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Energy-Loss Spectroscopy and Near-Edge Structures with Aberration-corrected Transmission Electron Microscopes

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Abstract – The presentation discusses examples of energy-loss spectroscopy imaging and near edge structures obtained with an aberration-corrected and monochromated TEM-STEM.

Aberration-corrected microscopy and new generations of instruments have the potential of significantly improving the development of new materials by providing superior imaging resolution, stability and spectroscopic capabilities. Applications of these techniques in the area of catalytic materials, functional oxides and electronic materials have emerged since the first aberration-corrected microscopes were developed over 10 years ago [1-5]. The improvements in the current density within a probe of about 1Ångstrom and the application of monochromators, make it possible to study the composition of samples and electron energy loss (ELS) near-edge structures with unprecedented energy and spatial resolution. Here we discuss examples of work where aberration-corrected instruments have provided significant benefits in the study of the local chemistry in complex oxides and in the study of changes in bonding at interfaces.

Experiments were carried out with a FEI Titan 80-300 Cubed equipped with two aberration correctors and a monochromator. This instrument achieved an information limit of 0.65-0.6Å, a STEM information transfer of better than 0.7Å and an energy resolution in ELS of 0.13eV.

Samples of multiferroic materials prepared by pulsed laser deposition techniques were studied with high-angle annular dark-field scanning transmission electron microscopy, energy-loss spectroscopy mapping and near-edge structures. Thin films of $Bi_2Fe_xCr_yO_6$ showed layered structures of similar nature as Aurivillius phases with Bi-O layers separated by transition metal oxides perovskite slabs. Energy loss Elemental mapping confirmed the location of the transition metal atoms in the perovskite layers and changes in the near-edge fine structures within the unit cell. In related perovskite compounds, our system has demonstrated atomic resolution in elemental mapping where atomically sharp interfaces have been studied. Further applications in the study of interfaces and other layered perovskites will be presented.

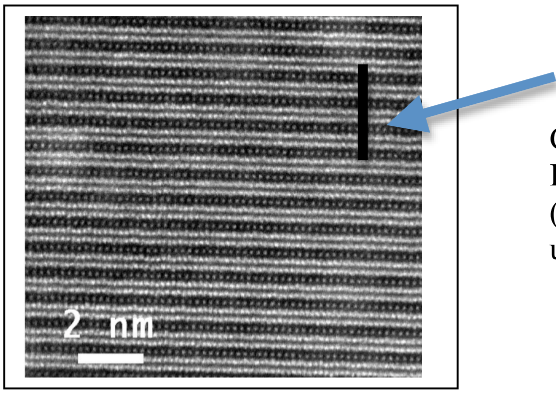

Figure 1: HAADF image of BiFexCryO6 and location of the line where EELS spectra were taken (pointed to by the arrow)

Cr L23 Intensity (arbitrary units)

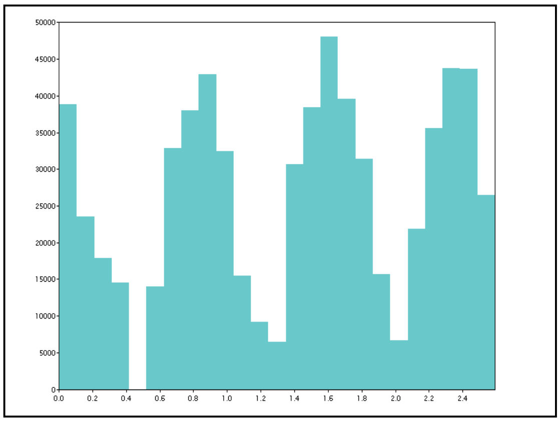

Figure 2: Line scan showing the CrL23 intensity as a function of position in the line scan pointed by the arrow in figure 1. The length of the line scan is 2.5nm

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