Scanning Electron Microscopy with Polarization Analysis (SEMPA / spin-SEM)

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2 sessions planned, 3 participants per session (3-4h). Dates: 10th and 11th September.

SEMPA, an ultra-high vacuum based technique, allows for an imaging of magnetic surfaces thanks to a detection of spin (spin-polarization) of secondary electrons emitted from a (ferro)magnet. It enables a simultaneous mapping of magnetization in two orthogonal directions (two in-plane, or one in-plane + out-of-plane components). This surface-sensitive microscopy is suitable for ultrathin samples (even few atomic layers). The spatial resolution can be even below 10 nm, but typically it is ≥20nm (trade-off between signal/acquisition time and resolution).

In this practical we will have a look on basics and instrumentation of the SEMPA. After a short introduction, we will check the cleanliness of our sample (surface) with a surface sensitive chemical analysis and do magnetic imaging on Fe microstructures.

1. SEMPA
    a. Basics (what it measures, extreme surface sensitivity, …)
    b. Requirements (UHV, clean sample surface & detector crystal)
    c. Sample (surface) preparation (sputtering, heating, decoration)
    d. Instrument description (brief)
2. Auger spectroscopy: Is my surface clean enough?
    a. Auger effect and basics
    b. Auger spectra measurement and identification
3. Magnetic imaging
    a. Setting up, crystal (detector) cleaning
    b. Imaging of Fe microstructures (patterned thin film).

Further/Recommended reading:

[1] H. Hopster & H.P. Oepen (Eds.), *Magnetic microscopy of nanostructures*, Springer, 2005; Chapter 7.
[2] K. Koike, Spin-polarized scanning electron microscopy, *Microscopy* **62**(1), 177–191, 2013. https://doi.org/10.1093/jmicro/dfs092 (free)
[3] J. Unguris, 6. Scanning electron microscopy with polarization analysis (SEMPA) and its applications. In *Experimental methods in the physical sciences* (Vol. 36, pp. 167-193, XV-XVI), Academic Press, 2001.