Strain tuning of free-standing infinite-layer nickelates

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The quest for a Ni-based analogous of cuprate high-Tc superconductors has reached a first success: $Nd_{0.8}Sr_{0.2}NiO_2$ thin films obtained after topotactic reduction of the perovskite $Nd_{0.8}Sr_{0.2}NiO_3$ have been found to host superconductivity below 15 K [1].

This project aims at significantly increasing the value of the critical temperatures achieved in the $(Nd,Sr)NiO_2$ system, taking advantage of the possibilities offered by strain-tuned free-standing thin films. Both theoretical and first experimental observations point towards an unusual role for the superconductivity of the Ni 3d-z^2 orbitals due to a strong hybridization with the Nd 5d orbitals, in addition to the Ni 3d-x^2-y^2 orbital of the NiO_2 square planar geometry. We propose to use epitaxial strain as a knob to tune the Ni-Nd hybridization in infinite-layer nickelates by imposing a different lattice mismatch between the exfoliated perovskite nickelate phase and the oxide template used for the reduction. The challenge presupposes to gain control over the transfer process of exfoliated $(Nd,Sr)NiO_3$ thin films onto different single crystals, as well as over the topotactic reduction for different Sr-doping levels and different strains.

The PhD candidate will grow nickelate thin films on dedicated buffer layers by pulsed-laser-deposition and will perform the subsequent exfoliation and reduction processes. X-ray diffraction and atomic-force-microscope techniques will be used to attest the quality of the as-grown and exfoliated/reduced thin films. Transport measurements at various temperatures and under various magnetic fields will be performed using a Physical Properties Measurement System (Dynacool, Quantum Design). Finally, synchrotron radiation will be used to obtain useful information about the electronic structure of the exfoliated infinite-layer thin films.

[1] D. Li, K. Lee, B. Y. Wang, M. Osada, S. Crossley, H. R. Lee, Y. Cui, Y. Hikita, H. Y. Hwang, *Nature* **2019**, *572*, 624.