NCMN

NEBRASKA CENTER FOR MATERIALS AND NANOSCIENCE
2011 SEMINAR SERIES PRESENTS

NCMN

Co-sponsor: Materials Research Science and Engineering Center

Dr. Ram S. Katiyar

Department of Physics and Institute
for Functional Nanomaterials
University of Puerto Rico-San Juan

Investigations on nanostructured magnetoelectric multiferroics

Multiferroics, which display simultaneous magnetic, electric, and ferroelastic ordering, have drawn increasing interest in recent years due to their multi-functionality for a variety of device applications, especially in non-volatile memory devices and weak magnetic field sensors.

$BiFeO_3$ (BFO) is the most studied material exhibiting multiferroism at room temperature. We observed Raman scattering from magnons (also known as electromagnons, meaning they possess electric dipole moment due to magnetoelectric coupling) in $BiFeO_3$ thin films grown on (111) $SrTiO_3$ substrates at cryogenic temperatures; the temperature dependence of the magnon at 18.2 cm^{-1} approximates an S=5/2 Brillouin function up to the temperature (280 K) at which the magnon becomes overdamped. The diverging cross-section and the frequency-shift at 140K and 200 K imply a spin-reorientation transition as in orthoferrites. The low frequency intense sharp modes appearing at 136, 172 and 212 cm^{-1} showed anomalies around the magnetic phase transition T_N (673K) that could be interpreted as an experimental evidence of perturbation at the magnetic phase transition (Spin phonon coupling).

The multilayered nanostructures of $Pb(Zr,Ti)O_3/CoFe_2O_4$ (PZT/CFO) showed reduction in dielectric constant and polarization, and enhance magnetization with decrease in temperature from 400 K to 100 K. The temperature dependent real part of the dielectric constant illustrated step like behavior, whereas the imaginary part gave a relaxation peak near the step maxima temperature. We observed a slow decrease in the polarization from 300 K to 200 K and a complete collapse of the polarization at ~ 100 K, which was reversible on heating. The remanent magnetization of the layered nanostructure was three times higher at 100 K than at room temperature. A slow enhancement in the remanent (internal) magnetization on lowering the temperature was observed in the above temperature region revealing a coupling in magnetic and electrical properties. The temperature dependent dielectric, polarization, and magnetization were different from the parent layer, indicating dynamic magneto-electric coupling in the layered nanostructures.

Bilayers and superlattices of $PbZr_{0.52}Ti_{0.48}O_3$(PZT) with half-metallic oxide $La_{0.67}Sr_{0.33}MnO_3$ (LSMO) were fabricated by PLD technique. The piezoforce microscopy (PFM) measurements revealed switching of polarization under external bias field confirming ferroelectric behavior. Frequency dependent dielectric anomaly was observed near room temperature suggesting dynamic magneto (resistance)-dielectric coupling. The polarization flop in the presence of magnetic magnetic field of 0.34T was explained due to excessive voltage across the PZT layer, causing short circuiting. This behavior was reversible.

Host:
Dr. Evgeny Tsymbal
Materials Research Science and Engineering Center

Please Post

Friday, May 13, 2011
237 Scott Engineering Center, 1:30 p.m.
UNL City Campus