MIP: PARADIM at Cornell University, DMR-2039380

External User Project - 2025

High-Temperature Superconductivity in New Nickelate at 1 atm Pressure

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Superconductivity is the ability of certain materials to conduct electricity with zero resistance. Though technologically promising, stabilizing superconductivity requires extremely low temperatures or extremely high pressures – constraints which not only impede applications but also limit fundamental research.

A new family of nickel-based superconductors achieve relatively high superconducting temperatures under high pressures. Instead of applying external pressure, a team at Stanford used thin-film growth techniques to impart lateral compression on thin films deposited atomic layer by atomic layer, conforming the crystalline lattice to a substrate and stabilizing superconductivity in $La_3Ni_2O_7$ at ambient pressure for the first time. Now, by **fine-tuning the films with praseodymium substitution**, growth optimization, and precision sample annealing, they achieve super-conductivity in films at 1 atm at temperatures comparable to those which require more than 100,000 atm in bulk samples.

PARADIM's capabilities in high-resolution electron microscopy provided the team with insights to the thin film-substrate interface, the role of defects, and the impact of the oxygen content in the nickelate films.

Y. Liu, *et al.* *Nat. Mater.* **24**, 1221–1227 (2025).

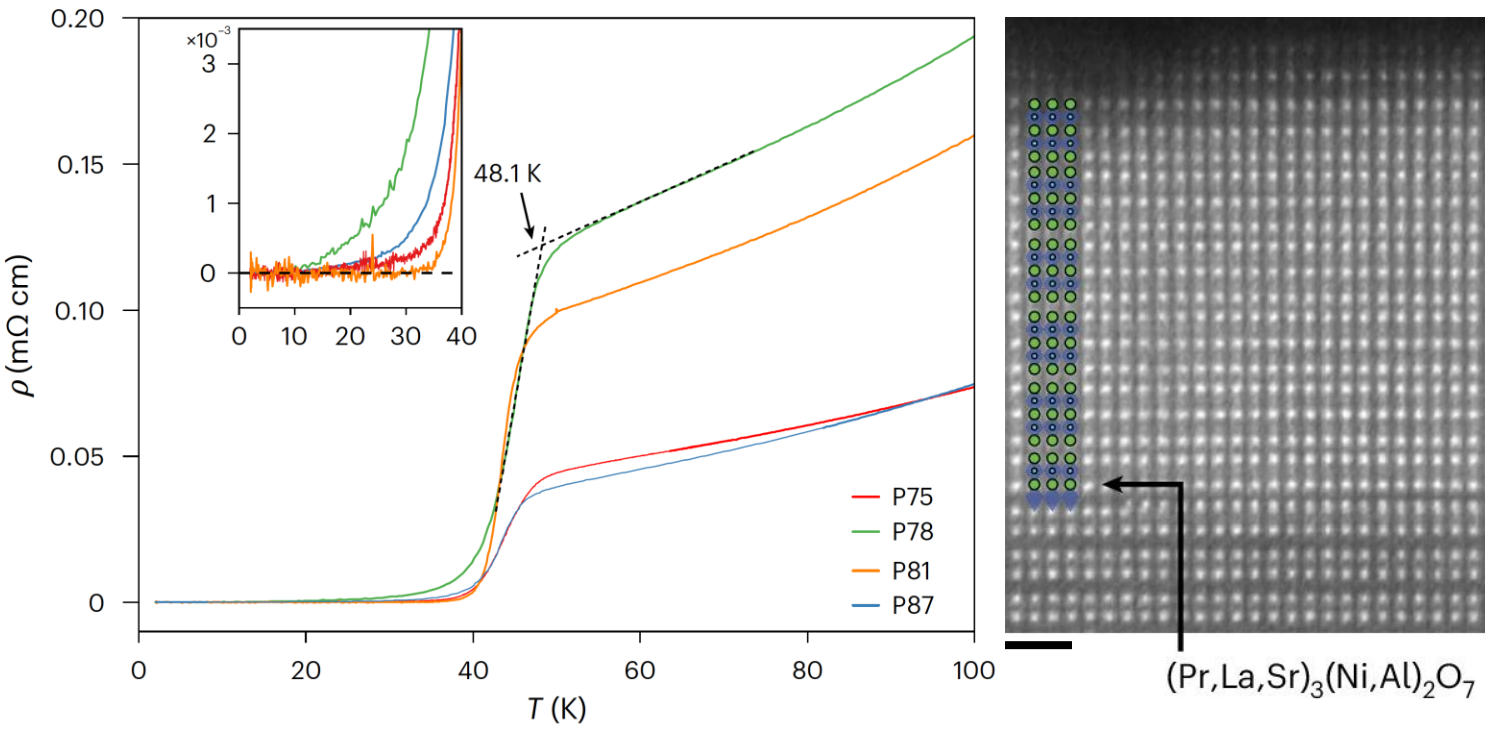

Figure. Superconductivity in thin-film $La_2PrNi_2O_7$. Left) Resistivity vs. temperature curves of several compressively strained thin films and onset of the zero-resistance state (inset). Right) Scanning transmission electron micrograph showing the layered atomic structure of a $La_2PrNi_2O_7$ film and the $SrLaAlO_4$ substrate. Scale bar 1 nm.