Dynamic Strength of Metals in Shock Deformation

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The Hugoniot and critical shear strength of shock-compressed metals can be obtained directly from molecular dynamics simulations without recourse to surface velocity profiles and their analyses. Results from simulations in aluminum containing an initial distribution of microscopic defects are shown to agree with experimental results.

We give a brief account of mapping results from MD simulations on a continuum description for the spatial and temporal distributions of all the thermodynamic variables: temperature, stresses and their rates, strains and their rates, and derivative parameters such as pressure, density, von Mises stress, and plastic strain and strain rates. With this information, it is then possible to directly relate pressure to density and temperature, and thereby construct Hugoniot curves of solid and liquid materials, without recourse to the Rankine-Hugoniot relationships. We can also directly determine the dynamic strength of materials from the spatial distribution of the von Mises stress.