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A dislocation dynamics model of the plastic flow of fcc polycrystals ABIGAIL HUNTER, DEAN PRESTON, Los Alamos National Laboratory — Plastic constitutive models applicable at strain rates of roughly $10^5 s^{-1}$ and higher are essential for simulations of material deformation and failure under shock wave loading. Accurately describing deformation physics in this strain rate regime remains a challenge due to the break down of fundamental assumptions that apply to material strength at low strain rates. Furthermore, continuum-scale models traditionally have difficulty accounting for specific mesoscale deformation behavior due to the larger length scales (tens to hundreds of microns) at which these models are applicable. Nevertheless, it is possible to construct a reliable, analytic dislocation dynamics based model of the flow stress as a function of strain, strain rate, temperature, and material density. We present a dislocation dynamics model of the plastic flow of fcc polycrystals from quasi-static to very high strain rates, pressures from ambient to 1000 GPa, and temperatures from zero to melt. The model is comprised of three coupled ordinary differential equations: a kinetic equation, which relates the strain rate to the stress, mobile and immobile dislocation densities, mass density, and temperature, and two equations describing the evolution of the mobile and immobile dislocation densities. Preliminary results will be presented. The relative importance of various deformation mechanisms vs. strain, strain rate, and temperature will be discussed.

Abigail Hunter
Los Alamos National Laboratory

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