Tunable Magneto-electric Subbands in Oxide Electron Waveguides

GUANGLEI CHENG, Univ of Sci and Tech of China, ANIL ANNADI, SHICHENG LU, Univ of Pittsburgh, HYUNGWOO LEE, JUNGWOO LEE, CHANG-BEOM EOM, Univ of Wisconsin-Madison, MENGCHEN HUANG, PATRICK IRVIN, JEREMY LEVY, Univ of Pittsburgh — Strontium titanate-based complex-oxide interfaces hold great promise for exploring new correlated electron physics and applications in quantum technologies. Previous reports show electron mobility can be greatly enhanced in 1D, while the 2D interface can contain 1D channels due to the presence of ferroelastic domains. In addition, carrier density measurements at the 2D interface by Shubnikov-de Haas (SdH) oscillations and Hall effect reveal a large discrepancy. Here we fabricate quasi-1D electron waveguides at the LaAlO$_3$/SrTiO$_3$ (LAO/STO) interface to locally probe the interface. The conductance of the waveguides is fully quantized, and the corresponding magneto-electric subbands can be depopulated by increasing the magnetic field. The 2D carrier densities ($10^{12}$ cm$^{-2}$) extracted from magnetic depopulation are consistent with measurements by SdH oscillations at the 2D interface. Our results show that magneto-electric subbands of quasi-1D electron waveguides can reproduce known SdH signatures without discrepancies in electron density, and suggest that 2D SdH measurements may also arise from quasi-1D channels.

1We gratefully acknowledge financial support from AFOSR (FA9550-12-1-0057 (JL) and FA9550-12-1-0342 (CBE)), ONR N00014-15-1-2847 (JL), and NSF DMR-1234096 (CBE).


Guanglei Cheng
Univ of Sci and Tech of China

Date submitted: 11 Nov 2016