Stony Brook University
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Doctoral Defense Announcement

Abstract

$PbTiO_3$ Based Ferroelectric Superlattices with Conventional and Novel Dielectric Components

By

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Within the family of oxide materials which have a perovskite structure there are many different types of materials: ferroelectrics, metals, ferromagnets and antiferromagnets, superconductors, and dielectric insulators. Ferroelectric materials are those with a switchable, spontaneous electric polarization and by combining them with other perovskite oxides in a superlattice structure, the properties of the system can tailored by exploiting competition between the interacting properties of the constituent materials.

In ferroelectric/dielectric superlattices important structural and functional properties of the system can be tailored by the relative thicknesses of the ferroelectric and non-ferroelectric layers. In $PbTiO_3/SrTiO_3$ superlattice $SrTiO_3$, an insulator, plays the role of a conventional dielectric. Ferroelectric stripe domains in this system were investigated and it was found that the domain periodicity as a function of $PbTiO_3$ layer thickness displays a scaling relation which raises interesting questions about the Kittel Scaling law as applied to ferroelectric superlattices. In addition to the static properties of the domains the evolution of domain structure under electric field was studied by time-resolved x-ray studies at the APS.

A second system, $PbTiO_3/SrRuO_3$, uses $SrRuO_3$, which is normally metallic in bulk but displays insulating behavior in the ultrathin limit, as a novel dielectric component to create superlattices that display an out-of-plane ferroelectric polarization. The incorporation of $SrRuO_3$ also breaks inversion symmetry at the interface between the two materials, which affects the ferroelectric double-well energy potential and the system's dielectric properties. The transport properties of this system are also of interest, with anistropic conductivity and resonant tunneling between layers. This was investigated by electrical measurements and photoemission studies performed at NSLS U13.

Date: April 11, 2013
Time: 3:00 pm
Place: Physics Building, B131

Program: Physics
Dissertation Advisor: Matthew Dawber