Control of superconductivity in bilayer nickelate thin films

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We invite applications for an M2 internship starting no later than January 2026 and focused on the optimization of the high-Tc superconductivity in $La_3Ni_2O_{7-\delta}$ (LNO327) thin films and related heterostructures at ambient pressure. At IPCMS, we have developed strong expertise in the growth of nickelate thin films via pulsed laser deposition (PLD), and in the characterization of their superconducting properties[1–4]. Very recently, we have also initiated the growth of LNO327 thin films, which already show excellent structural quality and clear superconducting properties (Fig. 1) which stability largely depend upon the capping-layer. Building on this know-how, the proposed internship will focus on understanding the post-growth ozone annealing process. The candidate will work on LNO327-based heterostructures deposited onto $SrLaAlO_4$ (SLAO) substrates. Ozone annealing will be carried out in a custom-built furnace coupled to an ozone generator, allowing real-time monitoring of the sample's resistivity during the thermal treatment. Magneto-transport measurements will be performed with a cryo-free Dynacool System, while STEM analyses will be performed in collaboration with Dr. A. Gloter (LPS Paris). The ideal candidate has a strong background in Solid-State-Physics. Continuation with a PhD is possible, provided that the candidate passes the doctoral school (ED182-Unistra) examination.

Context. The recent discovery of superconductivity[5] below 80 K in bulk Ruddlesden–Popper (RP) $La_3Ni_2O_7$ (LNO327) under high pressure (>14 GPa) has reignited intense interest in nickel-based superconductors. This breakthrough marks a new chapter in the "Nickel Age", demonstrating superconductivity in a compound with a nominal $Ni^{2.5+}$ valence state and a non–square-planar coordination geometry, clearly distinct from both cuprates and infinite-layer nickelates. As such, $La_3Ni_2O_7$ may represent the prototype of an entirely new family of high-Tc superconductors, where the straightening out of the Ni-O-Ni bond angle, accompanied by the loss of the octahedral tilting, is thought playing the main role. However, the requirement of relatively high hydrostatic pressure severely limits both fundamental investigation of its superconducting state, as most spectroscopic probes are incompatible with such conditions. By exploiting the unique tuning parameters offered by thin-film growth, such as epitaxial strain and dimensionality, significant progress has already been achieved. In late 2025, LNO327 thin films displayed a superconducting transition with a critical temperature below 42 K after ozone annealing[6]. However, the superconducting phase remains highly instable, leaving considerable room for further optimization and discoveries.

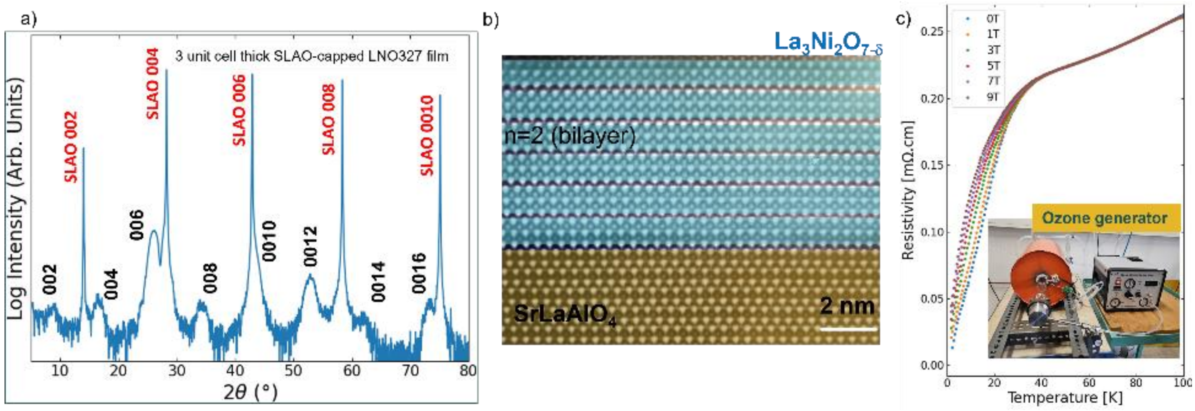

Figure 1 a) XRD of a SLAO-capped 3-unit-cell thick LNO327 sample and (b) related STEM image (Courtesy of A. Gloter-LPS). c) Temperature dependence of the resistivity measured in van der Pauw with a superconducting transition around 40 K which is very robust against the application of a magnetic field applied in the out-of-plane direction. Inset shows the system used for the Ozone annealing.

1. Krieger, G. *et al.* Synthesis of infinite-layer nickelates and influence of the capping-layer on magnetotransport. *J. Phys. D. Appl. Phys.* **56**, 024003 (2023). 2. Sahib, H. *et al.* Superconductivity in PrNiO2 Infinite-Layer Nickelates. *Adv. Mater.* **n/a**, 2416187 (2025). 3. Krieger, G. *et al.* Charge and Spin Order Dichotomy in NdNiO2 Driven by the Capping Layer. *Phys. Rev. Lett.* **129**, 27002 (2022). 4. Raji, A. *et al.* Charge Distribution across Capped and Uncapped Infinite-Layer Neodymium Nickelate Thin Films. *Small* **19**, 2304872 (2023). 5. Sun, H. *et al.* Signatures of superconductivity near 80 K in a nickelate under high pressure. *Nature* **621**, 493–498 (2023). 6. Ko, E. K. *et al.* Signatures of ambient pressure superconductivity in thin film La3Ni2O7. *Nature* **638**, 935–940 (2025).

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