Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

3D bulk grain evolution in polycrystalline Cu:comparison between HEDM observation and FFT based crystal plasticity simulations

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ABSTRACT

In this study, microstructural evolution in polycrystalline Cu is studied via high-energy X-ray diffraction microscopy (HEDM) and compared to the results of a fast Fourier transform (FFT) based small strain formulation of a crystal plasticity (CP) deformation model [1]. The nondestructive nature of the HEDM experiments enable in-situ measurement of bulk samples, thus allowing access to volumetric microstructure maps through multiple stages of deformation. A uniaxial tension experiment was performed and the reconstructed 3D image [2] of the initial state is used as a direct input in the CP-FFT model to simulate plastic deformation. Macroscopic texture evolution as well as local micromechanical fields evolution within individual 3D bulk grains are tracked and the prediction is compared with the observed phenomena. On a global scale, reasonable agreement is observed between the two results, whereas, only a weak match is demonstrated at grain level [3]. From the current results, we conclude the need for incorporating neighborhood effects and multigrain interactions in the polycrystalline models to improve the predictive capability.

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