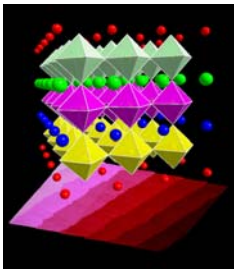
Center for Nanophase Materials Sciences (CNMS)

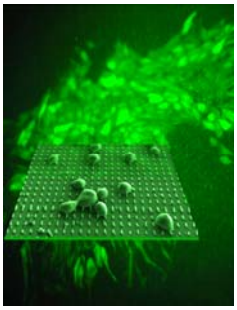
CNMS DISCOVERY SEMINAR SERIES

Joint Meeting with the

MATERIALS SCIENCE AND TECHNOLOGY DIVISION

Friday, March 16, 2007
11:00 am (refreshments available)
Iran Thomas Auditorium (8600)





"The Hunt for a Snark: 50 years of Landauer Paradox"

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Abstract: Ferroelectric polarization reversal is the functional basis of rapidly emerging applications such as non-volatile random access memories, ferroelectric tunnel junctions, and high-density data storage. Macroscopic ferroelectric polarization switching is controlled by nucleation centers that are necessary to account for experimentally observed low values of coercive fields. Despite 50 years of extensive research addressing the role of conductivity, surface dead layers, charge injection, and other factors, the microstructural origins of the Landauer paradox (switching fields correspond to implausibly large nucleation activation energies) are still a mystery.

In this presentation, I will demonstrate a local probe approach to visualize the spatial and energy distribution of nucleation centers with nanometer resolution, and correlate them to local microstructure. The symmetric and antisymmetric parts of disorder potential are extracted from positive and negative nucleation biases. Observation of enhanced nucleation activity at the intersections of 90° domain walls combined with phase-field modeling identifies them as a class of nucleation centers that are responsible for switching in defect-free material. The preliminary results on the polarization switching in materials with engineered defect structures (bicrystal grain boundaries) are presented. Finally, the "abnormal" hysteresis loops were observed in the vicinity of topographic defects in multiferroic thin films and PZT ceramics and attributed to the interaction of nascent domain with the strain field of the defect. This opens a pathway for establishing structure-property relationship for nucleation centers in ferroelectrics and suggests the general strategy for studying the role of defects on the kinetics and thermodynamics of first-order phase transitions on one-by-one basis.

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