Discontinuities as a way to influence the failure mechanisms and tensile performance of hybrid carbon fiber/self-reinforced polypropylene composites

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Discontinuities as a way to influence the failure mechanisms and tensile performance of hybrid carbon fiber/self-reinforced polypropylene composites

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Abstract: Interlayer hybrid carbon fiber/self-reinforced polypropylene composites possess a rare combination of lightness, stiffness and ductility, but they do suffer from a catastrophic stress drop when the carbon fiber layer fractures. To promote a gradual failure of the hybrids, we introduced discontinuities in the carbon fiber layer by partially cutting it at multiple locations perpendicularly to the fiber direction. By altering characteristics of the discontinuities (their length and number over the specimen width), we were able to influence the failure mechanisms and tensile performance of these hybrid composites. When the cut length was increased to 15 mm, the carbon fiber layer fragmented and delaminated at the cut sites inducing a gradual failure development in the hybrid. The concept of fracture process zone was applied to explain the failure mechanisms in these hybrid composites.

Keywords: A: Hybrid; B: Delamination; B: Fragmentation; D: Failure.

1. Introduction

Self-reinforced composites (SRCs), in which the reinforcement and matrix are composed of the same polymer, have been increasingly used due to their high impact resistance, high ductility and excellent processability [1,2]. At the same time, their application has been limited to non-structural applications because of their intrinsically low stiffness. Hybridizing self-reinforced polymers with high stiffness materials, like carbon fibers, is a promising solution for increasing the stiffness while maintaining ductility. Previous research [3,4] has illustrated that hybrid carbon fiber/self-reinforced polypropylene (SRPP) composites exhibit a rare combination of stiffness and failure strain in addition to their low density. Fig. 1 shows the results on their benchmarking