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Atomic Scale Control of Competing Electronic Phases in Ultrathin Correlated Oxides[1]

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Ultrathin epitaxial thin films offer a number of unique advantages for engineering the electronic properties of correlated transition metal oxides. For example, atomically thin films can be synthesized to artificially confine electrons in two dimensions. Furthermore, using a substrate with a mismatched lattice constant can impose large biaxial strains of larger than 3% ($\Delta a/a$), much larger than can achieved in bulk single crystals. Since these dimensionally confined or strained systems may necessarily be less than a few unit cells thick, investigating their properties and electronic structure can be particularly challenging. We employ a combination of reactive oxide molecular beam epitaxy (MBE) and angle-resolved photoemission spectroscopy (ARPES) to investigate how dimensional confinement and epitaxial strain can be used to manipulate electronic properties and structure in correlated transition metal oxide thin films. We describe some of our recent work manipulating and studying the electronic structure of ultrathin $LaNiO_3$ through a thickness-driven metal-insulator transition between three and two unit cells (Nature Nanotechnology 9, 443, 2014), where coherent Fermi liquid-like quasiparticles are suppressed at the metal-insulator transition observed in transport. We also will describe some recent unpublished work using epitaxial strain to drive a Lifshitz transition in atomically thin films of the spin-triplet ruthenate superconductor Sr_2RuO_4, where we also can dramatically alter the quasiparticle scattering rates and drive the system towards non-Fermi liquid behavior near the critical point (B. Burganov, C. Adamo, in preparation).

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