Society of Engineering Science 51st Annual Technical Meeting

1–3 October 2014

Purdue University, West Lafayette, Indiana, USA

Nondestructive determination of subsurface grain morphology

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ABSTRACT

Recent progress in experimental and numerical methods enables to scrutinize simulated polycrystal surface micromechanics at high spatial resolution. For the correct interpretation of similarities and deviations between experiment and simulation, the consideration of subsurface grain morphology is imperative because of its significant impact on the surface layer boundary condition. A novel method is presented that coarsely scans a relatively large area for subsurface crystallite orientation up to depths of ~0.2 mm by means of differential aperture X-ray microscopy. The resulting point set is categorized into grains according to proximity in physical and orientation space. Reconstruction of the subsurface grain structure starts with a Voronoi tessellation using the categorized set as seed points. Progressive smoothing of the resulting ragged grain boundary surfaces is achieved through mean curvature flow. As it turns out that the reconstruction quality of the bulk and on the surface are related, the latter can serve as guidance for optimum subsurface reconstruction.