Type of presentation: Oral

IT-7-O-1894 In-situ (S)TEM redesigned: Concept and electron-holographic performance

Börrnert F.[1,3], Riedel T.[2], Müller H.[2], Linck M.[2], Büchner B.[1,3], Lichte H.[1]

[1]Technische Universität Dresden, Germany, [2]CEOS GmbH, Heidelberg, Germany, [3]IFW Dresden, Germany

Email of the presenting author: felix.boerrnert@tu-dresden.de

The progress in (scanning) transmission electron microscopy and electron holography has led to an unprecedented knowledge of the microscopic structure of functional materials at the atomic level. Nevertheless, in-situ studies inside a (scanning) transmission electron microscope ((S)TEM) are extremely challenging. Here, we introduce a concept for a dedicated in-situ (S)TEM with a large sample chamber for flexible multi-stimuli experimental setups.

In conventional (S)TEMs the sample space is restricted by the pole pieces of the objective lens to a few millimeters; additionally, the sample is immersed into a strong magnetic field forbidding the investigation of magnetic phenomena. The solution to this problem is a radical redesign of the sample chamber and thus an adaptation of the electron optical layout. A versatile in-situ sample chamber requires space and access ports to incorporate different devices for applying various stimuli. This can be achieved by the use of a spherical-aberration corrected Lorentz type objective lens [1]. The size of the sample chamber is not anymore restricted by the electron optics and can be easily adapted to emerging experimental demands. Also, for the large-area control of experimental setups in situ a scanning surface imaging mode, i. e. a secondary electron detector, is needed.

A fundamental drawback of TEM is that the imaging process acts like an edge filter, thus no large-area field variations could be detected, and the image contrast is largely non-quantitative. In electron microscopy, the fully quantifiable image wave can be recorded only by an interferometric technique, i. e. off-axis electron holography [2]. Crucial for in-situ experiments is a large field of view while maintaining a high spatial resolution [3].

Here, we report on the state of the conversion of a JEOL JEM-2010F retro-fitted with two Cs correctors [4] from a dedicated low-voltage high-resolution (S)TEM into a large-chamber in-situ microscope. Both correctors are aligned to act as a corrected Lorentz lens in conventional as well as in scanning mode. The complete column section originally housing the pole pieces of the conventional objective lens will be replaced by a sample chamber providing multiple large ports for accessing the sample. Special care has been taken to make the chamber design most flexible.

[1] B Freitag et al., Microscopy and Microanalysis (2009), 184.
[2] H Lichte et al., Ultramicroscopy 134 (2013), 126.
[3] M Linck et al., Microscopy and Microanalysis (2010), 94.
[4] F Börrnert et al., Journal of Microscopy 249 (2013), 87.

Acknowledgement: The authors acknowledge financial support from the European Union under the Seventh Framework Programme under a contract for an Integrated Infrastructure Initiative (Reference 312483—ESTEEM2). We thank Prof. A. Kirkland (University of Oxford) for providing the SE detector.

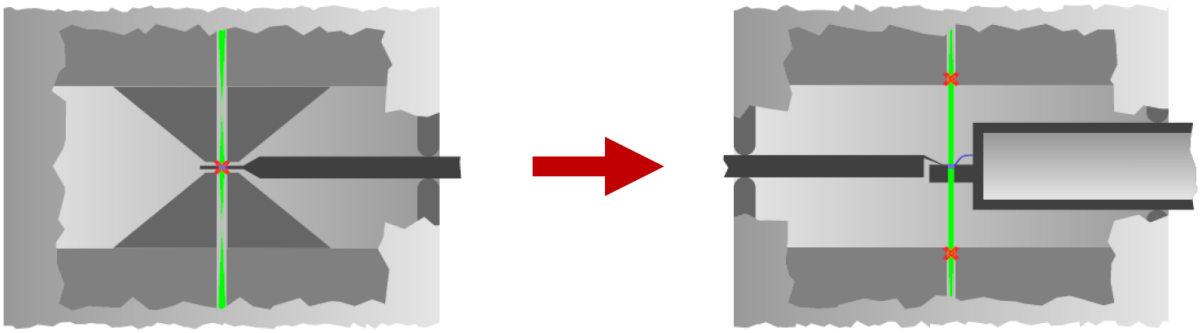

Fig. 1: Scheme illustrating the conversion of the (S)TEM sample region. Green – electron beam, red – lens magnetic field, blue − sample.