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Study of Fracture Mechanisms of High Performance Polyester Synthetic Fibers

S. G. Cardoso(1) and A. H. P. Andrade(2)

(1) Materials Science and Technology Center, Ipen-CNEN/SP, sergio_gomes@veyance.com
(2) Materials Science and Technology Center, Ipen-CNEN/SP, aandrade@ipen.br

Abstract – High performance synthetic fibers polyester have been developed for manufacture of several engineering products. Vital needs have led to the development of such fibers in various segments in daily life. The study of its fracture mechanisms is of great relevance for characterization and understanding of the causes as well the consequence of failures. In the present work monofilaments of polyester synthetic fibers were considered in three classes: regular, twisted and heat-treated.

High performance fibers are groups formed by molecular-chain-oriented monofilaments. Fibers play a fundamental role in human beings daily life and they can be found in several forms and geometries, such as monofilaments, yarns, beams, rope, fabric, composite, coatings, etc. They are used in various industrial segments such as civil, mechanical, electrical, electronics, military, naval, nautical, aviation, health, medicine, environment, communications, safety, space, etc. Fibers are divided into two distinct classes: natural and chemical ones, which cover synthetic and man-made sub-classes. They can be produced from several materials, such as polyester, nylon, wool, cotton, rayon, flax, silk, rock, polyethylene, poly-propylene, aramid, glass, carbon, steel, ceramic, etc. [1]

The fiber structure is made up by tenths of thousands of repeating units, grouped by a covalent bond. Globally, the participation of chemical fibers corresponds to approximately 52%, and the synthetic fiber polyester, the most used one, represents approximately 63% of the world market. The study of fracture mechanisms of fibers is of great relevance for characterization and understanding of causes as consequence of failures. [2]

For such reason, in the present work monofilaments of high performance polyester synthetic fiber used in engineered products such as tires, belts, hoses and pneumatic springs have been selected and analyzed before and after different processing steps and were divided into three classes: regular, twisted and heat-treated. Monofilaments samples were extracted from each step to be analyzed by scanning electron microscopy and the results showed the presence of multi axial state of stresses during the fiber processing steps. Through microscopy analysis, it was possible to find variations in the monofilament fracture face, caused mainly by the state of stress imposed during the stages of the process. [3]

Figure 1: Ductile fracture of the regular monofilament

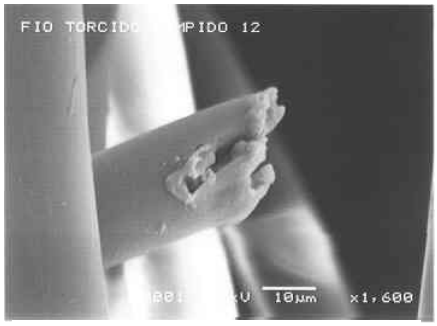

Figure 2: Multi axial stress fracture of the twisted monofilament

Figure 3: Multi axial stress fracture of the heat-treated monofilament

References

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