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Deformation induced grain rotations in single crystal tantalum

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ABSTRACT

Validation studies of crystal plasticity finite element models typically compare model predictions of strain fields with experimental measurements; often ignored are the grain rotations predicted by the model. Accurate predictions of crystallographic rotations are necessary for trustworthy predictions of strain fields, deformed texture, and failure. This is especially important for body centered cubic (BCC) metals because the exact nature of BCC slip is still under debate [1]. Orientation changes caused by deformation in BCC materials have been predicted by models [2], but little experimental data exists that can confirm or contradict these predictions. To further complicate the situation, there are indications that grain rotations follow different paths in different BCC metals (e.g., Mo and Ta). This study presents experimental measurements of grain rotations in single crystal Ta resulting from quasistatic deformation using multiple techniques. In one set of experiments, single crystal specimens are loaded using an in situ load frame within a scanning electron microscope. Crystallographic rotation is directly observed by repeated EBSD measurements at several load levels. In other experiments, grain orientations (measured by X-ray diffraction and/or EBSD) are compared before and after loading to specific strain levels. Full-field measurements of strain are made during loading to relate orientation changes to local deformation behavior. These grain rotation measurements are compared to predictions from a BCC crystal plasticity model [3] to examine the effects of model choices. Ultimately, these experiment-model comparisons should improve crystal plasticity model predictions of re-orientations and strains, not only for single crystals, but for polycrystals as well. Sandia National Laboratories is a multiprogram laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

REFERENCES

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