Materials Science & Engineering Seminar Series

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Imaging Functional Behavior in Nanoscale Heterostructures Using Lorentz Microscopy?

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ABSTRACT: Confinement of magnetic structures geometrically as well as energetically, leads to novel and unexpected domain behavior. Lorentz transmission electron microscopy (LTEM) is ideally suited for quantitative analysis of magnetic domains and microstructure in functional nanoscale heterostructures. The current state of art LTEM enabled using aberration correctors allows for imaging down to sub-nanometer scale in field-free conditions. In this talk, the study of magnetic domain behavior in strongly interacting magnetic nanostructures namely artificial spin ices as well as functional materials that host skyrmions will be presented. I will also discuss application of electron interferometric methods to study functional behavior of non-magnetic systems such as grain boundary behavior in CeO based solid fuel cell electrolytes.

Artificial spin ice lattices consist of lithographically patterned arrays of interacting magnetic islands that exhibit magnetic frustration. I will present the results on emergence of magnetic excitations in such lattices which are topologically non-trivial. Furthermore, I will discuss the effect of aperiodicity of the lattice on the magnetic frustration and a novel approach to understand such frustration based on network topology.

Topologically non-trivial spin textures such as skyrmions present unique opportunities to explore exciting fundamental phenomena, such as the topological Hall effect, as well as novel applications, such as skyrmion-based spintronics. The application of LTEM to visualize and understand the magnetic spin textures in multilayer $[Pt/Co]_x$ thin films that can host skyrmions will be discussed. In-situ magnetization reversal was used to understand the stability of the skyrmions.

BIOGRAPHY:

Dr. Charudatta Phatak is a Material Scientist at Argonne National Laboratory. He received his Ph.D from Carnegie Mellon University in Materials Science and Engineering in 2009. His research interests are focused on exploring magnetic frustration and physical curvature effects in patterned nanostructures, understanding grain boundary effects in solid state fuel cell electrolytes and Lithium-ion batteries. He has authored over 60 publications and reviews in the field.

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