

Imaging I

Goal

This experiment will be carried out with a polycrystalline metal foil. The goal is to practice the most common imaging techniques (bright-field imaging, dark-field imaging) and to observe typical contrast phenomena related to the microstructure of such specimens, as well as imaging artifacts. Since the features in TEM images of crystalline materials are sensitive to the orientation of the crystal lattice, you should document the conditions under which each image was recorded by acquiring corresponding diffraction patterns. By means of double exposure, it is possible to record the diffraction pattern as well as the position of the objective aperture.

Experiment

1. Load the specimen, start up the microscope, and align it. In order to obtain high-quality images also at high magnification, carefully align the current center and the objective lens stigmators.
2. After focusing the objective lens, record an image of an area of interest first without an objective aperture inserted. Then record images of the same region but with an objective aperture inserted, successively reducing the aperture diameter. (Don't forget to record the diffraction pattern for each image, see above.)
3. With an objective aperture of appropriate size inserted, record a few images of characteristic areas of the specimen at different magnifications. Observe characteristic features of the microstructure, particularly grain boundaries and dislocations.
4. Locate a region of interest close to the specimen edge. Tilt the specimen and observe moving contrast features that obviously do not belong to the microstructure of the specimen but constitute imaging artifacts - bend contours. Document this effect by recording pairs of images in the same region but at different specimen tilts.
5. Observe further effects of specimen tilt (e. g. change of relative brightness of individual grains, change of alpha fringes indicating inclined grain boundaries, ...) and document these effects by recording adequate images.
6. Choose a region of interest and tilt the specimens such that only one reflection is strong ("two-beam condition"). Record a bright-field image and an on-axis dark-field image of this region.
7. In the same region of interest, tilt the specimen to set up a "multi-beam condition." Record a bright field image and two on-axis dark-field images with two different strong reflections.

Report

- Comment on the effect of the objective lens aperture diameter on the contrast and resolution of conventional bright-field TEM images.
- Describe the contrasts of the most important features in the microstructure you have studied. To what extent and in which way do these features depend on the imaging conditions (objective aperture, specimen tilt)?
- How can imaging artifacts be recognized? What is the origin of bend contours, and under what conditions did you observe them?
- What do the gray levels reflect under which different grains appear in a bright-field image of a polycrystalline material? What does this imply for TEM studies on grain size and boundaries?
- What do dark-field images reveal, and what is their advantage compared to bright-field images?
- What is the relation between dark-field and bright-field images in (a) the two-beam condition and (b) a multi-beam condition?