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ELEVATED-TEMPERATURE FRACTURE RESISTANCES (K_{IC}, R-Curves, γ_{WOF}) OF MONOLITHIC AND COMPOSITE CERAMICS USING CHEVRON-NOTCHED, BEND TESTS

Asish Ghosh
Philips Display Components Company
1600 Huron Parkway, P.O. Box 963, Ann Arbor, MI 48106-0963

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Michael G. Jenkins and Mattison K. Ferber
Oak Ridge National Laboratory*
P.O. Box 2008, MS 6064, Oak Ridge, Tennessee 37831-6064, USA

Jouko Peussa
Federation of Finnish Metal, Engineering, and Electro-Technical Industries
Etelaranta10, SF00130, Helsinki, Finland

Jonathan A. Salem
NASA Lewis Research Centre
21000 Brookpark Road, MS 49-7, Cleveland, OH 44135, USA

The quasi-static fracture behaviours of monolithic ceramics (SiC, Si_3N_4, $MgAl_2O_4$), self-reinforced monoliths (acicular-grained Si_3N_4, acicular-grained mullite), and ceramic matrix composites (SiC whisker/Al_2O_3 matrix, TiB_2 particulate/SiC matrix, SiC fibre/CVI SiC matrix, Al_2O_3 fibre/CVI SiC matrix) were measured over the temperature range of 20°C to 1400°C.

The chevron-notched, bend bar test geometry was essential for characterizing the elevated-temperature fracture resistances of this wide range of quasi-brittle materials during stable crack growth. Fractography revealed the differences in the fracture behaviour of the different materials at the various temperatures. The predominantly transgranular fracture of fine-grained monoliths was contrasted with the mostly intergranular fracture interactions of the large-grained monoliths. The fracture resistances of the self-reinforced monoliths were comparable to those of the composites and the fracture mechanisms were found to be similar at room temperature. However at elevated temperatures the differences of the fracture behaviour became apparent where the superior fracture resistances of the self-reinforced monoliths were attributed to the minor amounts of glassy, intergranular phases which were often more abundant in the composites and affected the fracture behaviour when softened by elevated temperatures.

Possible fracture mechanisms are proposed for the microstructural- and temperature-dependence of the fracture behaviour of the various materials. Of particular concern are processing after-effects such as residual stresses which can contribute to the R-curve (or lack of R-curve) in the composites, the interactions of large grains during intergranular fracture in monoliths leading to the R-curves which develop with increasing crack length, the crack wake-bridging effects of whiskers and fibres in the composites which can produce dramatic, rising R-curves and large γ_{WOF} with relatively low K_{IC}'s, and finally the viscous effects of softened, glassy, intergranular phases on the stable crack growth behaviour of both monoliths and composites.

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