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A PARALLEL, EXPLICIT, HIGH-ORDER DISCONTINUOUS GALERKIN METHOD FOR DYNAMIC CRACK PROPAGATION IN BRITTLE FRACTURE

A. Rosolen*, **M. Hautefeuille, A. Jean, G. Becker and R. Radovitzky**

Institute for Soldier Nanotechnologies, MIT
77 Massachusetts Avenue, Cambridge, MA 02139, United States
*rosolen@mit.edu

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An explicit high-order method for modeling dynamic brittle fracture of solids in three dimensions is presented. The approach is based on a combination of a high-order discontinuous Galerkin (DG) discretization of the continuum problem and cohesive zone models of fracture. Prior to fracture, the consistency, symmetrization and penalty terms arising from the DG formulation are enforced at interelement boundaries. When a specified failure criterion is satisfied at an interelement boundary, the DG interface flux terms are replaced by an extrinsic cohesive zone model, which describes the irreversible traction-separation law governing the fracture process and eventually leading to complete decohesion and the formation of new crack surfaces. Upon crack closure, the reinstatement of the DG terms guarantee the appropriate description of compressive waves across closed surfaces.

The main advantages of the method are: (i) accurate stress wave propagation with minimal dispersion errors and enhanced representation of stress and displacement fields because of the high-order discretization schemes, (ii) scalability in parallel computations since it is not required to change the topology of the mesh as cracks develop, and (iii) preservation of consistency and stability in the uncracked interfaces, thus avoiding issues with wave propagation typical of intrinsic cohesive element approaches.

We show the effectivity and the good performance of the method in classical problems involving stress wave propagation and fracture.

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