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Modeling Single-Crystal Microstructure Evolution due to Shock Loading JEFFREY LLOYD, Georgia Institute of Technology, JOHN CLAYTON, US Army Research Laboratory, DAVID MCDOWELL, Georgia Institute of Technology — An existing high strain rate viscoplastic (HSRVP) model is extended to address single-crystal anisotropic, elastic-plastic material response and is implemented into a steady plastic wave formulation in the weak shock regime. The single-crystal HSRVP model tracks nucleation, multiplication, annihilation, and trapping processes of dislocations, as well as thermally activated and phonon drag regimes. The steady plastic wave formulation is used to model the evolving elastic-plastic response with respect to a propagating longitudinal wave, and assumes that the magnitude of quasi-transverse waves is negligible. This steady wave analysis does not require specification of artificial viscosity, which can give rise to spurious dissipative effects. The constitutive model and its numerical implementation are applied to single-crystal pure Al and results are compared with existing experimental and computational data. Dislocation evolution, lattice reorientation, and macroscopic velocity-time histories are tracked for different initial orientations subjected to varying peak shock pressures. Results suggest that initial material orientation can significantly influence microstructure evolution, which in turn has been shown to influence damage behavior during tensile unloading.

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