

STEM-EELS investigation of strain, oxygen octahedra rotation and charge distributions in perovskite oxide thin films

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We will report recent scanning transmission electron microscopy (STEM) and electron energy loss spectroscopy (EELS) studies on perovskite oxide heterostructures, and at their interfaces. We will see how key parameters such as lattice, charge and orbital distribution can be investigated with a sub-nanometer spatial resolution. In a first example, we will present the case of LaAlO₃/SrTiO₃ interfaces [1] and discuss the strains, charges and orbital splitting at the vicinity of these interfaces for layers and bi-layers.

A second example concerns (La,Sr)MnO₃/SrTiO₃ bilayers (figure 1) and multilayers. A strong reconstruction of the oxygen octahedra rotation was observed for multilayers with small numbers of unit cells (<5 uc) [2]. We will discuss these structural reconstruction with respect to the magnetism of these films.

We will finally discuss new perspectives opened by the NION-CHROMATEM microscope (LPS@Orsay) for such oxides hetero-structures. Early 2018, an EELS energy resolution of 5 meV has been demonstrated, and angstrom resolved STEM images were obtained at room and at LN₂ temperature. We will discuss how such spectral-spatial unique combination could, for instance, give new insights for nickelate thin films studies and the understanding of their MIT properties.

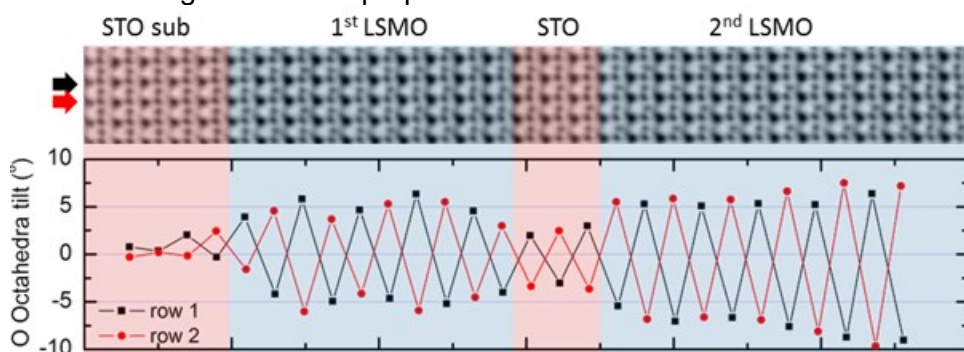


Figure 1 : STEM image in the annular bright field mode enabling a direct visualization of the oxygen columns and thus a possible quantification of the octahedra tilt in real space.

[1] D. Li, S. Gariglio, C. Cancellieri, A. Fête, D. Stornaiuolo and J.-M. Triscone, Fabricating superconducting interfaces between artificially grown LaAlO₃ and SrTiO₃ thin films, *APL Materials* **2**, 012102 (2014).

[2] X. Li, I. Lindfors-Vrejoiu, M. Ziese, A. Gloter, A. & P.A. van Aken, Impact of interfacial coupling of oxygen octahedra on ferromagnetic order in La_{0.7}Sr_{0.3}MnO₃/SrTiO₃ heterostructures. *Scientific Reports* **7**, 40068 (2017).