A micromechanics-based multiscale approach for simulating dynamic crack propagation

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ABSTRACT

Finite element-based micromechanics has been a useful tool for understanding brittle failure at micro and mesoscopic length scales. Growth and coalescence of microcracks are explicitly captured using cohesive interfaces, which also provide a way of modeling inter- and intragranular fracture mechanisms. However, due to the computational expense, systems-level (or macroscopic) simulations with grain-level resolution are currently out of reach.

In this presentation, we present our efforts towards the development of a concurrent multiscale approach aimed at modeling dynamic crack propagation across length scales. Our primary goal is to eliminate the need for phenomenological approaches that use rate-dependent constitutive laws in order to match simulation results with experimentally observed crack propagation speeds [1]. The approach uses a two-level multiscale model that passes boundary conditions from a macroscoipic level down to the microscale. Energy dissipated from cracking at the microstructural level is then passed back up and is used to modify rate-independent cohesive laws at the macroscopic level.

A significant discussion and overview of mesoscopic simulations, which allow both inter- and intragranular fracture will be covered. In addition, multiscale modeling aspects, including, but not limited to, implementation, treatment of boundary conditions across scales, size of representative volume element, and other issues are discussed.

REFERENCES

[1] F. Zhou, J.-F. Molinari, and T. Shioya, "A rate-dependent cohesive model for simulating dynamic crack propagation", *Engng. Fracture Mechanics.*, Vol. **72**, pp. 1383-1410, (2005).