# A Rate-Dependent Interfacial Damage Model for Multiscale Dynamic Fracture

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Dynamic fracture in brittle and quasi-brittle materials is a multi-scale, multi-physics problem, with rapidly evolving geometry and complex failure mechanisms triggered by microscopic flaws. This presentation describes a new interfacial damage model for dynamic fracture and its application within an adaptive, asynchronous Spacetime Discontinuous Galerkin (aSDG) model for high-resolution multi-scale fracture simulations. We use a novel interfacial damage model to represent the fracture process. Rather than use damage to degrade an interfacial stiffness or traction-separation law, we use a scalar damage parameter to interpolate between bonded and debonded Riemann solutions, consistent with the governing equations in the bulk material. The Riemann solutions for debonded conditions account for separation, contact–stick and contact–slip modes, so crack opening, closure, and slip are handled in a dynamically consistent fashion. We introduce a new two-term damage evolution rule in which the traction acting across a potential fracture surface initiates and drives early stages of the damage evolution, while the velocity jump across the interface (i.e., opening and slip velocities) drives the later evolution. This provides more realistic response because the velocity term allows allows damage accumulation to continue, even if tractions fall below their critical threshold, as is consistent with the inertial aspects of dynamic fracture. Nucleation of new cracks is governed by a probabilistic description of microscopic flaws. Simulation examples demonstrate our model's ability to capture multi-scale fracture features, such as crack oscillations, micro-cracking and crack branching as well as the influence of loading and the stochastic microscale flaw model on the crack-pattern morphology.