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Modeling crack propagation in polycrystalline microstructure using variational multiscale method. (English) Zbl 1400.74096

Math. Probl. Eng. 2016, Article ID 4715696, 14 p. (2016).

Summary: Crack propagation in a polycrystalline microstructure is analyzed using a novel multiscale model. The model includes an explicit microstructural representation at critical regions (stress concentrators such as notches and cracks) and a reduced order model that statistically captures the microstructure at regions far away from stress concentrations. Crack propagation is modeled in these critical regions using the variational multiscale method. In this approach, a discontinuous displacement field is added to elements that exceed the critical values of normal or tangential tractions during loading. Compared to traditional cohesive zone modeling approaches, the method does not require the use of any special interface elements in the microstructure and thus can model arbitrary crack paths. The capability of the method in predicting both intergranular and transgranular failure modes in an elastoplastic polycrystal is demonstrated under tensile and three-point bending loads.

MSC:

74R10 Brittle fracture
74M25 Micromechanics of solids
74S05 Finite element methods applied to problems in solid mechanics

Full Text: DOI

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