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Plasticity and spall in high density polycrystals: modeling and simulation JOHN CLAYTON, U.S. Army Research Laboratory, Impact Physics Branch — The dynamic thermomechanical response of a tungsten alloy is investigated via modeling and simulation. The material of study consists of relatively stiff pure tungsten grains embedded within a more ductile alloy comprised of tungsten, nickel, and iron. Constitutive models account for finite deformation, heat conduction, plastic anisotropy, strain-rate dependence of flow stress, thermal softening, and thermoelastic coupling. The potentially nonlinear volumetric response at large pressures is addressed by a pressure-dependent effective bulk modulus. Our framework provides a quantitative prediction of the total dislocation density, associated with cumulative strain hardening in each phase, and enables calculation of the fraction of plastic dissipation converted into heat energy. Cohesive failure models are employed to represent intergranular fracture at grain and phase boundaries. Dynamic finite element simulations illustrate the response of volume elements of the polycrystalline microstructure subjected to compressive impact loadings, ultimately resulting in spall of the material. Relative effects of mixed-mode interfacial failure criteria, thermally-dependent fracture strengths, and grain shapes and orientations upon behavior are weighed. Spatially resolved profiles of particle velocities at the free surfaces of the volume elements indicate the degree to which the incident and reflected stress waves are altered by the heterogeneous microstructure.

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