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Understanding nanoscale correlations in complex oxide heterostructures

Mesoscale phenomena play an important role in the dynamics of phase transitions in complex oxides. In order to fully understand and tailor nanoscale functionalities of strongly correlated oxides, detailed access to the nanoscale regime, correlation length scales and their temporal evolution is required. Coherent x-ray scattering at synchrotron sources have emerged as a unique technique to access both nanoscale lengthscales and fundamental timescales. Higher brightness, and coherence enabled by upcoming new sources such as NSLS-II, APS upgrade and ALS upgrade, provide a novel way to investigate material dynamics and fluctuations at fundamental limits of lengthscales and timescales. In this talk, I will discuss advanced synchrotron characterization techniques used by my group to investigate nanoscale properties of complex oxides heterostructures. The first part of my talk will focus on Gd/$La_{0.67}Sr_{0.33}CoO_3$ (LSCO) heterostructures, which have shown promises for magneto-ionic control of functional properties through the presence of oxygen getter layers such as Gd. We have utilized x-ray nanodiffraction to directly image the nanoscale morphology of LSCO thin films as they are progressively transformed from the equilibrium perovskite phase to the metastable brownmillerite (BM) phase with increasing Gd and Al thickness. The second part of my talk will focus on temporal evolution of domain fluctuations and dynamics in $BaTiO_3$ thin films, an archetypical ferroelectric material. By using coherent x-ray scattering technique, we compare domain fluctuations between second and first order phase transition in this material. The significant influence of heterogeneities on pathways of transition in both systems show the importance of nanoscale studies in correlated material systems.

Short Bio

Roopali Kukreja joined Materials Science and Engineering department at UC Davis as an Assistant Professor in Fall 2016. She received her B.S. in Metallurgical Engineering and Materials Science from the Indian Institute of Technology Bombay in 2008 and then her M.S. and Ph.D. degrees in Materials Science and Engineering from Stanford University in 2011 and 2014, respectively. Prior to her appointment at UC Davis, Kukreja worked as a postdoctoral researcher at the UC San Diego, with Profs. Oleg Shpyrko (Physics Department) and Eric Fullerton (Center for Magnetic Recording Research). Her research interests at UC Davis focuses on ultrafast dynamics in nanoscale magnetic and electronic materials, time resolved X-ray diffraction and imaging techniques, thin film deposition and device fabrication. She is recipient of Melvin P. Klein Scientific development award (2015), AFOSR Young Investigator Award (2018), NRC Faculty Development Award (2019), DOE and NSF Early Career Award (2021).