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# TOWARD ROBUST AND ACCURATE CALCULATION OF FRAGMENTATION

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We consider the fragmentation of a metal object by way of shock loading. The metal may be the casing of a munition accelerated by the detonation of an internal charge of explosive. Stress in the metal satisfies a yield condition based on an isotropic hardening model; its failure depends on the plastic strain associated with the stress. Shock loading conditions are determined by the nature of the explosive, defined mainly by its Equation--of--State and combustion energetics. In general this is a multifield problem involving both fluid fields and solid fields that interact with each other within some finite spatial domain. We use statistical (ensemble) averages to determine the dynamical equations for each material, the result of which is a multifield model having field equations for each material that are coupled via interface interaction terms. Closure for the interaction terms is accomplished by correlation to data from either experiment or from Direct Numerical Simulations specific to the materials of interest.

Here we focus on the numerical problem associated with the forward time integration of the multifield model equations, starting with specified (and arbitrary) initial conditions. The method described here uses an Eulerian frame of reference for nonviscous fluid materials (like the explosive product gases) and a Lagrangian frame of reference for the stress--bearing solid materials (metal layers). The common frame, necessary for computing the interactions of mass, linear momentum and energy, is the Eulerian one. We call this a mixed frame calculation in which we choose the reference frame in a materialwise fashion in order to obtain the most accurate and robust numerical solutions for each material field. Transport of the Eulerian field states is accomplished using a high--order advection scheme; Lagrangian field states are transported using mass markers (particles) on which the full thermodynamic state is preserved. Accuracy is maximized by using space--time centered numerical fluxes in the conservation equations. Robustness is maximized by locally time advancing the fluxes in accordance with rules from Total Variation Diminishing schemes in the literature. The numerical stability condition is given, and depends on the TVD method. The paper describes the numerical recipe in semi--discrete form, and includes one fragmentation example calculation with comparison to experimental data. We conclude that the mixed frame approach has significant promise for problems in fragmentation.