Materials Science & Engineering Seminar Series

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Emergent Phenomena at a Mott Insulator / Band Insulator Interface

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ABSTRACT: Advances in solid-state devices have been enabled by the introduction of new materials platforms and their subsequent improvements in carrier concentration, mobility and breakdown voltages. To this end, the exploration of interfaces, where a novel functionality or phenomenon is generated at the interface of two materials that is not present in either of the bulk forms of the constituent materials, is promising. With recent developments in complex oxide thin film deposition techniques, novel ground states at perovskite oxide interfaces have been studied intensively in order to understand the role of mismatches in bands, valences, and interaction lengths. The most well known example of such emergent phenomena at complex oxide interfaces has been the discovery of metallicity at the interface of two band insulators $LaAlO_3$ and $SrTiO_3$. We have recently discovered that low dimensional metallic behavior at the interface of a Mott insulator $LaTiO_3$ and a band insulator $SrTiO_3$ is characterized by quantum oscillations and strong in-plane anisotropic magnetoresistance. Our previous work showed that metallicity can be induced in the bulk of a $LaTiO_3$ film grown on a $SrTiO_3$ substrate. Once the $LaTiO_3$ film thickness is decreased down to 3 unit cells, we observe metallicity associated with the interface. This metallicity is characterized by Shubnikov de Haas oscillations that appear around 1T but unexpectedly disappear by 4T. The frequency of oscillations of $3.7 \pm 0.7T$ corresponds to a small cross sectional orbit of $0.015 \pm 0.003\%$ of the first Brillouin zone. The area of the pocket in the Fermi surface causing the oscillations is so small that by 4 T the system reaches the quantum limit in which all of the electrons in that pocket are in the lowest Landau level, thus explaining the disappearance of the oscillations by 4T. A Berry's phase of p is deduced from the Shubnikov de Haas oscillations and can be attributed to a large Rashba coupling. This is consistent with the observed in-plane anisotropic magnetoresistance as both its size and magnetic field dependence have been theoretically predicted for a system with a very strong Rashba effect. Such a large Rashba coupling suggests that such a Mott/band insulator interface may be an excellent candidate for spintronics.

BIOGRAPHY: Yuri Suzuki received an A.B. in physics magna cum laude with high honors from Harvard University in 1989 followed by a Ph.D. in Applied Physics from Stanford University in 1995. During her graduate career, she performed research on high temperature superconductivity and complex oxide thin films with NSF and ARCS Foundation fellowships. As a postdoctoral member of technical staff at AT&T Bell Labs (1994-1996), she moved into the field of magnetism. She then assumed an assistant professor position at Cornell University in the Department of Materials Science and Engineering (1997) and was later promoted to associate professor (2001). She moved to UC Berkeley in 2003 as an associate professor and was later promoted to professor in 2008. She is currently in the Department of Applied Physics at Stanford where she moved to in 2012. She has been recognized with an NSF Career Award, ONR Young Investigator Award, Packard Foundation Fellowship, Robert Lansing Hardy Award of TMS, Maria Goeppert-Mayer Award of the American Physical Society, American Competitiveness and Innovation Fellowship of the National Science Foundation, Fellowship in the American Physical Society and the DoD National Security Science & Engineering Faculty Fellowship.

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