Karlsruher Institut für Technologie

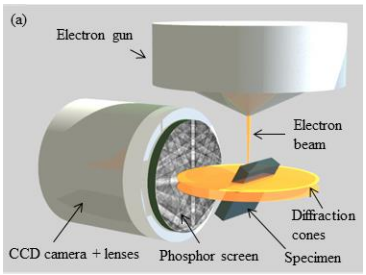
Laboratorium für Elektronenmikroskopie

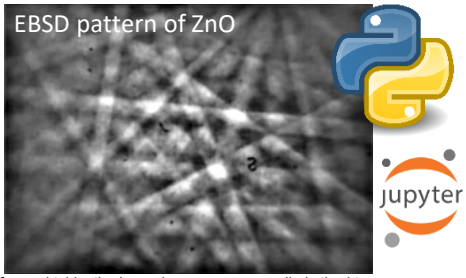
Bachelor Thesis

Establishing a Data Processing Pipeline for Electron Backscatter Diffraction (EBSD) Analysis

Motivation

Electron backscatter diffraction (EBSD) is a valuabe electron microscopy technique to determine the local crystal orientation and grain structure of a polished sample surface. In EBSD, a nm-sized electron beam is scanned across the sample and at each position a full electron diffraction pattern of the backscattered electrons is captured. The generated datasets have increasingly large file sizes (multiple GBs in a few minutes). At the Laboratory for Electron Microscopy (LEM), we have an EBSD system and we want to explore modern data processing approaches, e.g., unsupervised machine learning techniques such as principal component analysis (PCA). However, the vendor-specific file format prevents simple export of the data into, e.g., Python. This prevents the use of state-of-the-art processing algorithms.
In this work, we try to develop a data extraction and processing routine, starting from the actual data acquisition at the scanning electron microscope and ending at crystallographic information of the sample. We want to use Jupyter notebooks and Python to explore various data analysis and image processing workflows to extract the most information from the recorded EBSD patterns.





Left: Scheme of EBSD acquisition. Backscattered electrons from a highly tilted sample generate a so-called Kikuchi pattern on a phosphor screen, that is then captured by a camera (https://en.wikipedia.org/wiki/Electron_backscatter_diffraction).
Right: Exemplary EBSD pattern showing Kikuchi bands from electron diffraction.

Tasks

- Recording of exemplary EBSD diffraction patterns at a scanning electron microscope
- Setup of a workflow to convert the EBSD data into Python-readable format
- Subsequent exemplary analysis within Python using „Kikuchipy“, possibly in combination with other Python packages
- Exploration of image-denoising and machine-learning algorithms

Timeline

- **1st month**: Introduction to the topic by books/paper reading, clarification of the problem, learning microscope usage, and acquiring EBSD test data sets
- **2nd month**: Reading vendor data into Python, analyzing the data with different processing routines, iterating results/next steps with the supervisor
- **3rd month**: Summarizing the results into clear figures, writing of the thesis, giving a final presentation in the institute seminar

Goals:

- Development of a pipeline to extract and analyze EBSD patterns within Python
- Exploration of different data processing steps to optimize EBSD data analysis

What you will learn:

- Usage of a scanning electron microscope with an EBSD detector
- Multidimensional data processing with Python, including unsupervised machine learning
- Interpretation and presentation of experimental results

What you bring:

- Studies in physics, computer science, materials science, or similar disciplines
- Motivation to learn new topics and to work with Python and Jupyter notebooks

Starting date:

- To be determined

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