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Institute for Materials Science

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IMS Seminar Series

Professor Chris Leighton
Department of Chemical Engineering and Materials Science
University of Minnesota - NSF MRSEC

Electrolyte Gating of Complex Oxides

Friday, May 25, 2018
1:15 - 2:15 PM
Sig Hecker Conference Room (TA-03 Bldg 32 - Room 134)

Abstract: Recently,electrolyte gating techniques employing ionic liquids have proven highly effective in tuning very large carrier densities at material surfaces. These electrolytes enable electric double layer transistor operation, the large capacitances (10's of F/cm2) generating electron/hole densities up to 1015 cm-2, i.e., significant fractions of an electron/hole per unit cell in most materials. This is sufficient to induce and control electronic phase transitions, generating high interest. Uncertainties remain, however, including the true doping mechanism (electrostatic vs. electrochemical), the relation between 2D surface and bulk chemical doping, the role of disorder, the challenge of in operando characterization, and the universality of the approach. In this seminar I will review our work applying electrolyte gating with solid "ion gels" to complex oxide materials (e.g., ultrathin epitaxial La1-xSrxCoO3-), mostly focused on electrical control of magnetism. Our findings greatly clarify electrostatic vs. electrochemical response, resulting in a picture where electrostatic gating vs. oxygen vacancy formation can be understood and predicted based on bias polarity, and the enthalpy of formation and diffusivity of oxygen vacancies].This is achieved through development of in operando probes, such as synchrotron X-ray diffraction, and neutron reflectometry. Control of ferromagnetism is then demonstrated in both electrochemical and electrostatic modes.Most significantly, working in electrostatic mode, and guided by theory, we demonstrate reversible electrical control of Curie temperature over a 150 K window.This record electrostatic Curie temperature shift is achieved via gate-induced cluster percolation, enabling optimized control of ferromagnetism.

Bio: 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 Bachelor's Degree in Physics at the University of Durham in the UK (1994), and a Ph.D. in Condensed Matter Physics at the same institution (1998), 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 as an Assistant Professor, rising to Associate Professor in 2007, and Professor in 2011. His research deals with the 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 approximately 200 publications, which have accumulated almost 9000 citations to date. 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 is Past Chair of the American Physical Society Topical Group on Magnetism, and inaugural Lead Editor of Physical Review Materials, the newest addition to the APS family of journals.

To be on Professor Leighton's Agenda or for general information contact:
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