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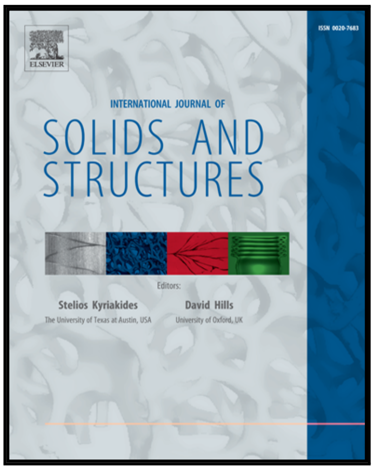

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Discrete Crack Dynamics: A Planar Model of Crack Propagation and Crack-Inclusion Interactions in Brittle Materials

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Abstract

The Multipole Method (MPM) is used to simulate the many-body self-consistent problem of interacting elliptical micro-cracks and inclusions in single crystals. A criterion is employed to determine the crack propagation path based on the stress distribution; the evolution of individual micro-cracks and their interactions with existing cracks and inclusions is then predicted using what we coin the Discrete Crack Dynamics (DCD) method. DCD is fast (semi-analytical) and particularly suitable for the simulation of evolving low-speed crack networks in brittle or quasi-brittle materials. The method is validated against finite element analysis predictions and previously published experimental data.

Keywords:
Crack-Inclusion interactions, Multipole Method, Discrete crack dynamics

1. Introduction

The path followed by a slowly propagating crack depends on the microstructure of the material, comprising features such as inclusions, grain boundaries and other cracks. Several techniques have been developed to predict crack paths. The finite element method (FEM) is one of the most widely used tools for studying stationary cracks and fracture along a pre-defined path (1–3), but localised features such as cracks, holes, and inclusions are not efficiently resolved by mesh refinement, and general path crack growth cannot be modelled accurately and efficiently using conventional FEM, which in part led to the development of the