Karlsruher Institut für Technologie

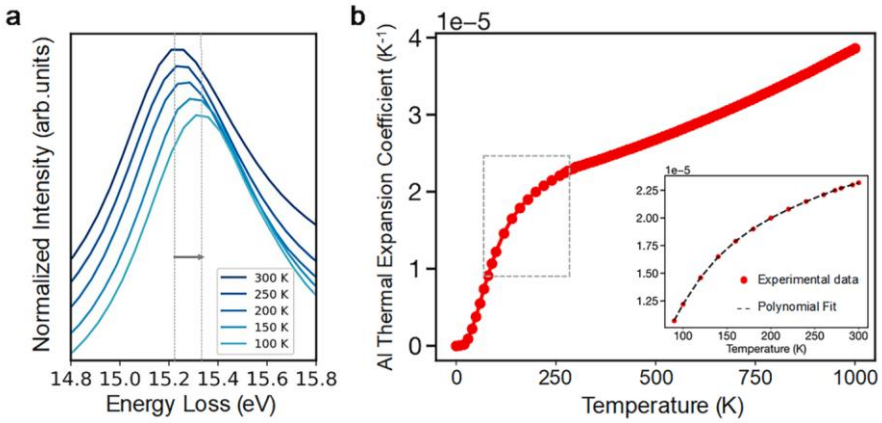
Laboratorium für Elektronenmikroskopie

Masterthesis

Electron energy-loss spectroscopy (EELS) and electron diffraction for *in-situ* temperature measurements

Motivation

In-situ transmission electron microscopy (TEM) allows to study dynamic processes inside the electron microscope. Specific holders allow to study specimens at elevated temperatures or during the application of electrical currents. Although the holders provide a value for the temperature during heating experiments, the temperature can vary locally due to e.g. varying thermal conductivities. The local temperature due to Joule heating upon application of electrical currents can only be roughly estimated through the resistance measurement. Both electron energy-loss spectroscopy (EELS) and electron diffraction are sensitive to the local temperature due to thermal expansion and increased phonon excitation. This thesis aims to investigate the possibilities of local temperature measurements for a set of different specimens



Literature example for temperature measurement using an Aluminum specimen. (a) EEL spectra of the Aluminum bulk plasmon for different temperatures showing a shift due to lattice expansion and a related change of the electron density. (b) Thermal expansion coefficient for Aluminum. [1]

Tasks

- Familiarization with the transmission electron microscope
- Literature research on *in-situ* temperature measurements
- Temperature-dependent data acquisition for different specimens
- Data analysis and evaluation of different measurement strategies

Tentative timeline

- 1st-3rd month: literature review and introduction to TEM and EELS
- 4th-10th month: Data acquisition and analysis
- 11th-12th month: Thesis writing

[1] A. Kumar *et al.* Ultramicroscopy 265 (2024) 114008.

Research area:
In-situ transmission electron microscopy, Electron spectroscopy and diffraction, Local temperature

What you will learn:
Transmission Electron Microscopy, Electron energy-loss spectroscopy, Advanced data analysis

What you bring:
Master student in physics, experience in electron microscopy

Starting date:
Spring of 2026

Language:
German or English

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