"Infinite Layer" Nickelates Superconduct even without Doping? (intrinsic behavior revealed by less-defective samples)

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Nickelates are the subject of considerable interest because they are close cousins of the well-known "cuprates," a family of copper oxide-based superconductors that can have high transition temperatures (T_c), upwards of 100 Kelvin, at which point electrical resistance vanishes.

Here, members of PARADIM's In-House Research Team report the observation of superconductivity with T_c onsets up to 11 K in undoped $NdNiO_2$ thin films with high crystallinity and low residual resistivities. The superconductivity appears to emerge when the residual resistivity falls below the quantum of resistance per NiO_2 sheet. We propose that superconductivity could be intrinsic to the clean limit of undoped $NdNiO_2$, as it already possesses key ingredients necessary for cuprate superconductivity, including holes in the NiO_2 plane (self-doped from rare-earth 5*d* orbitals) and short-ranged magnetic fluctuations. On the other hand, we cannot entirely rule out the possibility that residual apical oxygens could provide doped mobile holes to the NiO_2 plane, which would present a new pathway to superconductivity in the infinite-layer nickelates.

Our results showing superconductivity in undoped $NdNiO_2$ are accompanied by reports from other groups of superconductivity in undoped $LaNiO_2$ and $PrNiO_2$, suggesting that as film quality improves the intrinsic properties of these fascinating nickelates are beginning to emerge.

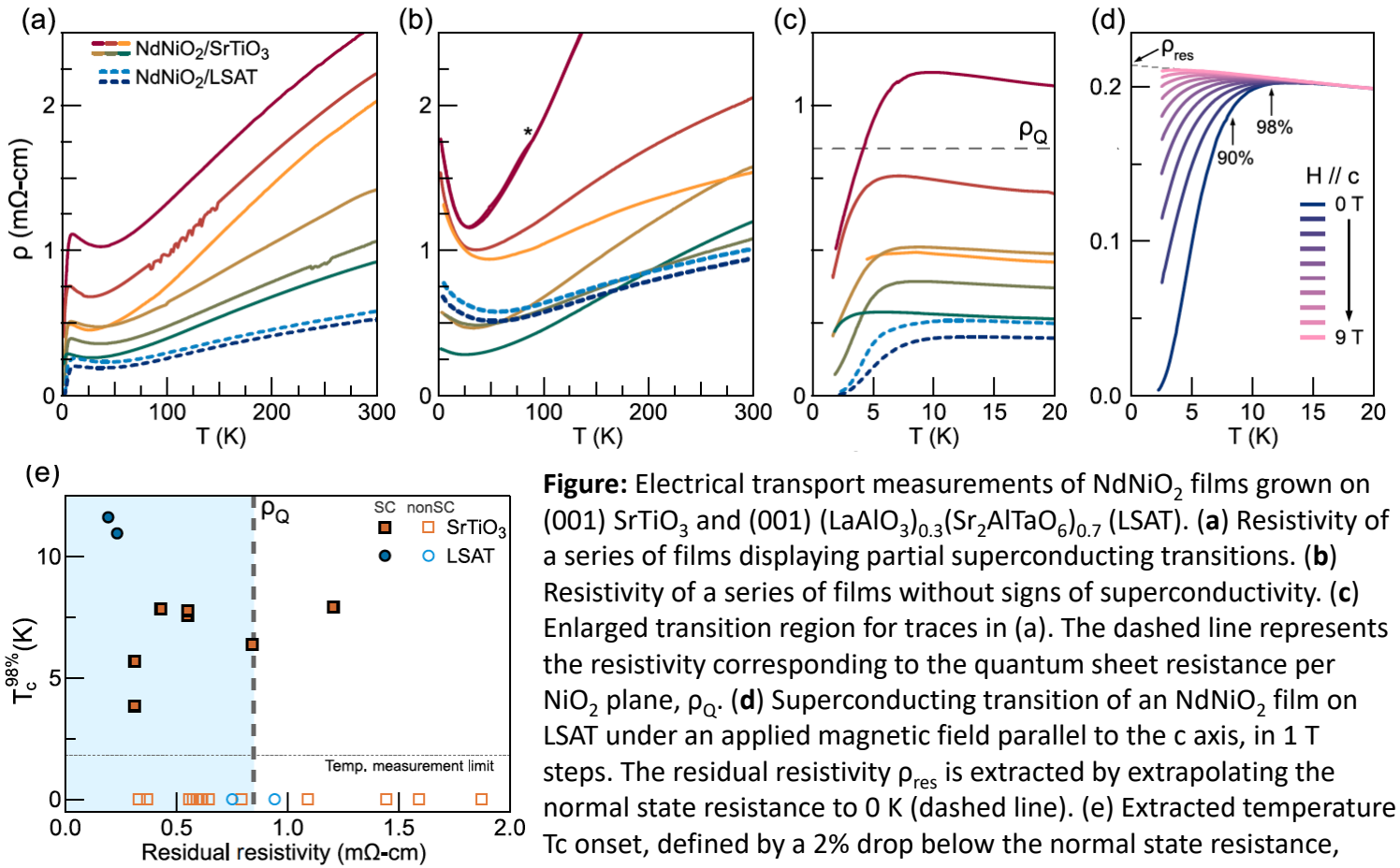

Figure: Electrical transport measurements of $NdNiO_2$ films grown on (001) $SrTiO_3$ and (001) $(LaAlO_3)_{0.3}(Sr_2AlTaO_6)_{0.7}$ (LSAT). (**a**) Resistivity of a series of films displaying partial superconducting transitions. (**b**) Resistivity of a series of films without signs of superconductivity. (**c**) Enlarged transition region for traces in (a). The dashed line represents the resistivity corresponding to the quantum sheet resistance per NiO_2 plane, ρ_Q. (**d**) Superconducting transition of an $NdNiO_2$ film on LSAT under an applied magnetic field parallel to the c axis, in 1 T steps. The residual resistivity ρ_{res} is extracted by extrapolating the normal state resistance to 0 K (dashed line). (e) Extracted temperature Tc onset, defined by a 2% drop below the normal state resistance, plotted versus the film residual resistivity extrapolated to 0 K using high field data for superconducting samples.

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