MODELING OF DEFORMATION AND PATTERNING IN FCC SINGLE CRYSTALS AT HIGH STRAIN RATES

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Plastic deformation at high pressure and high strain rate involves many uncertainties that current experimental capabilities cannot address. Current laser based experiments can address deformation and material strength at pressures < ~ 100 G.Pa. Since the deformation physics is a mutiscale problem, developing a good understanding of the material response to high strain rate requires development of models that are applicable at each spatial scale. The aim of this work is to investigate the response of FCC single crystals to ultra high strain rate loadings. A multiscale model of plasticity that couples discrete dislocation dynamic and finite element analyses is used to study the interaction between dislocations and shock waves. Computer simulations were carried out to study the deformation process in copper and aluminum crystals. The effect of strain rate, shock pulse duration, crystal orientation, and the nonlinear elastic properties were studied. Relaxed configurations using dislocation dynamics show formation of dislocation micro bands and weak dislocation cells microstructures. Statistical analysis of the dislocation microstructures were carried out to study the characteristics of the local dislocation densities and the distribution of the instantaneous dislocations velocities.