EXPERIMENTAL INVESTIGATION OF DAMAGE TRANSITION IN THERMOPLASTIC COMPOSITES AT THE MICROSCALE

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Keywords: Thermoplastic composite, microscale test, SEM

Abstract
Thermoplastic composites become very popular for making impact-prone structures. An efficient approach to estimate the out-of-plane mechanical performance of thermoplastic composites is proposed to support the material development stage as well as modeling approach. The estimation was done by isolating the principal damage modes in a relatively small sample subjected to three-point bending (3PB) load within micro-tensile/compression stage (Kammrath & Weiss). The *in situ* damage development, i.e. the transition from transverse crack to delamination, was recorded by scanning electron microscope. Two loading speeds were evaluated, e.g., 0.5 micron/sec and 20 micron/sec, in relation with the absorbed energy. The role of fibrillation in the wake of crack bridging is discussed.

1. Introduction

An efficient approach to estimate the out-of-plane mechanical performance of thermoplastic composites is needed to support the material development stage as well as modeling approach. The estimation can be done by isolating the principal damage mechanism through the microscale testing and *in situ* damage observation.

A combined experimental device consisting of three-point bending (3PB) fixture (within Kammrath & Weiss micro-tensile/compression stage) and scanning electron microscope (SEM) is here proposed to investigate the microscale damage transition from transverse crack to delamination in continuous glass fiber-reinforced impact polypropylene (GFIPP) laminates that were recently investigated [1,2]. Similar device was also employed by other researchers for the validation of the numerical models [3].

2. Experimental setup and preliminary results

The schematic of 3PB setup and Kammrath & Weiss micro-tensile/compression stage can be seen in Figs. 1a and 1b, respectively. A preliminary result of damage transition was carried out on cross-ply $[0_4/90_8]_T$ laminate at loading speed of 0.5 micron/s, and the damage transition observed by SEM and corresponding load-displacement curve can be seen in Figs. 1c and 1d, respectively. Fibrillation phenomena, which is a typical feature in crack opening mouth of GFIPP that we observed from the test, is shown in Fig. 2.

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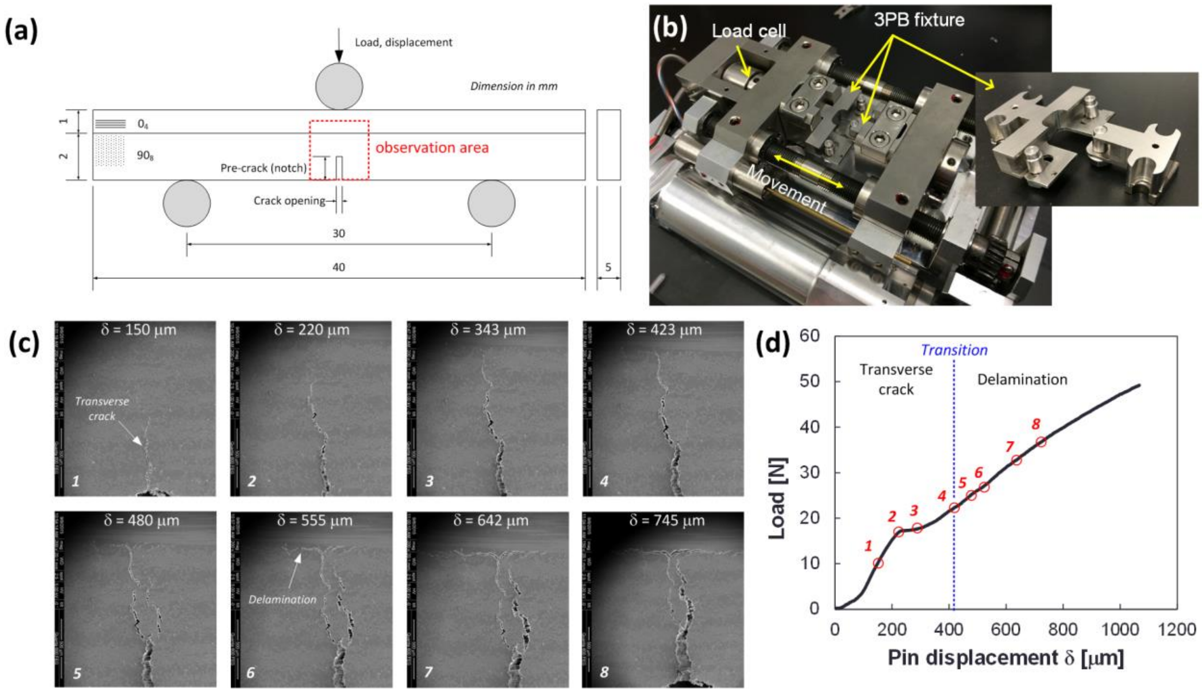

Figure 1. (a) Schematic of three-point bending of GFPP laminate, (b) Kammrath-Weiss micro-tensile/compression with 3-point bending fixture, (c) preliminary result: damage transition in cross-ply $[0\_4/90\_8]_T$ laminate (loading speed = 0.5 micron/s), (d) load-displacement curve and transition of transverse crack into delamination

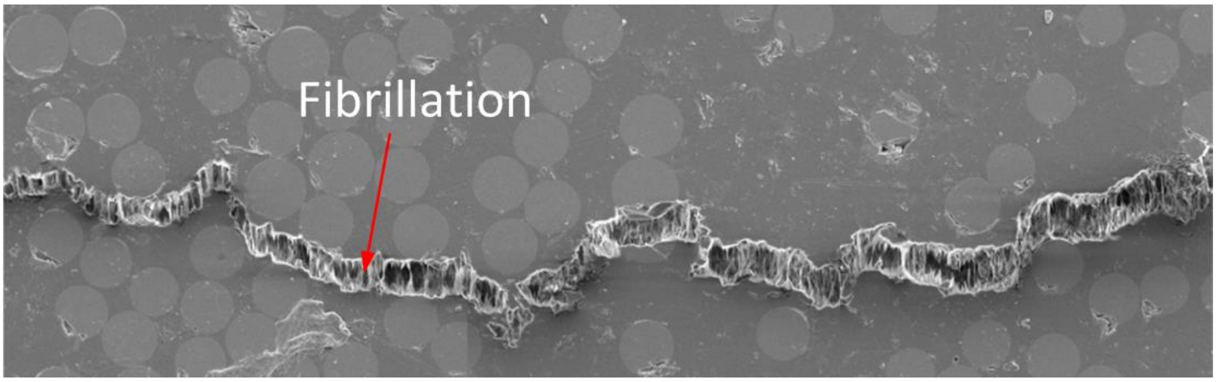

Figure 2. Fibrillation in wake region of the propagating crack

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Acknowledgments

We thank SABIC for providing research fund and materials.

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