Advanced Electron Microscopy in Materials Research

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Electron microscopy has seen tremendous developments over the last couple years providing unprecedented possibilities in materials characterization at the nanometer and atomic scale. With the high spatial resolution and high beam currents available in aberration corrected (S)TEM, highly sensitive detectors for imaging and spectroscopy and fast readout speeds, new microscopy methods have been established, which enable advanced insights into materials, their 2D/3D structure and chemistry as well as some of their functional properties.
With this presentation, I want to provide an overview of the techniques and the information that can be obtained by transmission electron microscopy. Examples will include atomic resolution imaging and spectroscopy, 4D-STEM, electron tomography and *in-situ* TEM to understand structures, properties and processes in oxide based quantum materials (Fig. 1a), electrochemical energy storage systems (Fig. 2) and metallic glasses (Fig 1b).

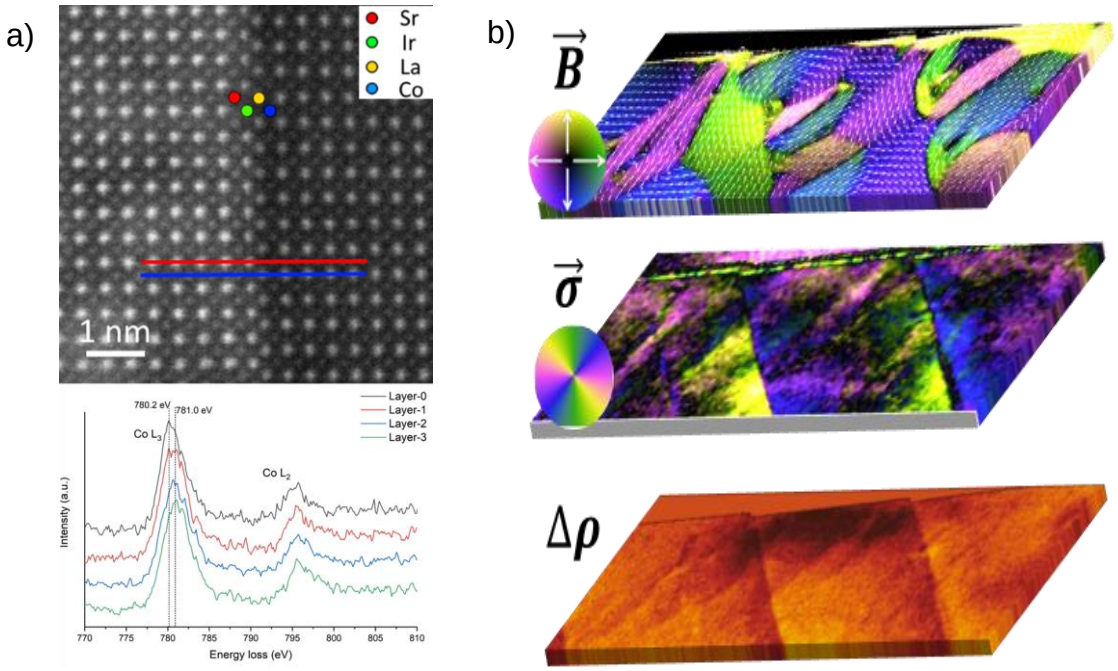

Fig. 1: (a) HRSTEM imaging and EELS analysis of proximity induced oxidation state changes at an $SrIrO_3/LaCoO_3$ interface; (b) 4D-STEM based correlation of magnetic domains, strain and packing density in a deformed $Fe_{85.2}B_{9.5}P_4Cu_{0.8}Si_{0.5}$ metallic glass.

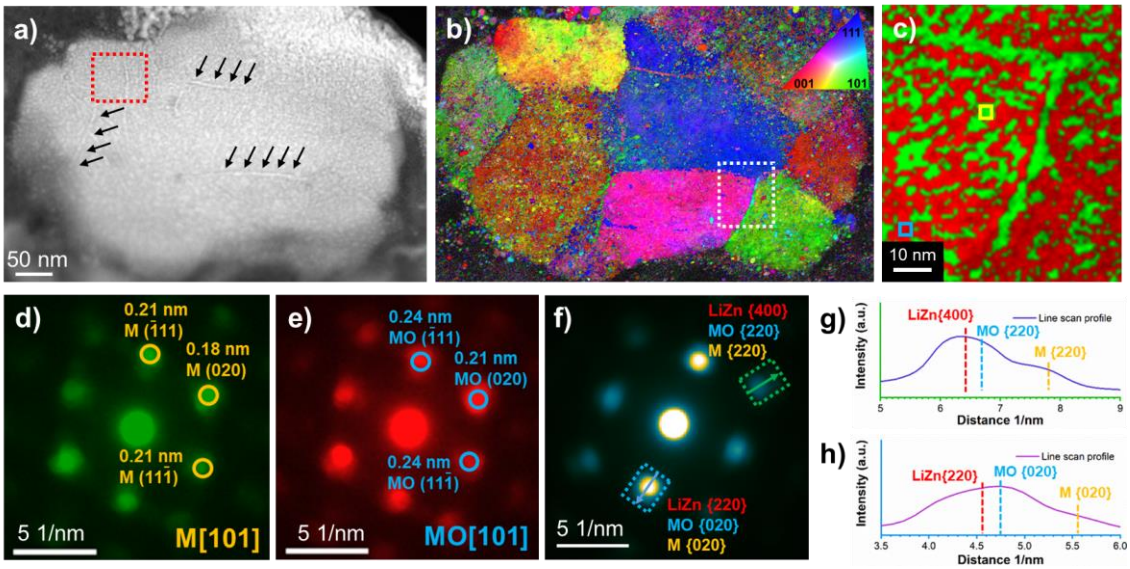

Fig. 2: Orientation and phase analysis in the fully discharged CCO $Mg_{0.2}Co_{0.2}Ni_{0.2}Cu_{0.2}Zn_{0.2}O$ used as anode in a lithium ion battery showing an epitaxial relationship between the metal alloy and the oxide phases.