Master Thesis

Automated Image Segmentation for Transmission Electron Microscopy (TEM) Images

The human eye and brain work well together for the understanding and interpretation of images. Therefore, humans can be well trained when it comes to interpret TEM mages correctly in order to distinguish physical and chemical effects such as thickness contrast, chemical or diffraction contrast. Automated image analysis and segmentation methods generally struggle with these tasks, but with advances in computer vision, supervised machine learning segmentation algorithms have become powerful and also easy to use tools for such applications.

TEM provides images with nanometer down to atomic resolution, and can serve as basis for a quantitative analysis for many cases. Examples are size and distribution of nanoparticles, precipitates or crystallographic grains in materials or liposomes in biological samples. At the same time, we do not only deal with single images, but also with multi-dimensional data stemming from multiple detectors and/or tomographic 3D reconstructions.

This master thesis deals with the analysis of these tasks und shall bring up reliable procedures for automated image segmentation of TEM images for specific case studies using single images, 3D volumes, multidetector image stacks and multichannel data (EELS, EDX, HAADF, ADF, BF, …). For this purpose, you will employ existing (open-source) software (e.g. https://www.ilastik.org/) to find solutions for specific model cases, and link the quantification results to materials properties.

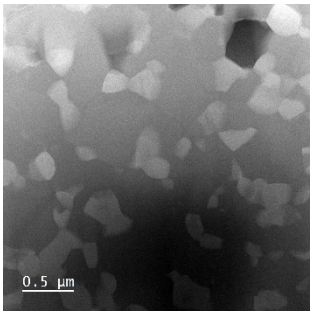
Tasks:

- Literature research to already existing methods for TEM images
- Get to know existing software and evaluate alternative software
- Understand basic functionality of segmentation algorithms, and define necessity of data pre-processing
- Apply and analyze techniques to several cases:
    - Grain size analysis
    - Size analysis for areas with different chemical composition
    - Segmentation using 3D data (STEM tomography)
    - Geometric analysis of liposomes
- Elaborate recipes based on the analyzed cases

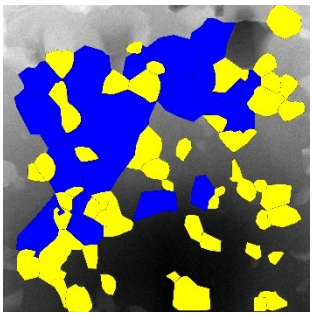
Your background:

- Technical Physics
- Advanced Materials Science
- Knowledge on TEM beneficial
- Interest in image processing & machine learning
- Programming skills beneficial, but not necessary

Start: June 2021/as soon as possible
Scholarship: 440€/month



Grains in a sample with thickness gradient


Incomplete grain size analysis

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