USC Viterbi School of Engineering

Mork Family Department of Chemical Engineering and Materials Science

Lyman Handy Colloquia

Electrolyte Gating of Functional Oxides

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Abstract:

Recently, incorporation of electrolytes such as ionic liquids into field-effect transistors has been shown to enable electric double layer transistors (EDLTs), which can induce very large (up to 10^{15} cm^{-2}) charge carrier densities at material surfaces. These densities correspond to significant fractions of an electron or hole per unit cell in most materials, sufficient to *electrically control* electronic phase transitions. While this has stimulated great interest, many challenges remain, including understanding the true gating mechanisms (*i.e.*, electrostatic *vs*. electrochemical [1]), developing *operando* characterization methods, and assessing the full power and universality of the approach. Here, I will review our work applying electrolyte gating using solid "ion gels" [1-6] to complex oxides (*e.g.*, $La_{1-x}Sr_xCoO_{3-\delta}$, $BaSnO_3$), focused on electrical control of magnetism yielding modulation of the ferromagnetic Curie temperature over a record (> 200 K) window. The latter is an important goal, with the potential to enable ultra-low-power data storage and processing technologies. Our findings greatly clarify the complex issue of electrostatic *vs*. electrochemical response, culminating in a picture where electrostatic gating *vs*. oxygen vacancy creation/annihilation can be understood and predicted based on bias polarity, and the enthalpy of formation and diffusivity of oxygen vacancies [1-4]. This understanding was achieved *via* development of *operando* probes, such as synchrotron X-ray diffraction [3,4] and neutron reflectometry [3,6]. References: [1] *Nat. Mater.* **18**, 13 (2019). [2] *ACS Nano* **10**, 7799 (2016). [3] *Phys. Rev. Mater*ials **1**, 071403(R) (2017). [4] *Phys. Rev. Mater*ials **3**, 075001 (2019). [5] *Phys. Rev. Lett*. **118**, 106801 (2017). [6] *Phys. Rev. Mater*ials **2**, 111406(R) (2018).

Biography:

Chris Leighton is a Distinguished McKnight University Professor of Chemical Engineering and Materials Science and a graduate faculty member in Physics at the University of Minnesota (UMN). Following a B.S in Physics (1994) and a Ph.D. in Condensed Matter Physics (1998) at the University of Durham in the UK, he pursued post-doctoral research at UC San Diego under Prof. Ivan Schuller (1998-2001). He joined the Chemical Engineering and Materials Science faculty at UMN in 2001 and is currently a full Professor. His research deals with electronic and magnetic properties of novel materials including complex oxides, oxide heterostructures, metallic spintronics, complex alloys, organic conductors, and earth-abundant photovoltaics. He has authored over 200 publications, which have accumulated more than 10,000 citations. He has received honors that include the Cozzarelli Prize from the Proceedings of the National Academy of Sciences, Fellowship in the American Physical Society (APS), and UMN's Taylor Career Development Award, McKnight Presidential Fellowship, Taylor Distinguished Research Award, Amundson Professorship, Distinguished McKnight University Professorship, and Tate Award for Undergraduate Advising. He serves as Lead Editor of the APS journal *Physical Review Materials*.

Tuesday, October 22, 2019

4:00 pm – SLH 102

The Scientific Community is cordially invited.