled into a nonwoven batt, separated and impregmented with polyurethane and then burnished to make artificial leather or polishing cloth.

The subject of this article is how this technology can be applied in a spunbond process so that low cost, fabric-like webs will result. The first product of this type, Evalon® has recently been commercialized by Freudenberg. This product uses both side-by-side and 16-segment bicomponent fibers. The side-by-side fibers are used to produce bulk through differential strain and the 16 segment pie fibers are split by hydroentangling to produce microdenier filaments. However, there are a number of techniques that are in development which may lead to similar spunbond webs with fabric like properties. These techniques are discussed below. In some cases, initial scouting work with these techniques have been successfully completed and other are still in the thinking stage.

Fiber Shapes

There are a number of bicomponent fiber shapes that have the potential to be split in a spunbond web. The sixteen or thirty-two segment pie shape mentioned earlier is the most common. However, this shape is difficult to split and depending on the polymers used may require both chemical reduction and mechanical processing to achieve splitting. One way to improve the splitting property of the fiber is to use a hollow fiber shape (Figure 3). This type of fiber is easily spun and can generally be split with simple mechanical agitation or drawing. It, therefore, is the most likely candidate for splitting in spunbond webs.

Other bicomponent shapes that can be split are segmented ribbons (Figure 4), striped round fibers (Figure 5) and island-in-the-sea fibers. INS fibers require the use of a dissolvable polymer and at present would be too expensive to use in spunbond fabrics. The segmented ribbon would work well since it is easily split, but it is a difficult fiber to spin. The striped round fibers are also more difficult to spin and to split than the segmented pies and therefore show little potential for use in spunbond fabrics at this time.

Polymer Combinations

Until recently the bicomponent fibers used for splitting were generally composed of polyester and nylon. A fiber composed of these two polymers is split when soaked in a hot caustic solution of 5 to 10% NaOH. This causes the fiber to swell and slightly extends and crystallizes the surfaces between the two polymers. With the development of new polymers many splittable fibers now use a combination of PET and ESPET; the latter which is used in a low ratio of 15% to 30%. (Figure 6). The splitting process in this fiber is obtained from partial dissolving of the ESPET rather that swelling of the fiber. This is particularly useful when making artificial leathers. In the last two years, we have seen rapid development of polymers such as EVOH and EXCEVAL® that dissolve very rapidly in water. Much of this work is being done in Japan by companies such as Kuraray.

Another interesting polymer combination is PET and PP. Since bonding between PP and PET is essentially non-existent once the fiber cools, subfilaments from this combination can be split by purely mechanical means. The same is also true of bicomponent fibers made of polypropylene and polyethelene which would be the polymers of choice for spunbond webs unless dyeing is required

Splittling Techniques

The ideal technique to split fibers in a spunbond process would be if the splitting could be accomplished on standard or slightly modified spinning equipment. The potential exists that if an open draw jet spunbond process (Figure 7) is used, certain polymer combinations such as PP/PE will split during the draw process without the need for a secondary operation. However, most attempts to accomplish this have been unsuccessful because freshly spun bicomponent fibers do not want to split regardless of the polymer combination or fiber shape.

Fleissner in Germany has recently been promoting hydroentangling as a method to split bicomponent fibers in spunbond webs. Hydroentangling in a separate operation has been successfully used to split fibers in both spunbond and carded web fabrics (for example: Evalon ®). however, combining the two processes into one operation is still in the experimental stage. Closely associated with hydroentangling would be a process where one of the polymers is either partially or totally dissolved. This process would of course require use of dissolvable polymer such as EVOH. Two of the major concerns with this concept are expense and disposal of the dissolved polymer.

Two other techniques also hold promise: sanding and/or brushing. These techniques will work only with fibers that are easily split such as hollow fiber or when used in combination with other techniques. As far as I know, little work has been done to apply these techniques to splittable spunbond webs.

Combinations

The best shape for bicomponent splittable spunbond fibers is a hollow pie shape with 16 or more segments. This shape is easily spun and easily split. There are a number of likely polymer combinations. One is PP/PE which is inexpensive and easily splits. Another likely polymer combination is polyester in one segment and a dissolvable polymer such as EVOH in the other.

Experimental trials with both of these polymer combinations have shown great promise. Hyrdrotangling is still the best developed of the splitting techniques as far as non-woven webs are concerned and some of the fabrics made this way are extremely soft and show potential for some apparel uses.

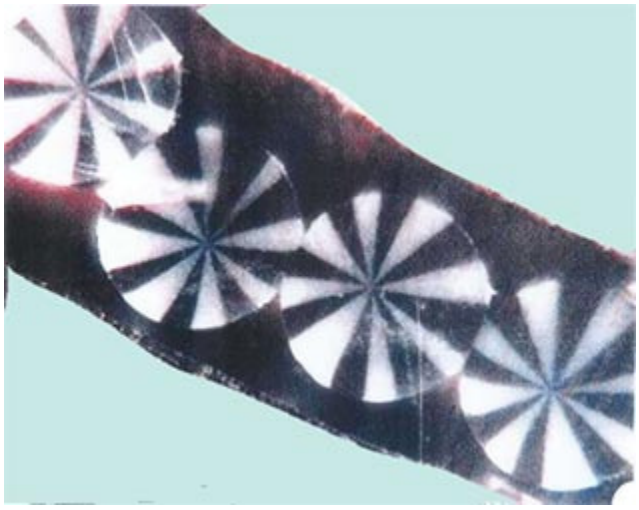

Figure 1

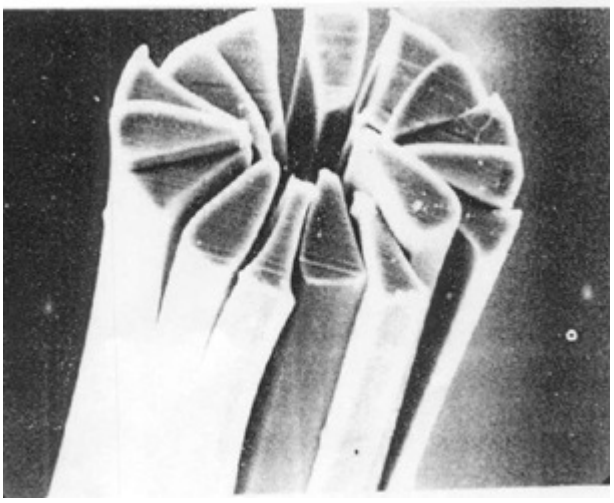

Figure 2

Figure 3

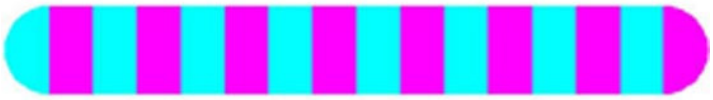

Figure 4

Figure 5

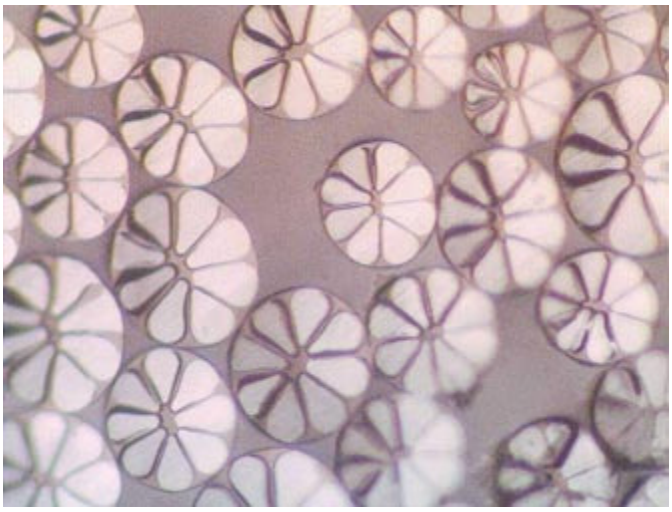

Figure 6

SCHEMATIC OF SPUNBOND PROCESS

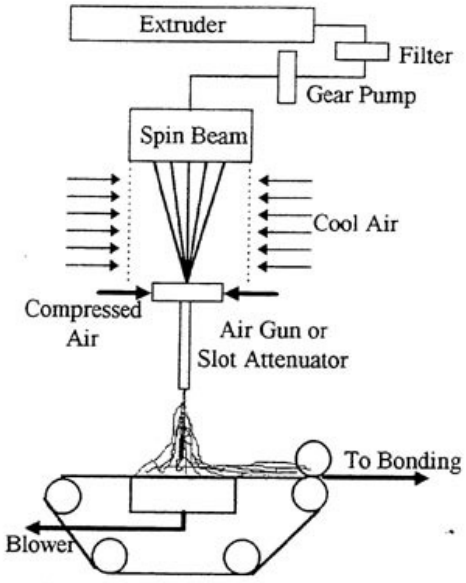

Figure 7