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A simple model for dislocation emission mediated dynamic nanovoid growth JUSTIN WILKERSON, University of Texas at San Antonio, K.T. RAMESH, Johns Hopkins University — Failure of ductile metals has long been attributed to the microscopic processes of void nucleation, growth, and finally coalescence leading to fracture. Our traditional view of void nucleation is associated with interface debonding at second-phase particles. However, much of this understanding has been gleaned from observations of quasi-static fracture surfaces. Under more extreme dynamic loading conditions second-phase particles may not necessarily be the dominant source of void nucleating material defects, and a few key experimental observations of laser spall surfaces seem to support this assertion. Here, we motivate an alternative mechanism to the traditional view, namely shock-induced vacancy generation and clustering followed by nanovoid growth mediated by dislocation emission. This mechanism only becomes active at very large stresses, and thus it is desirable to establish a closed-form criterion for the macroscopic stress required to activate dislocation emission in porous materials. Following an approach similar to Lubarda and co-workers, we make use of stability arguments applied to the analytic solutions of the elastic interactions of dislocations and voids to derive the desired criterion. We then propose a dynamic nanovoid growth law that is motivated by the kinetics of dislocation emission. The resulting failure model is validated against a number of molecular dynamics simulations with favorable agreement. Lastly, we make use of our simple model to predict some interesting anomalous behaviors associated with high surface energies and nonlinear elasticity.

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