KFM 8: Microscopy and Tomography with X-ray Photons, Electrons, Ions and Positrons

Chair: Theo Scherer (KIT Karlsruhe)

Time: Monday 12:10–13:10 Location: EMH 025

KFM 8.1 Mon 12:10 EMH 025

High angular momentum vortex electron beams in crystals — •Christian Bick and Dorothee Hüser — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

Since the introduction of beams with an orbital angular momentum (OAM), commonly known as vortex electron beams, into scanning transmission electron microscopy (STEM), they have been used in electron magnetic circular dichroism (ECMD) and nanoparticle manipulation [1]. Understanding the behaviour of these beams in material can help to better interpret experimental results. Previous studies have shown that vortex electron beams change their angular momentum as they propagate through the crystal. This change can be modelled by a superposition of eigenstates of the OAM operator [2,3].

We present a simulation-based study on the behaviour of higher order angular momentum vortex electron beams in crystalline material. The study is based on multislice calculations, which are commonly used in simulating STEM measurements.

[1] S. M. Lloyd, M. Babiker, and J. Yuan, Phys. Rev. A 86, 023816 (2012).
[2] S. Löffler and P. Schattschneider, Acta Crystallogr. A 68, 443 (2012).
[3] A. Lubk et al., Phys. Rev. A 87, 033834 (2013).

KFM 8.2 Mon 12:30 EMH 025

Three dimensional classification of dislocations from single projections — •Tore Niermann, Laura Niermann, and Michael Lehmann — Technische Universität Berlin, Berlin

Many material properties are governed by dislocations and their interactions. Examples range from strengthening of metals and alloys to efficiency in semiconductor laser devices. Thus, knowledge of the three dimensional topology of dislocation networks is crucial for material engineering. A two-dimensional projection of dislocation networks can be readily obtained by conventional (scanning-) transmission electron microscopy (S/TEM) images. However, the reconstruction of the three-dimensional structure of the network so far is mainly achieved by tomographic tilt series with high angular ranges, which is experimentally challenging and additionally puts constraints on possible specimen geometries. Here, we present a new way to reveal the three dimensional position of dislocations and simultaneously classify their type from single 4D-STEM measurements. The dislocation's strain field causes inter-band scattering between the electron's Bloch waves within the crystal. This scattering in turn causes characteristic interference patterns with sufficient information to uniquely identify the dislocations type and position in electron beam direction by comparison with multi-beam calculations. We expect this principle to lead to fully automated methods for reconstruction of the three dimensional strain fields from 4D-STEM measurements in future.

KFM 8.3 Mon 12:50 EMH 025

Lattice strain distribution within BCC polycrystals - How does the local grain neighbourhood influence strain localization — •Konrad Prikoszovich[1], Jonathan Wright[2], Wolfgang Ludwig[2,3], Patric Gruber[1], and Christoph Kirchlechner[1] — [1]Institute for Applied Materials IAM, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]ESRF- European Synchrotron Radiation Facility, Grenoble, France — [3]MATEIS, INSA Lyon, Villeurbanne, France

Strain and stress heterogeneities determine the lifetime and failure of structural materials. The relationship between macroscopic and microscopic stresses is central for a quantitative understanding of the mechanical behaviour of polycrystalline materials. We performed Diffraction Contrast Tomography (DCT) measurements at ID11, ESRF, to determine the shape, arrangement, orientation and average elastic strain tensor of a representative ensemble of grains during mechanical loading. Here, we want to present our results from the latest beam time, where we managed to investigate up to 10000 grains during tensile deformation. Different annealing protocols have been utilized prior to the experiments to vary the eigenstrains of our samples in order to investigate how those eigenstrains affect the strain localization during loading. By analysing the different local microstructural aspects present in this unique dataset, we hope to identify parameters, which promote strain localization. This information can then be used to design microstructures with improved resilience against strain localization, leading to a higher lifetime of structural materials.