Microscopy with Momentum and Imaging Spin-Filter (Au/Ir)

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Momentum Microscopy is a new technique in surface science, in which the momentum (or the real-space) distribution of photoelectrons is projected onto an image plane by using a photoemission electron microscope (PEEM) column. In case of momentum imaging the k_x-k_y plane can be energy-filtered by a double-hemispherical electrostatic analyzer (IDEA) to achieve a monochromatic momentum distribution. The ability of the method to map the complete angular distribution of photoelectrons is quite successfully used for photoemission orbital tomography (e.g. at the NanoESCA in Trieste [1]). An innovative extension of this technique is to use the monochromatic electron distribution behind the double-hemispherical analyzer for 2D imaging spin-filtering. Early experiments with a NanoESCA were performed with a W(100) single crystal as electron-mirror with spin-polarization dependent reflection [2], but only the step to a Au passivated Ir (100) single crystal with long-term stable scattering properties paved the way to a broadly based scientific useability.

We will show results from our two first commercial Au/Ir 2D Imaging Spin Filters. Pre-characterizations of the Au/Ir crystal were done with LEED and a Ferrum-Detector setup [3] to find optimal preparation conditions and scattering energies for a high single-point figure-of-merit (with Sherman function >60% and Reflectivity >1%) [4]. Spin-filtered images of magnetic domains show that along the diameter of the field of view (e.g. 36 µm) more than 100 separate image points can be resolved. This increases the effective 2D figure-of-merit of this spin-filter by nearly four orders of magnitude compared to single-channel spin-detectors.

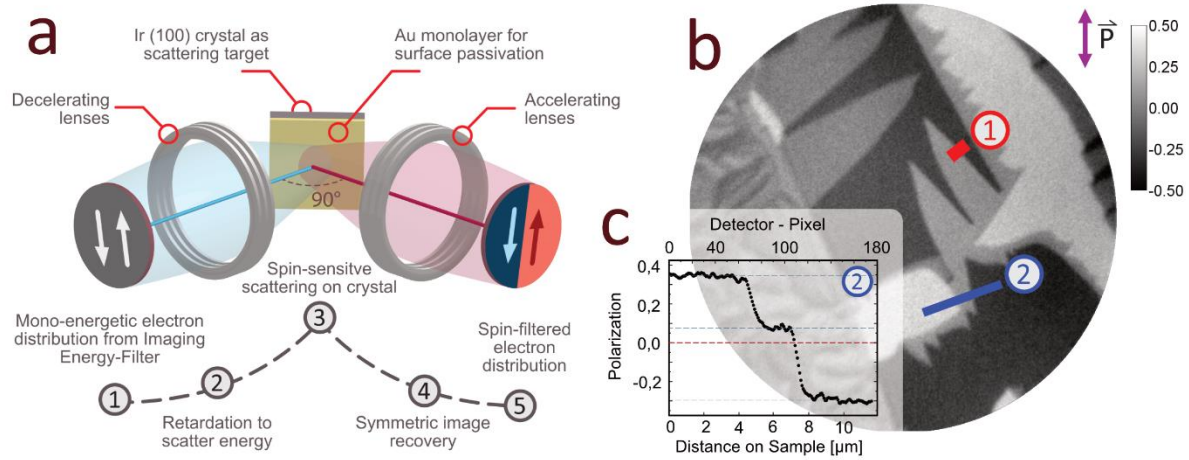

Figure 1: The monochromatic electron image delivered by the NanoESCA is spin-filtered by a scattering process (a) which allows to measure the spin polarization of the whole image simultaneously, e.g. magnetic domains of a poly-crystalline iron film (b).

References: [1] M. Wießner et al., Nature Comm.5 4156 (2014), [2] C.Tusche et al., Appl. Phys. Lett. 99, 032505 (2011), [3] Escher, et al., e-J. Surf. Sci. Nanotech. Vol. 9, 340-343 (2011), [4] C.Tusche et al., Ultramicroscopy 159, 520–529 (2015), Legal rights of protecting patents secured by sublicensing from Surface Concept GmbH