Advantages of chromatic aberration correction for energy-filtering in the transmission electron microscope

M.Luysberg[1], L. Houben[1], J. Barthel[2], D.G. Stroppa[1], C.B. Boothroyd[1], H. Du[2], J. Mayer[2], R.E. Dunin-Borkowski[1]

[1] Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C), and Peter Grünberg Institute 5, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany.
[2] Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C), and Central Facility for Electron Microscopy, RWTH Aachen, Germany.

The advent of chromatic aberration correction in the transmission electron microscope offers new prospects of high-resolution imaging at low voltages and of energy filtering. The lack of delocalization caused by chromatic aberrations allows to record elemental maps on the atomic scale. Furthermore, improved signal/noise ratios can be obtained by use of large energy windows in energy filtered images. In practice, accurate control of aberrations and the microscope stability is necessary, because energy filtered images are dominated by elastic scattering and phase contrast in pre-edge and core loss edge images.

Examples of energy filtered images of complex oxides and thin layered materials will be presented, which have been obtained with Jülich's chromatic aberration corrected microscope "Pico". Filtered images with an energy window width of 10 eV of $CaTiO_3/SrTiO_3$ multilayers are exemplified in Figure 1. The elemental map in Figure 1c shows the background subtracted signal of the energy window at 346 eV, with an integration range of 20 eV corresponding to the Ca $L_{2,3}$ edge. Although all images show preservation of elastic contrast, the positions of the Ca atomic columns are clearly resolved in the Ca $L_{2,3}$ image.

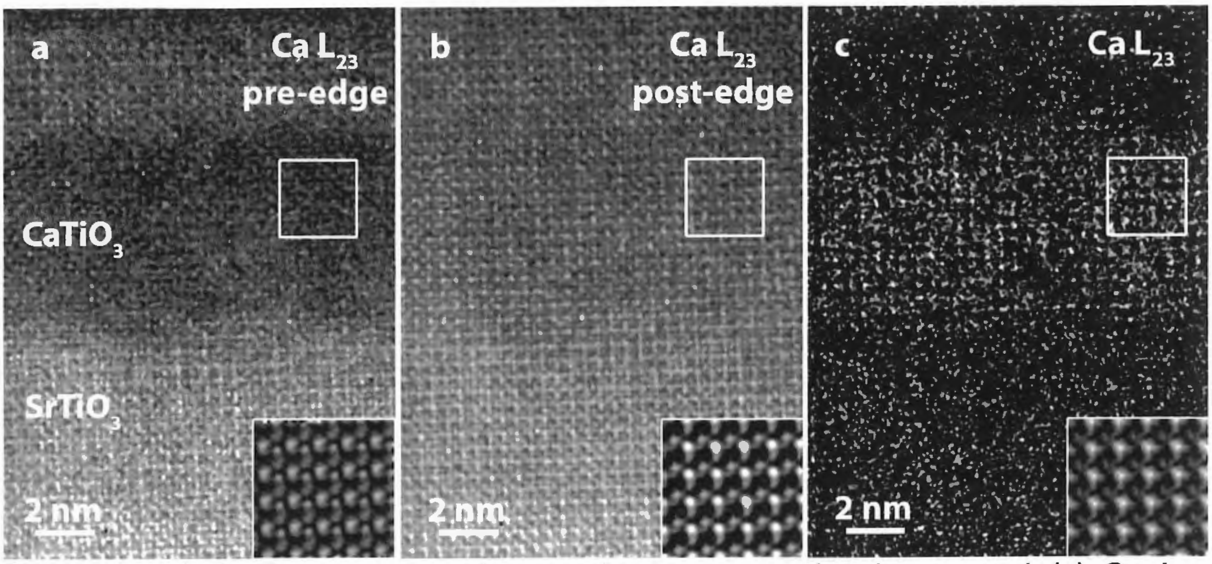

Figure 1: (a) Ca $L_{2,3}$ pre-edge image, Ca $L_{2,3}$ post-edge image and (c) Ca $L_{2,3}$ elemental map obtained at 300 kV with 10 eV energy window. Insets show averages of the unit cell within the frames indicated.