Northeastern University

SPECIAL SEMINAR
Quantum Materials and Sensing Institute (QMSI)

"Tailoring Magnetic Spin Textures in $La_{0.7}Sr_{0.3}MnO_3$-based Micromagnets"

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Monday, Aug 26, 2024, 11:00 am – 12:00 pm
Venue: Building 5, 1st floor – C Conf. Room, Burlington Campus
147 South Bedford St, Burlington, MA

Seminar is both in person and online (https://northeastern.zoom.us/j/98053030724)

Abstract: The development of next-generation computing devices based on spintronics and magnonics requires an understanding of how magnetic spin textures can be tailored in patterned magnetic materials. Within the wide range of magnetic materials available, complex oxides such as ferromagnetic (FM) $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and antiferromagnetic (AF) $La_{1-x}Sr_xFeO_3$ (LSFO) provide an ideal platform for tailoring magnetic spin textures when lithographically patterned as nano/micromagnets. This unique tunability arises due to the strong interactions between charge, spin, lattice, and orbital degrees of freedom. In this talk I will demonstrate how an intricate interplay exists between shape and magnetocrystalline anisotropy energies as well as exchange coupling interactions at LSMO/LSFO interfaces, and therefore, the resulting AF and FM spin textures can be controlled using parameters such as the LSMO and LSFO layer thicknesses, micromagnet shape, and temperature. These spin textures are imaged using x-ray photoemission electron microscopy for a variety of shapes (circles, squares, triangles, and hexagons with their edges oriented along different low index crystallographic directions) with and without their core regions removed (aka donut structures). LSMO nanomagnets were also patterned into artificial spin ice (ASI) structures, where large arrays of nanomagnets are arranged into geometries where all the magnetic interactions cannot be satisfied simultaneously. While one might expect shape anisotropy to dictate Ising states in the nanomagnets, the unique combination of magnetic parameters associated with LSMO enables the formation of both Ising and complex spin textures (CSTs) based on the nanoisland width and spacing. These CSTs consist of single and double vortices and alter the nature of dipolar coupling between nanomagnets, giving rise to exotic physics in the ASI lattices. These studies demonstrate that complex oxide provide a unique platform for engineering FM and AF spin textures for next generation spin-based devices.

Biography: Yayoi Takamura received her B.S. from Cornell University in 1998 and her M.S. and Ph.D. degrees from Stanford University in 2000 and 2004, respectively, all in the field of Materials Science and Engineering. She was a postdoctoral researcher at UC Berkeley with Prof. Yuri Suzuki in the Dept. of Materials Science and Engineering before joining the Dept. of Materials Science and Engineering at UC Davis in July 2006. Since July 2020, she has been serving as Department Chair. Her research focuses on the growth of complex oxide thin films, heterostructures, and nanostructures and the characterization of the novel functional properties associated with their interfaces. Prof. Takamura is a recipient of the NSF CAREER Award, the DARPA Young Faculty Award, and the 2020 College of Engineering Mid-Career Research Award.