Electrostatic control of the metal-insulator transition of ultrathin NdNiO$_3$ films

JUNWOO SON, BHARAT JALAN, ADAM P. KAJDOS, Materials, UCSB, LEON BALENTS, S. JAMES ALLEN, Physics, UCSB, SUSANNE STEMMER, Materials, UCSB — Rare earth nickelates (RNiO$_3$) exhibit a first order metal insulator transition upon cooling. Bulk studies on chemical doping indicated that both divalent and quatrovalent ions were effective in shifting $T_{MIT}$ to lower temperatures by $\sim 50$ to $25$ K for $1\%$ hole and electron doping, respectively. However, separating the influence of structural distortions from band filling is particular important for the nickelates. Here we present a new approach to control the band-filling in nanoscale NdNiO$_3$ thin films by modulation doping. NdNiO$_3$ is remotely doped by interfacing it with a degenerately doped conventional band insulator, La-doped SrTiO$_3$. We show that the remote doping approach allows for purely electronic modulation of a carrier density in the absence of other structural changes. The proposed approach is experimentally tested using ultrathin (2.5 nm) NdNiO$_3$ films grown on La-doped SrTiO$_3$ films with different carrier concentrations. We show that remote doping systematically changes the charge carrier density in the NdNiO$_3$ film and causes a moderate shift ($\sim 20$ K) in the metal-insulator transition temperature. These results will be discussed in the context of theoretical models of the materials exhibiting a metal-insulator transition.

Junwoo Son
Materials, UCSB

Date submitted: 11 Nov 2011