★★★★★ FIVE STAR CHAPTER
ASM INTERNATIONAL® Oak Ridge Chapter
The Materials Information Society

Thursday, March 25, 2010
Oak Ridge Chapter of ASM International's
Past Chairs Night

"Optical properties of iron oxides: Light harvesting in the new iron age"

Prof. Janice Musfeldt
University of Tennessee, Knoxville

The interplay between charge, structure, and magnetism is the origin of rich physics in complex oxides. Because these interactions are so strong, oxides straddle several competing regions of physical, chemical, and size-shape phase space. An important consequence of this phase proximity is the physical property tunability and, in some cases, the opportunity to drive new functionality via modification of important energy and length scales in a material. To this end, we investigated the optical properties of $LuFe_2O_4$ and $BiFeO_3$, systems that exhibit the highest magnetic and ferroelectric ordering temperatures among known multiferroics. $LuFe_2O_4$ is a frustrated system with several phase transitions that result in electronically driven multiferroicity. To understand how this peculiar multiferroic mechanism correlates with magnetism, we studied electronic excitations by optical spectroscopy and other complementary techniques. We show that the charge order, which determines the dielectric properties, is due to the "order by fluctuation" mechanism, evidenced by the onset of charge fluctuation well below the charge ordering transition. We also find a low temperature monoclinic distortion driven by both temperature and magnetic field, indicating strong coupling between structure, magnetism and charge order. $BiFeO_3$ is the only known single phase multiferroics with room temperature magnetism and ferroelectricity. To investigate the spin-charge coupling, we measured the optical properties of $BiFeO_3$. We find that the absorption onset occurs due to on-site Fe^{3+} excitations at 1.41 and 1.90 eV. Temperature and magnetic-field-induced spectral changes reveal complex interactions between on-site crystal-field and magnetic excitations in the form of magnon sidebands. The sensitivity of the magnon sidebands allows us to map out the magnetic-field temperature phase diagram which demonstrates optical evidence for spin spiral quenching above 20 T and suggests a spin domain reorientation near 10 T. Interestingly, polar oxide heterostructures based on $BiFeO_3$ are also providing a novel approach to solar energy conversion with open circuit voltages of 0.8 – 0.9 V and efficiencies of 10% above the band gap. The photovoltaic efficiency of $BiFeO_3$ is, however, limited by the 2.67 eV bandgap. Several strategies to improve the match with the solar spectrum will be discussed including (i) bandgap control via cationic substitution, (ii) control of morphology, and (iii) exploitation of nanoparticle size-shape effects. These efforts are directed at achieving a better match with the solar spectrum and enhancing the photoferroelectric properties of $BiFeOO_3$.

Speaker Bio

Dr. Jan Musfeldt is a recognized expert in the use of optical spectrosocpies to investigate the local structural and dynamical properties of functional materials. In recent work, she has employed these techniques to understand the interplay between structure, magnetism, bonding, reactivity, and dynamics in low-dimensional, molecular, and nanoscale solids. During her career, Dr. Musfeldt has championed interdisciplinary education in the area of complex materials, most recently in the area of nanoscience.

Registration (Guests Welcome!)
Cost: $20

Students: Free if RSVP by Mar. 19th;
$5 if RSVP late
RSVP by noon on Friday Mar. 19th
Contact: Jun Qu
(865)-576-9304 or qujn@ornl.gov

Rothchild's Conference Center
8807 Kingston Pike
(865) 690-0103

Thursday, Mar 25th
Schedule
5:30 pm– Social Hour
6:30 pm– Dinner
7:30 pm– Talk

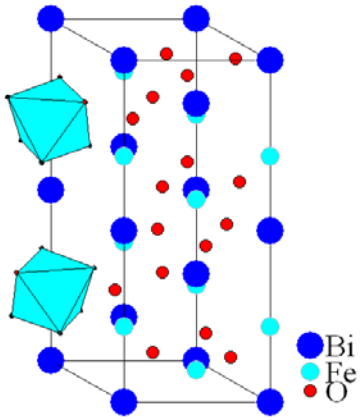
Oak Ridge Chapter of ASM International

2009-2010 Technical Calendar

MARK YOUR CALENDAR FOR REMAINING MEETINGS!

April 20-21st: Educational Symposium
"Advanced Characterization Methods: Understanding the Structure and Functionality of Materials"
@American Museum of Science and Energy, Oak Ridge, Tennessee

May 20th: Awards Night
Rogelio Sullivan **- tentative**
"Future Renewable Electric Energy Delivery and Management"
@ Rothchild Catering Center



$BiFeO_3$