SHOCK13-2012-000005

Abstract for an Invited Paper
for the SHOCK13 Meeting of
the American Physical Society

An Overview of Mesoscale Material Modeling with Eulerian Hydrocodes[1]

KARL OLNEY, University of California, San Diego

Eulerian hydrocodes were originally developed for simulating strong shocks in solids and fluids, but their ability to handle arbitrarily large deformations and the formation of new free surfaces makes them attractive for simulating the deformation and failure of materials at the mesoscopic scale. A summary of some of the numerical techniques that have been developed to address common issues for this class of problems is presented with the shock compression of powders used as a model problem. Achieving the correct packing density with the correct statistical distribution of particle sizes and shapes is, in itself, a challenging problem. However, since Eulerian codes permit multiple materials within each element, or cell, the material interfaces do not have to follow the mesh lines. The use of digital image processing to map the pixels of micrographs to the Eulerian mesh has proven to be a popular and useful means of creating accurate models of complex microstructures. Micro CT scans have been used to extend this approach to three dimensions for several classes of materials. The interaction between the particles is of considerable interest. During shock compression, individual particles may melt and form jets, and the voids between them collapse. Dynamic interface ordering has become a necessity, and many codes now have a suite of options for handling multi-material mechanics. True contact algorithms are now replacing multi-material approximations in some cases. At the mesoscale, material properties often vary spatially due to sub-scale effects. Using a large number of material species to represent the variations is usually unattractive. Directly specifying the properties point-wise as history variables has not proven successful because the limiters in the transport algorithms quickly smooth out the variations. Circumventing the limiter problem is shown to be relatively simple with the use of a reference configuration and the transport of the initial coordinates.

[1]Research supported by Los Alamos National Laboratory and the Office of Naval Research