Turning a metal into an insulator

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Rare-earth nickelates ($RENiO_3$) belong to the wider family of perovskite oxides and are well known for their temperature dependent metal-to-insulator transition (MIT), which occurs together with a lowering of the crystal symmetry, i.e. a breathing distortion of the NiO_6 octahedra units [1,2]. By means of RF off-axis magnetron sputtering, the growth of high quality epitaxial $RENiO_3$ solid solutions thin films and superlattices can be achieved. In a previous study involving nickelate superlattices, the characteristic length scale over which a metallic or an insulating phase can be established and the physics that sets it was investigated [3,4]. In this work, we design a system that exploits the phase boundary cost of maintaining an interface between a metal and an insulator to control the electronic properties of a nickelate based solid solution, specifically the orthorhombic and metallic $La_{0.3}Nd_{0.7}NiO_3$. We show that a single thin layer of this solid solution turns insulating when sandwiched in a superlattice with $SmNiO_3$ layers, whereas in the form of a bare thin film, it remains metallic down to low temperatures.

[1] M. L. Medarde, J. Phys.: Condens. Matter 9, 1679 (1997).
[2] G. Catalan, Phase Transitions 81, 729 (2008).
[3] C. Domìnguez, Nat. Mater. 19, 1182-1187 (2020).
[4] L. Varbaro et al. Adv. El. Mater. 9, 2201291 (2023).