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A Dedicated *In-situ* Off-axis Electron Holography (S)TEM: Concept and Electron-Optical Performance.

Felix Börrnert[1,3], Thomas Riedel[2], Heiko Müller[2], Martin Linck[2], Bernd Büchner[3], and Hannes Lichte[1]

[1.] Speziallabor Triebenberg, Technische Universität Dresden, 01062 Dresden, Germany.
[2.] CEOS GmbH, Englerstraße 28, 69126 Heidelberg, Germany.
[3.] IFW Dresden, PF 270116, 01171 Dresden, Germany.

The progress in (scanning) transmission electron microscopy has led to an unprecedented knowledge of the microscopic structure of functional materials at the atomic level. Additionally, although not widely used yet, electron holography is capable to map the electric and magnetic potential distributions at the sub-nanometer scale. 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 and report about the electron optical performance of the instrument.

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, *e. g.* a drift-free liquid He cryostat in combination with several nano-manipulators for electrical probing and a freely adjustable magnetic vector field or LASER illumination. This implies the use of a variable focal length Lorentz type objective lens. The Lorentz lens characteristics make the correction of the spherical aberration mandatory for sub-nanometer resolving power [1]. In turn, 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 orientation on the sample when using *e. g.* nano-manipulators, a large-area 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]. For a flexible potential field mapping independent of the sample geometry a split illumination multiple-biprism setup is advantageous [3]. Crucial for *in-situ* experiments is a large field of view while maintaining a high spatial resolution [4].

Here, we report on the state of the conversion of a JEOL JEM-2010F retro-fitted with two C_s correctors [5] 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. Moreover, an electrostatic biprism is incorporated into the condenser aperture bar to be able to separate the object wave and the reference wave further apart to reduce the influence of far-reaching fields on the field quantification as well as measuring regions away from the sample edge.

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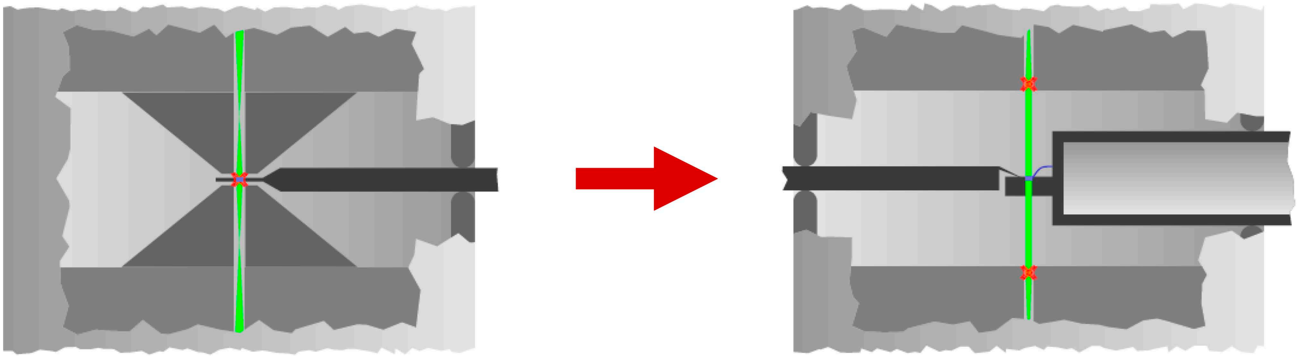

Figure 1. Scheme illustrating the conversion of the TEM sample region. Green – electron beam, red – lens magnetic field, blue − sample.