High-Resolution Reciprocal Space Mapping for Characterizing Deformation Structures - DTU Orbit (18/10/2019)

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With high-angular resolution three-dimensional X-ray diffraction (3DXRD), quantitative information is gained about dislocation structures in individual grains in the bulk of a macroscopic specimen by acquiring reciprocal space maps. In high-resolution 3D reciprocal space maps of tensile-deformed copper, individual, almost dislocation-free subgrains are identified from high-intensity peaks and distinguished by their unique combination of orientation and elastic strain; dislocation walls manifest themselves as a smooth cloud of lower intensity. The elastic strain shows only minor variations within each subgrain, but larger variations between different subgrains. On average, subgrains experience backward strains, whereas dislocation walls are strained in a forward direction. Based on these observations the necessary revision of the classical composite model is outlined. Additionally, subgrain dynamics is followed in situ during varying loading conditions by reciprocal space mapping: during uninterrupted tensile deformation, formation of subgrains is observed concurrently with broadening of Bragg reflections shortly after the onset of plastic deformation. When the traction is terminated, stress relaxation occurs, but no changes in number, size and orientation of the subgrains are observed. The radial profile asymmetry becomes reversed, when pre-deformed specimens are deformed in tension along a perpendicular axis.

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In that case, because of the difficulty of isolating unambiguously a single-grain ÂµLaue pattern, a reliable analysis of strains is tedious manually and hardly achievable with current automated methods. This issue is even more severe for low-symmetry crystals or when high-energy X-rays are used, since each single-crystal ÂµLaue pattern already contains a large number of spots.Â The capabilities of this `EBSD-assisted ÂµLaue' automated method are illustrated on a monoclinic zirconia-based specimen and ÂµLaue diffraction patterns are analysed with the crystal orientation input from EBSD.Â Strain and Dislocation Gradients from Diffraction:Spatially-Resolved Local Structure and Defects. Rozaliya Barabash, Gene E. Ice. 2014. PDF | Spatially resolved X-ray diffraction (SRXRD) is applied for micro-imaging of strain in laterally modulated epitaxial structures. In GaAs layers grown by liquid phase epitaxial lateral overgrowth (ELO) on SiO2-masked GaAs substrates a downward tilt of ELO wings caused by their...Â   Diffraction profiles for different models of dislocation arrangements are calculated directly by the Monte Carlo method and compared with the strain distributions for the same arrangements, which corresponds to the Stokes-Wilson approximation. It is shown that the strain distributions and the diffraction profiles are in close agreement as long as long-range order is absent. Analytical calculation of the strain distribution for uncorrelated defects is presented. For straight dislocations, the Stokes-Wilson and the Krivoglaz-Wilkens approximations give the same diffraction profiles, with the Gau