Karlsruher Institut für Technologie

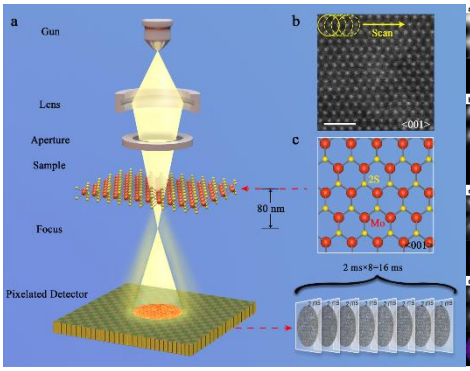
Laboratorium für Elektronenmikroskopie

Masterthesis

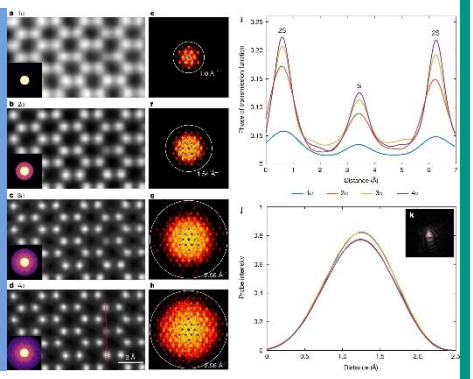
Setting up Electron Ptychography workflow and application on nanomaterials

Motivation

The phase of the electron wave is lost during image acquisition in (scanning) transmission electron microscopy ((S)TEM). However, it carries valuable information on the investigated specimens, making phase reconstruction mechanisms interesting. The development of aberration correctors and fast direct electron detectors allow the phase reconstruction via electron ptychography beyond the technical resolution limit of the microscope through the reconstruction of amplitude and phase of both the illuminating electron beam and of the specimen in an iterative process from a dataset of experimental diffraction patterns. Our new transmission electron microscope is equipped with both aberration corrector and direct electron detector and the goal of this thesis is to establish electron ptychography in our lab.



The electron beam is scanned over the specimen and diffraction patterns are acquired at various beam positions to obtain the dataset for ptychographic reconstruction [1].



Example ptychographic reconstruction of MoS2, comparing different virtual apertures for reconstruction [2].

Tasks

- Familiarization with scanning transmission electron microscope
- Literature research on electron ptychography methods
- Development of ptychographic reconstruction algorithm and test on simulated data
- Acquisition of experimental datasets on suitable specimens
- Application of developed algorithm on experimental dataset

Tentative timeline

- 1st-3rd month: literature review and introduction to STEM
- 4th-7th month: Development of reconstruction algorithm
- 8th-10th month: Data acquisition and analysis
- 11th-12th month: Thesis writing

[1] Song, J. *et al. Sci Rep* **9**, 3919 (2019).
[2] Jiang, Y. *et al*. *Nature* **559**, 343–349 (2018).

Research area:
Scanning transmission electron microscopy, Phase reconstruction, Data analysis

What you will learn:
Scanning Transmission Electron Microscopy, Ptychography reconstruction

What you bring:
Master student in physics, experience in computer-based data analysis

Starting date:
Spring of 2026

Language:
English or German

Contact:

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