Materials Science Seminars

Spring 2021

UCI Samueli School of Engineering | Department of Materials Science and Engineering

UC San Diego Jacobs School of Engineering

UCLA Samueli Materials Science & Engineering

Fri, February 19th, 2021

Title: Tuning Transport and Magnetism at Polar Oxide Interfaces

Presenter: Dr. Divine Kumah, Assistant Professor of Physics, North Carolina State University

Time:
10:00 AM – 11:00 AM (Pacific time)

Connection:
Zoom meeting ID: 842 506 6501
Password: 587901

Atomic-scale interactions at the interfaces between polar and non-polar transition metal oxides have led to the realization of exciting phenomena including two-dimensional electron gases, superconductivity and interfacial magnetism. However, these interactions may lead to the suppression of electronic and magnetic ordering at interfaces with strong structure-property relationships. By imaging the atomic structure of the interface between polar LaSrMnO3 (LSMO) and non-polar SrTiO3, we identify interfacial structural distortions which are correlated with thickness-dependent metal-insulator and ferromagnetic-paramagnetic transitions in the rare-earth manganites. We show that these structural distortions can be tuned by inserting polarity-matched spacer layers at the LSMO interfaces leading to a stabilization of ferromagnetism in LSMO layers as thin as two unit cells. The stabilized magnetism is found to be independent of strain. We employ a combination of synchrotron X-ray diffraction, temperature-dependent magnetization measurements and X-ray magnetic circular dichroism to elucidate the interplay between structural and spin degrees of freedom in the rare-earth manganites.[1,2] Additionally, we find that by tuning growth and post-growth processing conditions, a two-dimensional electron gas (2DEG) forms at the interface between antiferromagnetic LaCrO3 and SrTiO3 providing a route to design all-oxide heterostructures which couple magnetic ordering with the mobile carriers within the 2DEG.[3] These results demonstrate the intimate role of picometer-scale structural distortions on the physical properties of transition metal oxides and have important implications for designing novel quantum materials.

[1] Koohfar et. al., ***npj Quantum Materials*** 4 (1), 25 (2019). [2] Koohfar et. al., ***Physical Review B*** 101 (6), 064420 (2020). [3] Al-Tawhid et. al., ***AIP Advances*** 10 (4), 045132 (2020)

Divine Kumah received his Ph.D in Applied Physics from the University of Michigan in 2009 and did postdoctoral research at the Center for Research in Interface and Surface Phenomena at Yale University. His research interests are in experimental condensed matter physics and are aimed at understanding the novel properties which emerge at the interfaces between crystalline materials. The Kumah Research Group at NC State uses state of the art atomic layer-by-layer deposition techniques including molecular beam epitaxy to fabricate thin crystalline oxide films. The group is focused on understanding how atomic-scale structural distortions at interfaces can be manipulated to induce novel electronic and magnetic phenomena and the development of pathways for harnessing these unique functionalities for electronic and energy applications. Tools used by the group include atomic force microscopy, electron diffraction and synchrotron-based x-ray spectroscopy and diffraction.

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