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A Transport Perspective on Local Manipulation of Ferroelectric and Correlated Electron Surfaces

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The majority of transport studies aim to identify intrinsic electronic properties of materials, thus avoiding large electric fields, hysteresis, chemical reactions and hot electrons. In this talk, I will discuss the electron transport signatures of the opposite regime, where a complex oxide surface is subjected to strong local field and/or force gradients. Most notably, we have established an insulator-metal transition within an insulating perovskite oxide controlled solely by ferroelectric switching at the nanoscale [1]. This was the first time metallic conductivity has been found in a ferroelectric, despite a variety of theoretical scenarios dating back to the 70's that hypothesized such a behavior. Equally intriguing is the ability to tune the type and magnitude of metallic conductivity of ferroelectric nanodomains by orders of magnitude using applied electric field. Landau-Ginzburg-Devonshire (LGD) formalism captures the essence of these effects, by describing carrier accumulation or depletion at inclined and charged domain walls. On the other hand, local transport measurements on the surfaces of nominally conducting surfaces (such as manganites and nickel oxide) have induced an insulating state, the effect we refer to as 'piezochemistry' and assign to strain-induced redistribution of oxygen vacancies [2]. These coupled transport phenomena in oxides have practical implications, while transport itself appears to be a highly sensitivie probe of ferroic transitions and ionic effects. Experiments were conducted at the Center for Nanophase Materials Sciences, sponsored at Oak Ridge National Laboratory by the Division of Scientific User Facilities, U.S. Department of Energy. Work was also supported by the U.S. Department of Energy, Basic Energy Sciences, Materials Sciences and Engineering Division.

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