Using Ultrafast Optical Spectroscopy to Explore Magnetolectric Coupling in Multiferroic Oxide Heterostructures

Abstract

Multiferroic oxides have attracted much attention in recent years due to their potential for controlling magnetism with an electric field and ferroelectricity (FE) with a magnetic field. Existing materials, however, typically display relatively weak coupling between these parameters, making a deeper understanding of magnetolectric (ME) coupling in multiferroics critical for optimizing their performance in applications. In the past few years, we have demonstrated that ultrafast optical spectroscopy (UOS) is a unique tool for exploring ME coupling in canonical multiferroics such as TbMnO$_3$ and BiFeO$_3$. Here, I will describe more recent work extending these approaches to probe the interplay between FE and magnetic ordering in multiferroic heterostructures. These studies have revealed a long-lived, photoinduced enhancement of the FE polarization in a FE/ferromagnet (FM) heterostructure, as well as the polaronic nature of interfacial magnetic order in a FM/BiFeO$_3$ heterostructure. Furthermore, preliminary results indicate that femtosecond optical pulses can induce transient magnetolectric coupling in a FE/FM heterostructure, with implications for high speed magnetolectric devices. Overall, our studies demonstrate the utility of UOS in exploring magnetolectric coupling in multiferroic oxides and their heterostructures.

Dr. Rohit P. Prasankumar received a B.S. in Electrical Engineering from the University of Texas at Austin in 1997 and the M.S. and Ph.D. degrees in Electrical Engineering from MIT in 1999 and 2003, respectively. His thesis work, completed in 2003, concentrated on developing novel approaches for self-starting mode-locking in solid state lasers. Dr. Prasankumar subsequently performed his postdoctoral research at Los Alamos National Laboratory, focusing on ultrafast mid-to-far-infrared dynamics in semiconductor nanostructures and strongly correlated compounds. He has been a technical staff member at the Center for Integrated Nanotechnologies (CINT) since February 2006, with research interests principally directed towards the measurement of dynamics in complex materials, such as high-$T_c$ superconductors, multiferroics, and semiconductor nanowires, with high temporal and spatial resolution over a broad spectral range. He was appointed as an Adjunct Assistant Professor at the University of New Mexico in 2008.