Comparison of Mesoscale Finite Element Deformation Modeling with Measurements using X-ray microscopy*

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The deformation of a nickel bi-crystal under tension is simulated using a mesoscale finite element model, and the results are compared with corresponding experiments. The simulations make use of crystal plasticity to model the material constitutive response, and discretization of the bi-crystal with a large number of elements to capture the heterogeneous deformation of each crystal. The simulations are used to predict changes in the orientation of each crystal during deformation, and the results are compared with experimental measurements of grain reorientations. The measurements are made using a polychromatic three-dimensional X-ray microscope which can provide in-situ spatially resolved orientation data at the sub-micron scale in individual grains during deformation of polycrystalline samples. Such detailed comparisons provide a valuable means to evaluate the capability of the crystal plasticity based finite element simulations to model the heterogeneous microstructure evolution during deformation of polycrystalline materials.

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