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Tuning Electronic Conductivity in Nickelate Heterostructures
DIVINE KUMAH, JOSEPH NGAI, HANGHUI CHEN, ANKIT DISA, Center for Research on Interface Structure and Phenomena and Department of Applied Physics, Yale University, KARYN LEHUR, Department of Physics Yale University, SOHRAB ISMAIL-BEIGI, CHARLES AHN, FREDRICK WALKER, Center for Research on Interface Structure and Phenomena and Department of Applied Physics, Yale University — Bulk $LaNiO_3$ (LNO) is a metallic material, but for thin films below a critical thickness of about 5-6 unit cells of LNO, a transition occurs from metallic to insulating transport behavior. This transition is suppressed in superlattice structures with $LaAlO_3$ (LAO) spacers which are found to be metallic down to 3 unit cell thick LNO. To understand the differences between thin film and superlattices, we have identified structural differences in thin films and superlattice structures of LNO and LAO using a combination of first principles theory and synchrotron x-ray diffraction. Distortions are observed in the Ni-O-Ni bond angle in LNO epilayers grown on LAO resulting from relaxations at the vacuum-LNO interface. These distortions are suppressed in superlattice structures. Based on our observations, we propose that the electronic properties of nickelate superlattices can be designed by carefully selecting spacer layers that result in specific structural distortions in the LNO conducting layers. By tuning the observed distortions in this fashion, we identify a new pathway for controlling the electronic properties of rare earth nickelate compounds.

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