Chez Pierre

Presents ...

Friday, December 2, 2011
12:00pm
MIT Room 4-331

SPECIAL CHEZ PIERRE SEMINAR

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"Landscape of Organized Electron Flow in Novel Quantum Matter "

Understanding and controlling local conductivity have been a corner stone for important scientific breakthroughs and technological inventions, as exemplified by the Nobel prizes related to semiconductors – transistor, integrated circuit, Anderson localization, quantum hall effect and fractional quantum hall effect. In these cases, local visualization and control of doping, mobility, gating, dielectric, heterostructure, and inter-diffusion is important.

In an era where the frontier of science and technology has been pushed down to ever smaller scale, the ability to image and control conductivity at meso- and nano-scale is essential. While local electrical probes such as scanning tunneling microscope, scanning gate microscope, conductive AFM, electrostatic force microscope, and Kelvin probe microscope already exist, there is no mature probe for local complex conductivity (σ, ε). Microwave Impedance microscopy addresses this important gap, and provides a new platform to image the landscape of electronic flow in novel quantum materials.

In this talk, we will report our progress in developing an AFM based, and scalable (batch processed tip) non-resonance microwave impedance microscope that achieves a resolution ~ 50 nm and reduces stray field coupling. The non-resonance approach and merge with the AFM platform also greatly reduce many of the "practical problems" that severely compromises advances of the earlier resonator based scanning microwave microscope, such as thermal drift, height control, and tip consistency – all critical for quantitative and repeatable measurements.

We will show samples images from a range of materials – semiconductors, dielectrics, complex oxides, phase change memory materials, graphene, and topological insulators, also functional properties such as metal-insulator transition, semiconductor metrology, photoconductivity, imaging in water and bio-cells . We will cap the science examples with recent success in imaging the colossal magnetoresistivemanganites and quantum hall edge state that highlights the power of this technique in imaging subsurface phenomena.

References:

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K.J. Lai et al., Science 329, 190 (2010)
K. Worasom et al., Rev. of Scientific Instrument, 82, 033705 (2011)
K.J. Lai et al, to appear in Phys. Rev. Lett. (2011)