(755) A Fracture Resistance Measurement Procedure for Brittle Materials

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A procedure has been developed to measure the fracture resistances of nominally brittle materials (monolithics or composites) using chevron-notched, three-point bend specimens at room temperature and elevated temperatures. A comparison of the chevron-notched specimen and the traditional single-edge-notched fracture specimen is shown in Figure 1.

The chevron-notched geometry promotes stable crack growth during quastic-static fracture tests. For each test a continuous record of load versus crack mouth opening displacement (CMOD) is obtained. The fracture toughness, work-of-fracture, and the classical crack growth resistance curves (R-curves) are then determined from the stable crack growth loading curves and previously established relations between the CMOD compliance, effective crack length, and the load point displacement (LPD).

R-curves have been measured for various materials which show flat, rising linear, and rising non-linear behavior as illustrated in Figure 2. The flat R-curve is for a monolithic silicon carbide and is indicative of the constant crack growth resistance observed in brittle, linear elastic materials. The rising linear R-curve is for a silicon carbide whisker/aluminum oxide matrix composite and shows the increasing fracture resistance effect of the whiskers. The rising non-linear R-curve is for monolithic polycrystalline magnesium aluminate spinel and the shape of the curve is similar to R-curves observed for unidirectional fibre reinforced materials such as silicon carbide fibre/silicon carbide matrix or carbon fibre/carbon matrix composites. This measurement procedure will be used to determine the effects of increasing fibre volume percent on fracture toughness, work-of-fracture, and crack growth resistance in silicon carbide fibre and carbon fibre reinforced/carbon matrix composites. Anticipated increases in the fracture resistances as functions of the fibre volume percent will indicate the 'toughening' mechanisms due to the fibres in these composite materials.

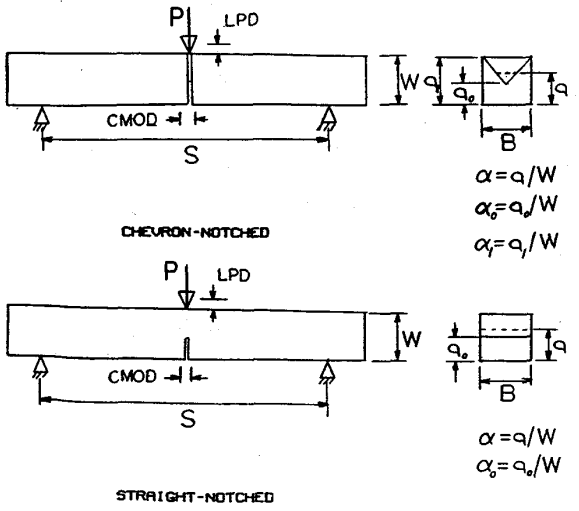

Figure 1 Comparison of chevron-notched and straight-notched geometries.

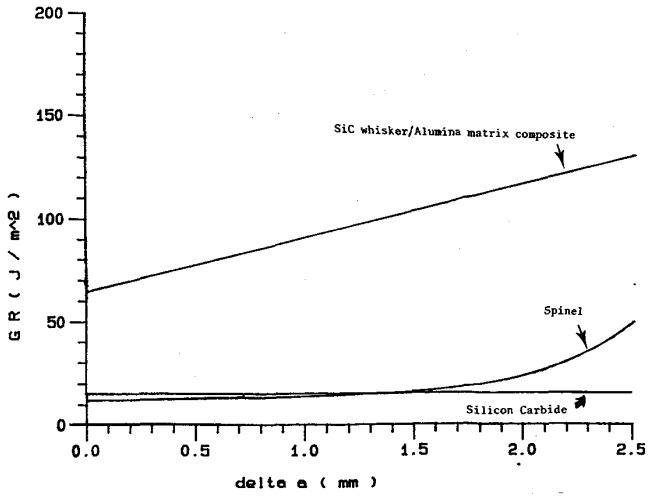

Figure 2 Crack growth resistance curves for various materials at room temperature.