Design and First Results of SESAM

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We present design and first results of the Sub-Electronvolt-Sub-Ångstrom-Microscope (**SESAM**) equipped with a Monochromator (MC) integrated in the Field Emission Gun (MC-FEG) and an advanced energy filter, the so-called Mandoline [1].

Figure 1 shows a photograph of the instrument during the build-up phase (a) and a schematic principal set-up of the microscope (b). A completely new plinth concept has been developed for the microscope, which is based on supporting the column close to the centre of gravity. The underframe as well as the holding structure has been optimised by FEM analysis in order to achieve the high stability required [2]. The essential modules of this microscope are a Field Emission Gun (FEG) with Monochromator (MC) and an aberration corrected, highly dispersive in-column energy filter. For STEM investigations two High Angular Annular Dark Field Detectors (HAADF) are available as well as a 2k Slow Scan-CCD camera for acquiring TEM images.

Figure 2 shows the principle set-up of the MC-FEG, which consists of an Schottky-emitter assembly, a gun lens, the Monochromator itself and the 200 kV multistage accelerator. The electrostatic Omega-type MC according to a proposal of Kahl and Rose provides a dispersion of 12µm/eV (@ 4 kV extractor voltage) in the symmetry plane and a dispersion free virtual round Cross Over (CO)-image [3]. In the MC Off Mode the gun lens delivers a CO-image close to the entrance image plane and the accelerator lens generates a CO outside the gun. Switching to the MC On mode only a slight readjustment of the gun lens excitation is required for optimum signal transfer and by refocusing the first condenser lens the spot is kept focused on the specimen. Due to the optical design, the illumination system inherently preserves the spot size while the brightness is only reduced proportional to the amount of beam current cut out by the Monochromator [4].

For energy-filtering TEM-applications (EFTEM), the instrument is equipped with an imaging in-column energy filter. The newly developed Mandoline based on a design by Uhlemann and Rose [1], consists of 1 homogenous and 2 inhomogeneous sector magnets and provides full second- and third-order correction by means of multipole elements. A superior transmissivity of $T_{real} = 3300\ nm^2/eV$ (@ 200 kV and 1 eV energy width) is achieved, enabling transfer of highly resolved energy filtered images even at large fields of view. Furthermore the Mandoline energy filter provides a dispersion of 6,2 µm/eV @ 200 kV. Combined with the Monochromator this makes the SESAM instrument to an extreme powerful tool for ELNES investigations.

First examples for the superior advantages of the modules incorporated into the system as well as their combined performance will be presented.

References

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[3] F. Kahl & H. Rose, Proc. EUREM Brno/Cz, Vol. III (2000), 1459
[4] M. Haider et al., Proc. 15th Int. Congr. on El. Micr., Durban South Africa (2002)

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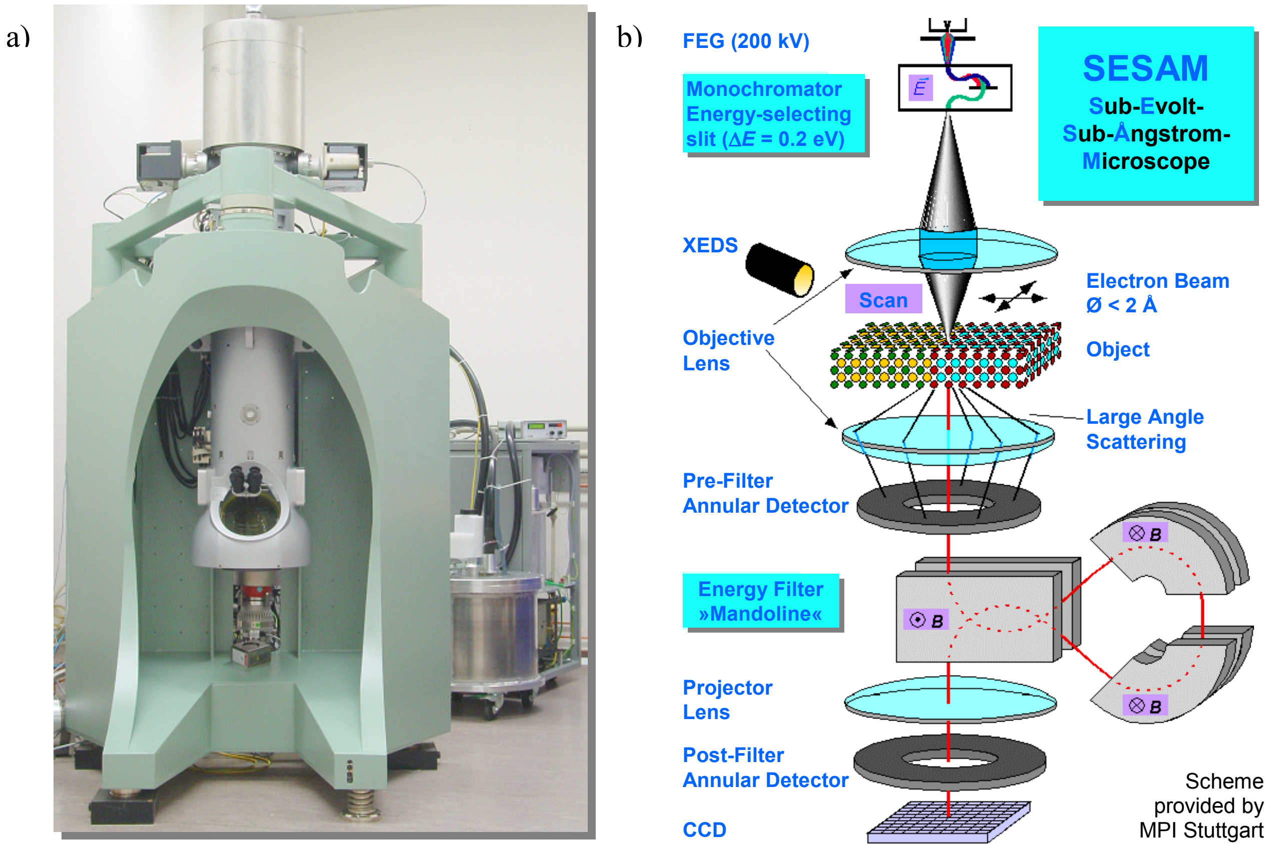

Figure 1:
Photograph of the SESAM in build-up phase (a) and schematic optical set-up of the microscope (b)

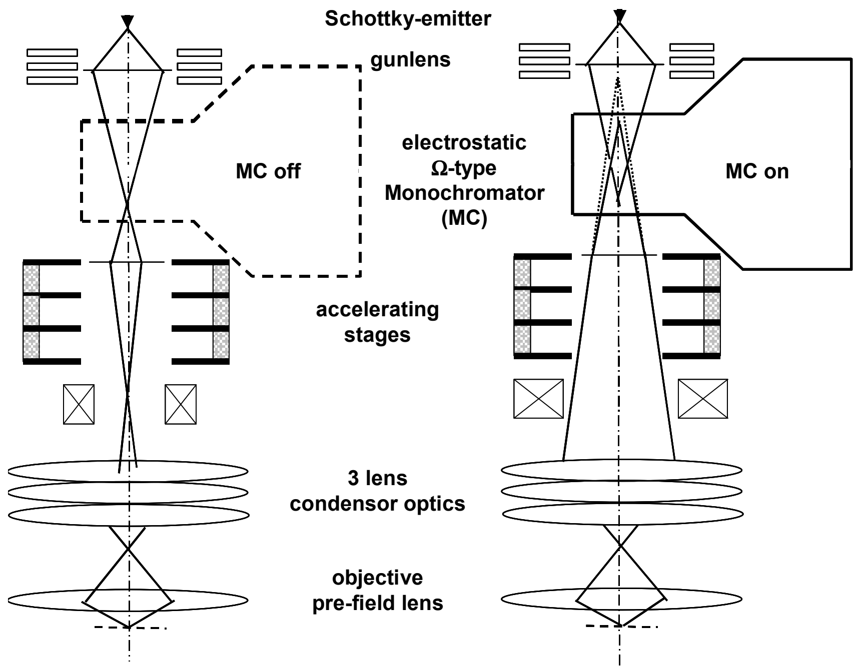

Figure 2: Principal set-up of the MC-FEG with asymptotic positions of the Cross-Over (left) with Monochromator OFF and (right) with Monochromator ON