Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Computational modeling of dislocation evolution and strain hardening in deformed metals

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ABSTRACT

We develop a continuum model of dislocation dynamics that predicts the main features of the crystal plasticity at the mesoscale. The model is based on a set of kinetic equations of the curl type that govern the space and time evolution of the dislocation density in all slip systems. These equations can take cross-slip and short range reactions into account. The kinetic equations are coupled with crystal mechanics, stress equilibrium, through a staggered finite element scheme customized to capture the crystallographic nature. The results for the evolution of dislocation density, dislocation patterns, lattice rotation field, and stress–strain relationships are going to be presented. These features are compared with X-ray measurements and that obtained by discrete dislocation dynamics. This study was supported by the U.S. DOE Office of Basic Energy Sciences, Division of Materials Science & Engineering via contract # DEFG02-08ER46494 at Florida State University and by funding from the School of Nuclear Engineering at Purdue University.