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Off-Axial Aberration Correction using a B-COR for Lorentz and HREM Modes

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A dedicated Hitachi HF3300C microscope, "I2TEM", has recently been installed in CEMES. This microscope has been specially designed to carry on electron interferometry and *in-situ* TEM experiments. I2TEM is a 300 kV cold FEG microscope fitted with a multibrism set-up, two stages capability, a GIF quantum ER, a 4k X 4k camera and a Cs-corrector "B-COR" from CEOS.
The first stage location within the objective pole piece allows performing classical HREM experiments while the second location is in a field free region above the objective lens and below the third condenser lens and allows carrying TEM imaging or electron holography in Lorentz mode. Contrary to non-dedicated microscope, I2TEM allows, in Lorentz mode, using apertures in the focal plane of the objective lens (i.e. used as "Lorentz lens") to select diffracted beams.
In addition, the B-COR can be adjusted to correct for the objective lens aberrations when excited in HREM or in Lorentz modes at voltages of 60kV, 80kV, 200kV and 300kV. This unique multipolar optical system (also called "Aplanator") has been specially designed to correct not only for the Cs, the axial coma (B2), the three-fold astigmatism (A2), but also to compensate for the radial and azimuthal off-axial coma [1]. These off-axis corrections are achieved thanks to two additional pair of short hexapoles located in between two image planes inside the corrector. These planes are located between three long hexapoles used to compensate the axial aberrations (Cs, B2, A2, …) like in the standard C-COR (Fig. 1). As conventional Cs-correctors allow for correcting most of the important first and second order aberrations confined close to the optic axis in HREM images of few ten of nanometers wide, the Aplanator compensates for aberrations in much larger field of view images (the number of equally resolved point regarding the standard π/4 limit is indeed considerably higher). It is therefore of huge interest for large field of view HREM images recorded with a 4k X 4k camera and for low magnification images or holograms obtained in Lorentz mode.

We will present recent results showing the capacity of the B-COR to correct for the axial and off-axial aberrations of the 11 mm pole piece gap of the I2TEM objective lens and achieve 80pm spatial resolution in HREM mode (Fig. 2a). Results will also be presented showing the capacity of the Aplanator to correct for the objective lens aberration when used in Lorentz mode where 0.5 nm spatial resolution has been achieved (Fig. 2b).

[1] H. Muller, I. Maßmann, S. Uhlemann, P. Hartel, J. Zach, M. Haider, Nuclear Instruments and Methods in Physics Research A **645** (2011) 20–27
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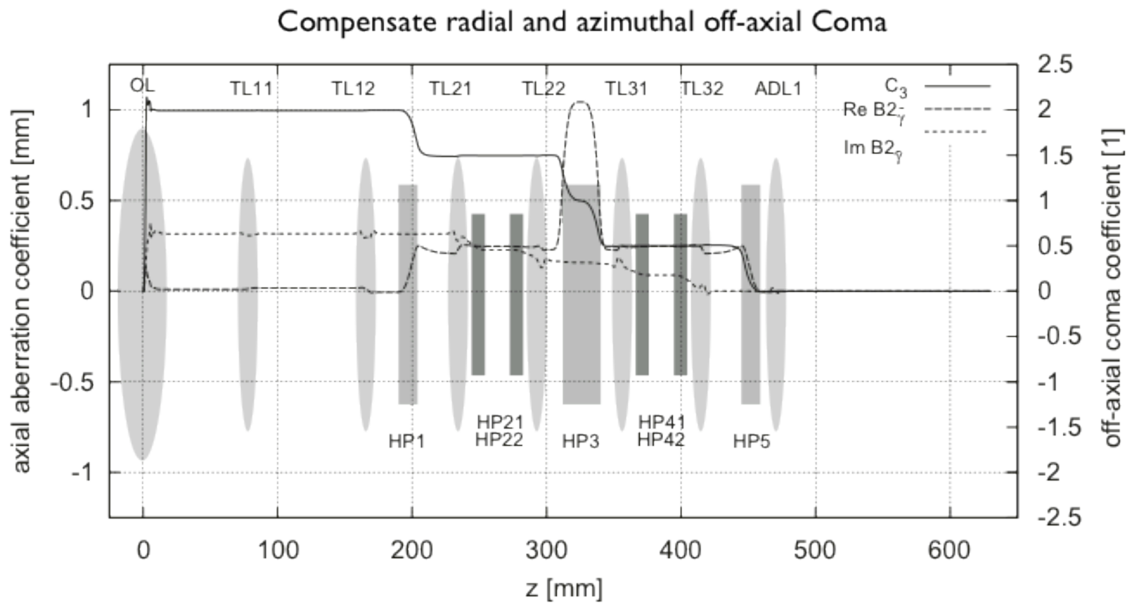

Figure 1. Schematic drawing of the B-COR from CEOS

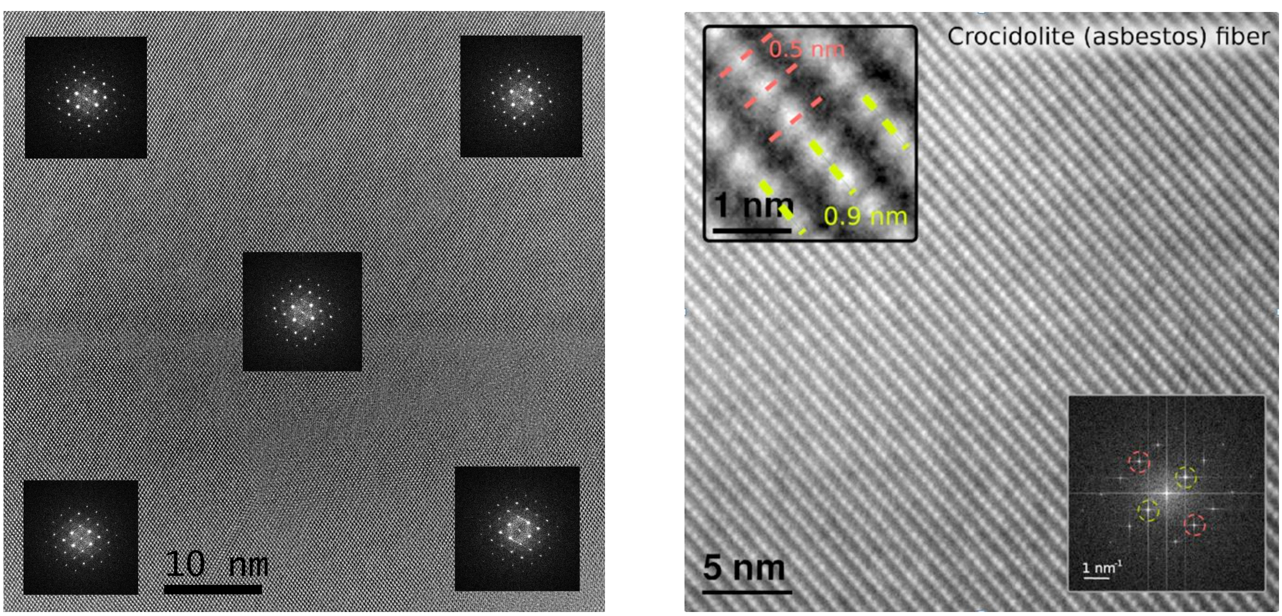

Figure 2. Spatial resolutions achieved with the B-corr**: (a) HREM mode:** Dumbles observed in InAs over large field of view with the B-COR associated to the 11mm gap I2TEM objective lens. **(b) Lorentz mode:** 0.5 nm resolution observed in Crocidolite sample

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