doi:10.1017/S1431927610061544
Microsc. Microanal. 16 (Suppl 2), 2010

Performance of Corrected Transmission Electron Microscopes in Combination with an In-Column Filter and a Distortion-Free Monochromator

S. Pokrant,*A. Merkle** and D. C. Bell***,****

* Carl Zeiss NTS, 73447 Oberkochen, Germany
** Carl Zeiss SMT Inc., Peabody, MA 01960
*** School of Engineering and Applied Sciences, Harvard University, Cambridge, MA 02138
**** Center for Nanoscale Systems, Harvard University, Cambridge, MA 02138

After the proof of concept of spherical aberration correction (Cs) by Haider et al. [1], working with Cs correctors has become a standard method to achieve higher resolution in both High Resolution - Transmission Electron Microscopy (HR-TEM) and HR-Scanning TEM (HR-STEM). Moreover, Cs correction leads to better analytical results due to the availability of higher probe currents. However, both the resolution of the microscope and the analytical capabilities can be enhanced by using highly corrected energy filters and by monochromation. This combination gives not only a better energy resolution in Electron Energy Loss Spectroscopy (EELS) and Energy Spectroscopic Imaging (ESI), but also an improvement of the information limit in TEM mode by the reduction of chromatic aberrations (Cc) in addition to spherical aberrations. Hence, the integration of a highly stable doubly corrected in-column energy filter and a dispersion-free monochromator (designed by CEOS) together with Cs correctors into one microscope results in a highly versatile analytical TEM based on user friendly technological concepts. In this abstract we would like to present results on the performance of a novel modular microscope platform in combination with a truly intuitive user interface.

The improvement of the resolution by the combination of monochromation and Cs objective lens correction is demonstrated best at low acceleration voltages, where the Cc reduction by monochromation has a lager impact on the information limit. At 200 kV acceleration voltage an information limit of 70 pm can be achieved with a 0.2 eV beam as shown in Fig. 1 (90 pm without monochromation), while at 80 kV young fringes can be detected below 90 pm with monochromation (120pm without monochromation).

The analytical capabilities of the instrument in EELS are given by the combination of the stable in-column energy filter and the monochromator. At 200kV the energy resolution of the total system measured at the full width at half maximum (FWHM) of the zero loss peak can be as small as 41 meV for very short exposure times (0.03s), while at 80kV 50meV can be reached for 1s exposure time (Fig. 2).

For structure determination the concept of precession diffraction has been proven to be very successful [2], since the acquired diffraction patterns with the precession technique are nearly kinematical. The modular concept of the platform allows a convenient integration of this application commercialized as stand alone version by Nanomegas. The success of this method can also be enhanced by the combination with in-column energy filtering. Energy filtering reduces the inelastic background in the diffraction pattern and reveals the first Laue zone, which gives rise to higher order structural information (Fig 3.).

References
[1] M. Haider et al. *Ultramicroscopy* 75 (1998) 53.
[2] R.Vincent et al.*Ultramicroscopy* 53 (1994) 271

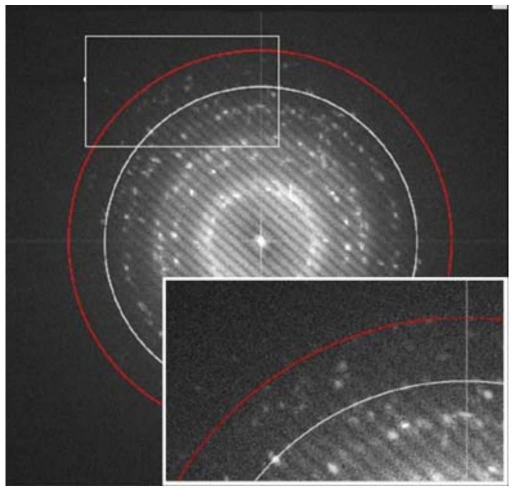

FIG. 1. Young fringes pattern of gold on Carbon foil at 200kV with a monochromated electron beam (0.2eV). The white circle marks the frequency in Fourier space corresponding to 75 pm in real space, the red circle 60 pm. Information transfer below 70 pm is observed (see inset)

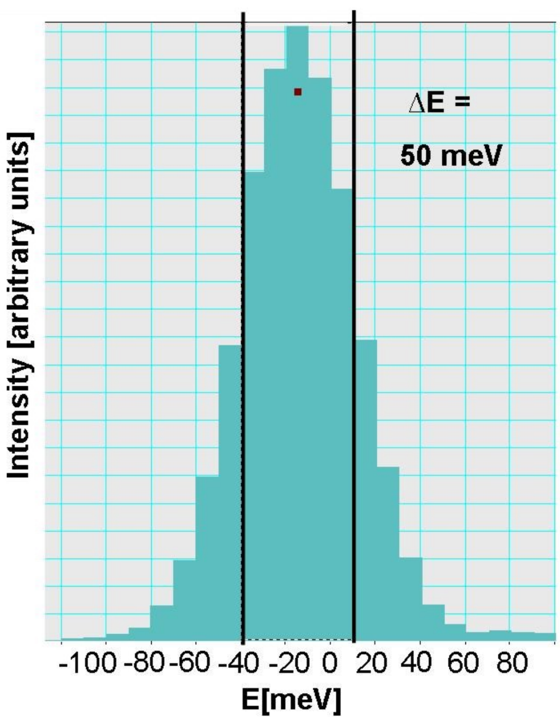

FIG. 2. Energy resolution at 80kV with monochromator and in-column filter

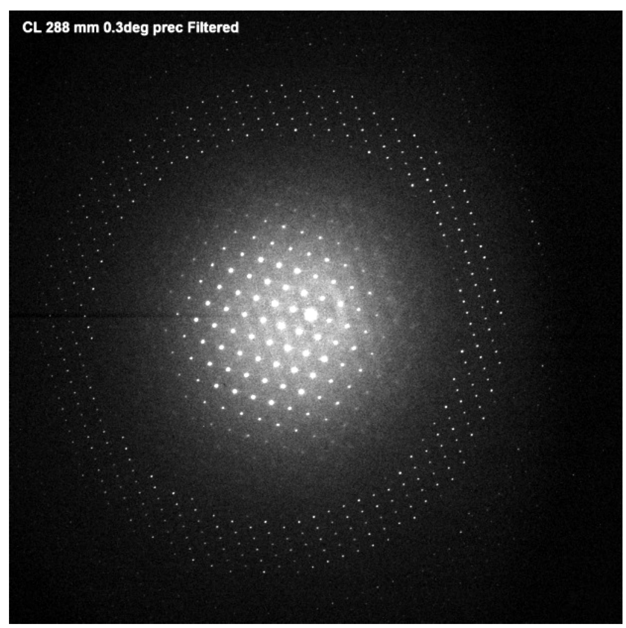

FIG. 3. Zero loss filtered diffraction pattern of Mayenite with a precession angle of 0.3°. The first Laue zone is visible

https://doi.org/10.1017/S1431927610061544 Published online by Cambridge University Press