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Linking the Grain Scale to Experimental Measurements and Other Scales[1]

TRACY VOGLER, Sandia Natl Labs

A number of physical processes occur at the scale of grains that can have a profound influence on the behavior of materials under shock loading. Examples include inelastic deformation, pore collapse, fracture, friction, and internal wave reflections. In some cases such as the initiation of energetics and brittle fracture, these processes can have first order effects on the behavior of materials: the emergent behavior from the grain scale is the dominant one. In other cases, many aspects of the bulk behavior can be described by a continuum description, but some details of the behavior are missed by continuum descriptions. The multi-scale model paradigm envisions flow of information from smaller scales (atomic, dislocation, etc.) to the grain or mesoscale and the up to the continuum scale. A significant challenge in this approach is the need to validate each step. For the grain scale, diagnosing behavior is challenging because of the small spatial and temporal scales involved. Spatially resolved diagnostics have begun to shed light on these processes, and, more recently, advanced light sources have started to be used to probe behavior at the grain scale. In this talk, I will discuss some interesting phenomena that occur at the grain scale in shock loading, experimental approaches to probe the grain scale, and efforts to link the grain scale to smaller and larger scales.

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