Understanding the behavior of nanoscale magnetic heterostructures: how electron microscopy can help

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As the dimensions of magnetic materials decrease to the nanoscale, novel distributions of spin can be created. We are exploring the formation of these novel distributions and ways to control them through gaining an understanding of the local energy landscape of the nanostructures. We have used a combination of Lorentz TEM and in-situ magnetizing experiments, together with magnetic force microscopy (MFM) to study the micromagnetic behavior at the sub-micron scale of magnetic nanostructures such as heterostructures composed of coupled, patterned magnetic disks, and artificial spin ice arrays. Quantitative analysis of the Lorentz TEM data has been carried out using the transport of intensity equation (TIE) approach, which we have also extended to allow us to visualize the magnetic structure in three dimensions. By comparing these data with the results of simulations, we are able to gain a fuller understanding of the various energy terms that contribute to the behavior that we observe.

Biography

Dr. Amanda K. Petford-Long is an Argonne Distinguished Fellow in the Materials Science Division at Argonne National Laboratory. In addition to her own research program, she heads the strategic initiative on Integrated Imaging at Argonne. She holds a D.Phil in Materials Science from the University of Oxford (1985) and a Bachelor's degree in Physics from University College, London (1981). She moved to Argonne in 2005 from the University of Oxford where she was a full professor in the Materials Department and a tutorial fellow at Corpus Christi College. From January 2010–Feb 2014 she was director of the Center for Nanoscale Materials, a Department of Energy national user facility at Argonne National Laboratory, focused on capabilities tailored to the creation and characterization of new functional materials on the nanoscale.

Dr. Petford-Long's research interests include the dependence of magnetic, transport and optical properties of layered ferroic films and nanostructures on microstructure and composition. She has been particularly involved in exploring the physical properties of the nanomaterials, such as magnetic domain behavior and transport behavior, using in-situ transmission electron microscopy techniques including Lorentz microscopy. She has published over 300 papers in the scientific literature. She is a Fellow of the Royal Academy of Engineering and of the American Physical Society, and she is also a full professor in the Materials Science and Engineering Department at Northwestern University, where she is active in graduate teaching.