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High strain-rate plastic flow in Fe and Al RAYMOND SMITH[1], JON EGGERT, ROBERT RUDD, Lawrence Livermore National Laboratory, CYNTHIA BOLME, Los Alamos National Laboratory, GILBERT COLLINS, Lawrence Livermore National Laboratory — Understanding the nature and time-dependence of material deformation at high strain rates is an important goal in condensed matter physics. Under dynamic loading, the rate of plastic strain is determined by the flow of dislocations through the crystal lattice and is a complex function of time, distance, sample purity, temperature, internal stresses, microstructure and strain rate. Under shock compression time-dependent plasticity is typically inferred by fitting elastic precursor stresses as a function of propagation distance with a phenomenologically based dislocation kinetics model. We employ a laser-driven ramp wave loading technique to compress 6-70 micron thick samples of bcc-Fe and fcc-Al over a strain rate range of 1e6-1e8 1/s. Our data show that for fixed sample thickness, stresses associated the onset of plasticity are highly dependent on the strain rate of compression and do not readily fit into the elastic stress - distance evolution descriptive of instantaneous shock loading. We find that the elastic stress at the onset of plasticity is well correlated with the strain rate at the onset of plastic flow for both shock- and ramp-wave experiments. Our data, combined with data from other dynamic compression platforms, reveal a sharp increase in the peak elastic stress at high strain rates, consistent with a transition in dislocation flow dominated by phonon drag.

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