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A Phase-Field Fracture Model for Brittle Anisotropic Materials

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ABSTRACT

Anisotropy is inherent in many materials, either because of the manufacturing process, or due to their microstructure, and can markedly influence the failure behavior. Anisotropic materials obviously possess both anisotropic elasticity and anisotropic fracture surface energy. Phase-field methods are elegant and mathematically well-grounded, and have become popular for simulating isotropic and anisotropic brittle fracture. Here, we developed a variational phase-field model for strongly anisotropic fracture, which accounts for the anisotropy both in elastic strain energy and in fracture surface energy, and the asymmetric behavior of cracks in traction and in compression. We implement numerically our higher-order phase-field model with mixed finite element, inspired by formulations for plate/shell elements, where similar continuity requirements exist. For strongly anisotropic materials, as reported in the recent experiments, one could obtain several crack propagation directions for a given loading configuration, depending on imperfections of the initial crack. From an energy point of view, the selection of crack propagation direction is dictated by local principle of the generalized maximum energy release rate. Herein, for the first time we examine numerically this local principle, reproduce the crack behaviors observed in recent experiments. Numerical simulations exhibit all the features of strongly anisotropic fracture.

KEYWORDS

Brittle fracture; anisotropy; phase-field model; strain-decomposition

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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