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The Metal-Insulator Transition in Simple Oxides

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Simple transition metal oxides exhibit spectacular Metal-Insulator Transitions (MIT) as a function of temperature in which the conductivity of the material can change by as much as 5 orders of magnitude. This transition is generally first order, correlated with structural transitions and therefore it is inhomogeneous and hysteretic.

I will describe a series of experiments done to understand the nature of the transition, the effect of voltage (or current) on the transition, spin propagation and exchange-bias of a ferromagnetic film in proximity with the oxide. We have performed transport, First Order Reversal Curve (FORC), impedance spectroscopy, local temperature and low-temperature scanning electron microscopy (LTSEM) measurement. Interestingly, we find that the MIT occurs through a series of avalanches, which imply large inhomogeneities with the avalanche exponent indicative of long-range interactions. The LTSEM, FORC and impedance spectroscopy measurements confirm the presence of filamentary transitions across the MIT. The voltage (or current) induced transition produces considerable local heating as manifest from quantitative, local temperature and LTSEM measurements. The spin dependent properties of hybrid systems which incorporate these oxides are very interesting and hold promise of useful applications.

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