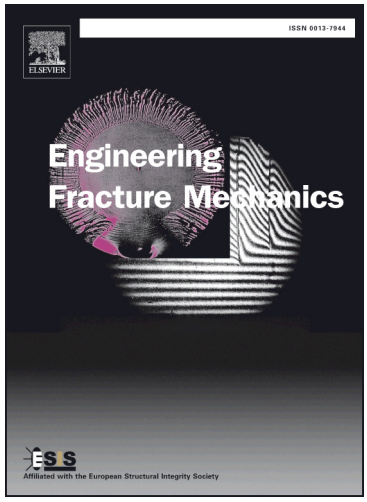

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Dynamic mixed-mode fracture behaviors of PMMA and Polycarbonate

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Abstract

Mixed-mode dynamic crack initiation and growth in polymethymethacrylate (PMMA) and polycarbonate (PC) are studied experimentally. A simple specimen geometry in conjunction with a dynamic loading configuration to generate different mode-mixities at crack initiation is demonstrated. A Hopkinson pressure bar is used to rapidly load free-standing edge cracked samples in a reverse impact configuration. By eccentrically loading the specimen relative to the crack line, various mode-mixities at crack initiation are achieved by simply increasing the initial crack length while keeping all other experimental parameters the same. A relatively new full-field optical technique, Digital Gradient Sensing (DGS), along with high-speed photography is used to perform full-field measurements. DGS measures instantaneous angular deflections of light rays representing two orthogonal stress gradients under plane stress conditions. The mode-I and -II stress intensity factor histories are evaluated via over-deterministic least-squares analysis of optically measured data. By quantifying the critical stress intensity factors evaluated at crack initiation, dynamic fracture envelopes are developed for both the polymers. The results are studied comparatively and relative to the brittle fracture criteria.

Keywords: dynamic fracture; mixed-mode crack initiation; material characterization; fracture envelope; optical measurements; transparent materials

Introduction

Different yet complementary factors have motivated this research. They include a need for (a) characterizing mixed-mode dynamic fracture behavior of transparent armor materials [1], (b) extending a commonly used loading geometry to generate a range of mode-mixities at dynamic crack initiation, (c) extending a relatively new full-field optical methodology to visualize and quantify dynamic mixed-mode crack initiation and growth parameters in ductile and brittle polymers.

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