Finite element modeling of the deformation of 3D polycrystals including the effect of grain size distribution[1]

Wei Li and Nicholas Zabaras
Materials Process Design and Control Laboratory
Sibley School of Mechanical and Aerospace Engineering
188 Frank H T Rhodes Hall
Cornell University
Ithaca, NY 14853-3801

A finite element analysis of the large deformation of 3D polycrystals is presented using pixel-based elements as well as elements conforming with grain boundaries. The macroscopic response is obtained through volume-averaging laws using a recently developed homogenization model. A constitutive framework for thermo–elastic-viscoplastic response of single crystals is utilized along with a fully-implicit Lagrangian finite element algorithm for modeling microstructure evolution. The effect of grain size distribution is included by considering a physically motivated measure of lattice incompatibility which provides an updated shearing resistance within grains. A domain decomposition approach is adopted for parallel computation to allow efficient large scale simulations. The computed mechanical properties of polycrystals are shown to be consistent with experimental results for different grain size distributions.

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