

Scanning TEM

Goal

In this experiment, you will be introduced to another transmission electron microscope, the Tecnai F30. This is a 300 kV field-emission gun energy-filtering high-resolution analytical scanning transmission electron microscope - a state-of-the-art instrument. Since this instrument has a rather complicated illumination system and the computer interface integrates many different functions (including still imaging, STEM imaging, and all analytical capabilities), operating of this instrument is somewhat more complex than the operation of the Philips CM20. Therefore, the set up of the instrument in this laboratory will be run as a demonstration.

The purpose of this laboratory is to familiarize you with the practical usage of scanning transmission electron microscopy. The specimen for this experiment is a thin foil of polycrystalline aluminum.

Experiment

1. In conventional bright-field still imaging, locate a specimen area that you can easily identify.
2. Switch to STEM mode and insert the HAADF detector.
3. In the search mode, relocate the area previously identified.
4. Choose a camera large length and a large spot size.
5. Observe the STEM image and discuss the visible features of the microstructure.
6. Experiment with the effect of changing scanning parameters, for example the scan rate, the dwell time, etc.
7. Change magnification until you can see that the spatial resolution is limited.
8. Optimize the contrast and record images.
9. Study the effect of misaligning / aligning the condensor stigmators. Record images that document the effect.
10. Reduce the spot size and observe the effect on the spatial resolution. Record images to document this effect.
11. Change the camera length to smaller values and observe how this affects this STEM image. Record images to document this effect.
12. Record bright-field and dark-field *still* images from the same specimen area at the same magnification you have used for STEM.

Report

- What are the main conceptual differences between the Tecnai F30 and the CM20? Why is the Tecnai F30 a "better" transmission electron microscope?
- How do you set up the STEM mode? What are the most important parameters and how do they influence the image?
- Compare STEM to still imaging TEM. What practical advantages and disadvantages did you find?
- Explain the principle of a HAADF (high-angle annular dark-field) detector. What is the advantage of having this detector instead of having a bright-field detector?
- What is the significance of the spot size? What do you gain decreasing the spot size - and what do you lose?
- Discuss the importance of aligning the condenser stigmators.
- What is the role of the camera length in HAADF STEM imaging?
- Compare your STEM images compare with the BF and DF still images and explain the differences.