Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Investigation of strength limiting mechanisms in aramid fibers

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ABSTRACT

Aramid fibers owe their high tensile strength and stiffness to their orderly fibrillar structure. The synergistic effect of individual fibrils comprising an aramid fiber, and the interfibrillar interactions determine the strength of an individual fiber. In order to study the existence and role of statistical defects in failure initiation of aramid fibers, quasi-static tensile tests were performed with individual fibers of different molecular compositions and gage lengths in the range of 100 μm–10 mm. The experimental results pointed out to a relative insensitivity of the tensile strength to the fiber gage length, which suggested that failure initiation is governed by processes and/or flaws active at length scales well below micron scale. Therefore, differences in tensile strength between the particular types of aramid fibers discussed in this study were attributed to interfibrillar interactions. The magnitude of the latter was assessed by longitudinal crack growth experiments with individual fibers, as interfibrillar interactions are expected to be similar to the van der Waals interactions between the hydrogen bonded macromolecular sheets comprising the aramid fibers. The initial fracture experiments showed stable crack propagation under relatively constant force taking place for very large lengths of individual fibers. This presentation will provide the current results on the cohesive energy measurements on two types of aramid fibers designed to provide high tensile strength.