MICROSTRUCTURAL EFFECTS ON DAMAGE EVOLUTION IN SHOCKED COPPER POLYCRYSTALS

E.J. Lieberman[1,2], R.A. Lebensohn[2], C.A. Bronkhorst[3], A.D. Rollett[1]

1. Department of Materials Science and Engineering,
Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, USA
2. Materials Science and Technology Division, Los Alamos National Laboratory, MS G755, Los Alamos, NM 87455, USA
3. Theoretical Division, Los Alamos National Laboratory, MS B216, Los Alamos, NM 87455, USA

Focus Material: Metals

Focus of the Presentation: *Physics-based multi-scale model development*

Abstract

Three-dimensional crystal orientation fields of a copper sample, characterized before and after shock loading using High Energy Diffraction Microscopy (HEDM), are used for input and validation of direct numerical simulations using a Fast Fourier Transform (FFT)-based micromechanical model. The locations of the voids determined by X-ray tomography in the incipiently-spalled sample, predominantly found near grain boundaries, were traced back and registered to the pre-shocked microstructural image. Using FFT-based simulations with direct input from the initial microstructure, micromechanical fields at the shock peak stress were obtained. Statistical distributions of micromechanical fields restricted to grain boundaries that developed voids after the shock are compared with corresponding distributions for all grain boundaries. Distributions of conventional measures of stress and strain (deviatoric and mean components) do not show correlation with the locations of voids in the post-shocked image. Neither does stress triaxiality, surface traction or grain boundary inclination angle, in a significant way. On the other hand, differences in Taylor factor and accumulated plastic work across grain boundaries do correlate with the occurrence of damage. Damage was observed to take place preferentially at grain boundaries adjacent to grains having very different plastic response.