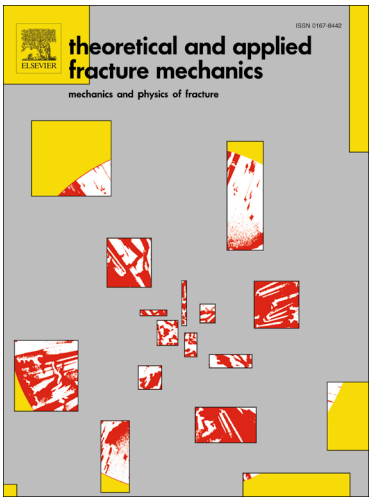

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Influence of microfluidic flow rates on the propagation of nano/microcracks in liquid core and hollow fibers

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Abstract

Melt-spinning is a conventional method for the production of synthetic fibers. The development of melt-spun liquid core or liquid filled fibers in which the liquid component is already incorporated during fiber spinning has been reported as a viable alternative to traditional hollow fibers. The elucidation of the mechanical behavior of this new type of bicomponent fiber is of interest, with particular emphasis on its fracture mechanics. In this paper we describe a microfluidics method used to induce liquid flows through these fibers (internal diameter 15 – 30 μm), aiming at analyzing the influence of flow rate on crack formation and/or propagation. Although only a very small number of fibers show the presence of cracks (1 – 4% of the tested specimens), it is possible to establish a clear correlation between flow rate and the appearance of cracks. The main fracture mechanism found to be operating in these melt-spun fibers is the type I (opening mode) fracture, evidenced as the internal pressure exerted by the liquid being injected through the fibers increases during microfluidic testing. As fiber spinning and drawing force the polymer chains that compose the sheath to be preferentially oriented in the fiber direction, the formation of axial cracks over transverse cracks is favored due to a lack of strong intermolecular interactions between polymer chains in the transverse direction of the fiber.

Keywords: Melt-spinning, Liquid core fiber, Fracture, Nano/microcrack, Leakage