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Micron-Resolution X-ray Structural Microscopy Studies of 3-D Grain Growth in Polycrystalline Aluminum

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Micron-Resolution X-ray Structural Microscopy Studies of 3-D Grain Growth in Polycrystalline Aluminum

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We describe a new polychromatic x-ray microdiffraction technique providing 3D measurements of lattice structure, orientation and strain with submicron point-to-point spatial resolution. The instrument is located on the UNI-CAT II undulator beamline at the Advanced Photon Source and uses Kirkpatrick-Baez focusing mirrors, differential aperture CCD measurements and automated analysis of spatially-resolved Laue patterns. 3D x-ray structural microscopy is applicable to a wide range of materials investigations and here we describe 3D thermal grain growth studies in polycrystalline aluminum (~1% Fe,Si) from Alcoa. The morphology and orientations of the grains in a hot-rolled aluminum sample were initially mapped. The sample was then annealed to induce grain growth, cooled to room temperature, and the same volume region was re-mapped to determine the thermal migration of all grain boundaries. Significant grain growth was observed after annealing above ~350°C where both low-angle and high-angle boundaries were mobile. These measurements will provide the detailed 3D experimental input needed for testing theories and computer models of 3D grain growth in bulk materials.

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