

Carnegie Mellon

Materials Science and Engineering Seminar Series

Amanda K. Petford-Long

Materials Science Division
Argonne National Laboratory

“Structure property relationships in nanoscale magnetic heterostructures”

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11:30AM Seminar in Baker Hall 136A

The properties of nanoscale magnetic materials depend critically on their microstructure and composition, with variations on the atomic scale leading to variations in properties. Of particular interest for technological applications in information storage systems are magnetic structures composed of thin layers, such as spin tunnel junctions. In such devices the microstructure and chemical profile across the layers are critical in determining the magnetic and transport properties, and therefore need to be critically controlled. In order to analyze the microstructure and composition profile we have used a range of transmission electron microscopy (TEM) techniques such as HREM and EFTEM mapping, in addition to atom probe tomography (APT) analysis.

However, these data are really only of interest in so far as they enable us to understand the origins of the magnetic and transport properties, and we have been using in-situ TEM to investigate these properties. We have used a combination of Lorentz TEM and in-situ magnetizing experiments, plus micromagnetic modeling to study the micromagnetic behavior at the sub-micron scale of magnetic nanostructures such as patterned exchange-biased magnetic disks. Quantitative analysis of the Lorentz TEM data has been carried out using the transport of intensity equation (TIE) approach. We have also developed in situ TEM capabilities that enable us to correlate the local tunneling properties of magnetic tunnel junctions with microstructure, and results of these studies will also be presented.

Amanda Petford-Long is a Senior Scientist in the Materials Science Division at Argonne, National Laboratory, which she joined in August 2005. Since October 2008 she has also been a Professor in the Materials Science and Engineering Department at Northwestern University. She has a BSc in Physics from University College London and a DPhil in Materials Science from the University of Oxford, where she was a Professor in the Materials Department until she joined Argonne. Her research focuses on correlating physical properties of layered thin films and nanoparticles with microstructure and composition profile. Of particular interest are materials for information storage applications. She has developed in-situ TEM facilities for analyzing magnetization and transport behavior and has published over 250 papers.