MIP: PARADIM at Cornell University, DMR-2039380

External User Research - 2025

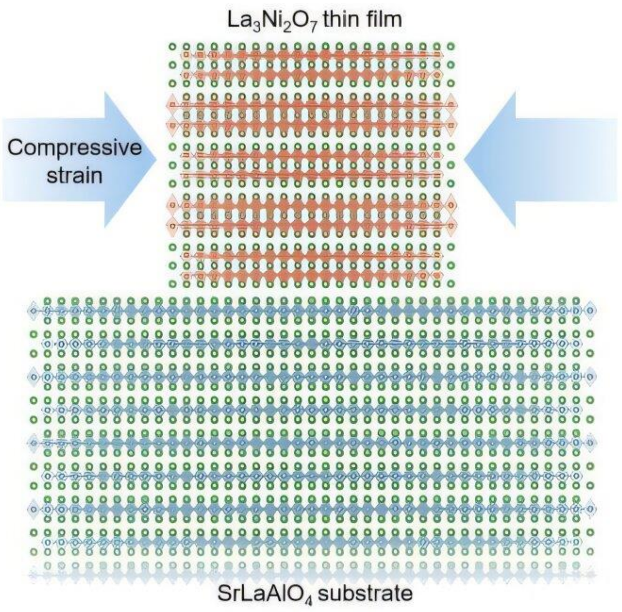
Signatures of Ambient Pressure Superconductivity

Harold Hwang (Stanford) and collaborators

Superconductivity is the ability of certain materials to conduct electricity with zero resistance, and it commonly requires extremely low temperatures and sometimes even high pressures, constraints that not only impede applications but also limit fundamental research. Instead of applying external pressure, a team of Stanford and SLAC researchers lead by Harold Hwang focused on thin-film growth techniques, where the substrates supporting the thin film is used to add lateral compression to the material as the film grows atom by atom and the atomic structure adapts to it. Their approach succeeded in stabilizing superconductivity in the nickelate $La_3N_2O_7$ at ambient pressure for the first time. Overcoming the limitations of high-pressure constraints enables access to conduct comprehensive studies to expand the understanding of these novel materials.

PARADIM's capabilities in high-resolution electron microscopy provided the team with insights into microstructure of the superconducting thin film and the role of defects and the impact of the oxygen content in the nickelate layer.

E.K. Ko, *et al*. [*Nature* **638**, 935–940 (2025)].



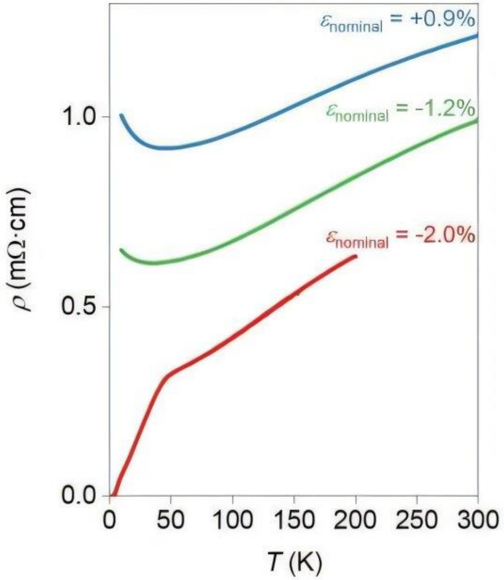


Figure:
(left) Schematic of the pressure created in the nickelate film grown on SLAO substrate leading to 2% compressive strain (red curve).
(center) Resistivity *versus* temperature plots of the ozone-annealed films, red curve for SLAO substrate.
(bottom) Electron microscopy image of the $La_3N_2O_7$ thin film on SLAO substrate, with occasional defect regions highlighted.