



Direct Imaging of Nanoscale Conductance Distribution in Novel Field-Effect Transistors

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Abstract: The research of complex quantum materials, in which a dazzling number of emergent phenomena take place in the nanoscale, is a major theme in modern condensed matter physics. For real-space imaging of complex systems, electrical impedance microscopy fills an important void that is not well represented by the existing local probes. Using shielded cantilever probes and sensitive microwave electronics, we can now perform non-invasive electrical imaging with sub-100nm resolution and sub-aF sensitivity. In this talk, I will focus on the visualization of metal-insulator transition of functional materials in field-effect-transistor configurations, which is enabled by the sub-surface imaging capability of impedance microscopy. The microwave images vividly show the spatial evolution of channel conductance and its local fluctuations through the transition, as well as the uneven conductance distribution established by a large source-drain bias. Local probing on the anomalous conduction in multiferroic domain walls will also be discussed.

Education Background:

Tsinghua University, Electrical Engineering, B.S. 2001

Princeton University, Electrical Engineering, Ph.D. 2006

(Graduate advisor: Prof. Daniel C. Tsui)

Stanford University, Applied Physics, Postdoc 2006 – 2011

(Postdoctoral sponsor: Prof. Zhi-Xun Shen)



Selected Publications:

1. Y. Liu, R. Ghosh, D. Wu, A. Ismach, R. Ruoff, and K. Lai, "Mesoscale Imperfections in MoS₂ Atomic Layers Grown by Vapor Transport Technique", *Nano Lett.* 14, 4682 (2014).
2. K. Lai, W. Kundhikanjana, J. Shabani, M. Shayegan, M.A. Kelly, and Z.-X. Shen, "Imaging of the Coulomb driven quantum Hall edge states", *Phys. Rev. Lett.* 107, 176809 (2011).
3. K. Lai, W. Kundhikanjana, M. Nakamura, M. Kawasaki, Y. Tokura, M. A. Kelly, and Z.-X. Shen, "Mesoscopic orientation-ordered percolating network in a manganite thin film", *Science* 329, 190 (2010).
4. K. Lai, W. Pan, D.C. Tsui, S. Lyon, M. Mühlberger, and F. Schäffler, "Intervalley gap anomaly of two-dimensional electrons in silicon", *Phys. Rev. Lett.* 96, 076805 (2006).