Ferroelectric Field Effect in Ultrathin Epitaxial Sm$_{0.5}$Nd$_{0.5}$NiO$_3$ Films

LE ZHANG, H. JEFFREY GARDNER, VIJAY RAJ SINGH, XIA HONG,
University of Nebraska - Lincoln — We report the study of ferroelectric field effect modulation of the metal-insulator transition in ultrathin Sm$_{0.5}$Nd$_{0.5}$NiO$_3$ (SNNO) films. We have fabricated high quality epitaxial SNNO thin films and Pb(Zr,Ti)O$_3$ (PZT)/SNNO heterostructures on (001) LaAlO$_3$ substrates using off-axis RF magnetron sputtering. X-ray diffraction and atomic force microscopy studies reveal (001) oriented films with highly crystallinity and surface roughness of 3-4 Å. Thin SNNO films (4-6 nm) typically have the transition temperature $T_{MI}$ around 230 K, showing thermally activated transport below $T_{MI}$ followed by 3D variable range hoping at low temperature. Hall effect measurements reveal p-type conduction with ~ 4 holes/uc in the metallic phase. Working with films one to two unit cells thicker than the electrical dead layer thickness (~ 4 nm), we have demonstrated nonvolatile, reversible ferroelectric field effect modulation of $T_{MI}$ in SNNO by up to 10 K. The maximum resistance ratio $R_{\text{high}}/R_{\text{low}}$ is 1.7 at 140 K, which is in the thermally activated regime. In the metallic phase, the carrier density has been modulated by $1x10^{15}$ cm$^{-2}$, corresponding to the polarization field of PZT of 80 μC/cm$^2$. 

Le Zhang
Univ of Nebraska - Lincoln

Date submitted: 13 Nov 2014

Electronic form version 1.4