Using STEM-EELS as a Swiss Knife Tool to Extract Atomic-Scale Information from Rare-Earth Nickelate Heterostructures

Achieving precise knowledge about how the structural and electronic properties evolve across epitaxial heterostructures is strongly required to engineer novel devices with enhanced functionalities. This is of particular interest for the rare-earth nickelate compounds ($ReNiO_3$, where Re stands for rare-earth), a system in which the electronic and structural properties are strongly correlated. [1,2]

In this talk, I will show that aberration-corrected scanning transmission electron microscopy in combination with electron energy loss spectroscopy (STEM-EELS) is a versatile and powerful tool that allows multiple signals to be simultaneously acquired, which provide local structural, chemical and electronic information with atomic resolution. First, I will show how we used this technique to track unit cell by unit cell the vertical propagation of the structural and electronic properties across a series of $NdNiO_3/SmNiO_3$ superlattices.[3] This analysis was key for the discovery of a new kind of electronic coupling associated to the interfacial energetics. [4] Then, I will talk about how we used STEM to assess the spatial distribution of the different phases that emerge when crossing the orthorhombic-rhombohedral phase transition occurring in $Nd_{1-x}La_xNiO_3$ solid-solution thin films when increasing the La concentration.

[1] L. Medarde, *J. Phys. Condens. Matter* 9, 1667-1707 (1997)
[2] S. Catalano et al., *Rep. Prog. Phys.* 81(4), 046501 (2018)
[3] B. Mundet et al., *Nano Letters* 21(6), 2436-2243 (2021)
[4] C. Domínguez, A.B. Georgescu, B. Mundet et al., *Nat. Mater.* 19, 1182-1187 (2020)