Title

Workshop on opportunities in polarization dependent X-ray spectroscopy and microscopy in magnetism and magnetic materials research

Journal

Synchrotron Radiation News, 16(1)

Author

Smith, Neville

Publication Date

2002-12-12

Workshop on Magnetic Materials

Hans Siegmann takes questions after his presentation.

The workshop on "Scientific Opportunities in Polarization-Dependent X-Ray Spectroscopy and Microscopy for Magnetism and Magnetic Materials Research" was held on October 11th and 12th as part of the 2002 Advanced Light Source (ALS) Users' Meeting at Lawrence Berkeley National Laboratory (LBNL). The workshop was co-organized by Elke Arenholz (ALS), Anthony Young (ALS), Yves Idzerda (Montana State University, Bozeman) and Neville Smith (ALS). More than 20 speakers presented their research and vivid discussions among the attendees bear witness of the excitement in this field.

The Friday afternoon session chaired by Anthony Young focused on spin and magnetization dynamics. Manfred Schabes (IBM Almaden) made the first presentation of the session discussing the dynamics of magnetic data recording. Micromagnetic simulations allow Schabes to calculate in detail the time dependent magnetization reversal in perpendicular magnetic recording media, which are being considered for future generations of ultra-high density magnetic recording applications. Paul Crowell (University of Minnesota) followed with a presentation on imaging spin dynamics in patterned ferromagnetic thin films using time-resolved Kerr microscopy. Crowell was able to observe distinct excitations modes in individual micron-scaled ferromagnetic thin film structures. The excitation modes are determined by the shape of the structure as well as strength and orientation of the exciting field. Next Hans Siegmann (Stanford Linear Accelerator Center, SLAC) discussed new results on spin dynamics studied with the picosecond magnetic

field pulses from SLAC. Samples can be exposed to 2-5 picosecond short magnetic field pulses of up to 20 T in the Stanford Linear Accelerator by directing 50 GeV electron bunches through the sample. Examining the microscopic domain structure of the sample after exposure then provides valuable information on the magnetic switching in the system. After a break Andreas Scholl (ALS) discussed some of the scientific and technical issues in determining the time dependent magnetization phenomena in nanostructures using photoemission electron microscopy (PEEM). Yves Acremann (SLAC, ALS) continued the discussion by describing magneto-optical Kerr effect studies of magnetic excitations with picosecond time resolution. He was able to map the local precessional motion of the magnetization vector of a 6 micrometer Co dot with submicrometer spatial resolution. The final presentation of the day was given by Peter Fischer (Max Plank Institut Stuttgart, Germany). Fischer described first results of his efforts to image magnetization dynamics with soft x ray transmission microscopy at the ALS.

In the Saturday morning session chaired by Elke Arenholz selected frontiers in current magnetism research were discussed. Nitin Samath (Pennsylvania State University) made the first presentation of the day discussing his group's research on the magnetic and electronic properties of the ferromagnetic semiconductor $Ga_{1-x}Mn_xAs$. Ferromagnetic semiconductors are currently intensely researched since they might allow the incorporation of ferromagnetic elements into spintronics devices. Samath discussed the complexity of the ferromagnetism in $Ga_{1-x}Mn_xAs$, which even a fixed Mn composition is highly sensitive to the detailed growth conditions. Next Franz Himpsel (University of Wisconsin Madison) discussed the possibility of tuning the spin dependent mean free path in Ni by magnetic doping. Using angle resolved photoemission he could show that iron suppresses the mean free path of minority spins only while adding Cr effects electrons with both spins. Jeff Kortright (LBNL) followed with a brief tutorial on the basic concepts of resonant soft x-ray scattering. He emphasized that this technique can provide novel insight into magnetic and chemical structure of thin films on the nanometer length scale allowing to investigate the correlation between chemical heterogenity and characteristic magnetic length scales. After a short break S.X. Wang (Stanford) discussed the role of advanced magnetic materials and transductor development for information technology. He emphasized the need for soft magnetic materials with high saturation magnetization (>20kG) and large permeability roll-off frequency (>1GHz) for use in extremely high density magnetic write heads. Wang described the progress made in his lab in developing these materials. Z.Q. Qiu (UC Berkeley) reported on his studies of spin reorientation transitions (SRTs) in magnetic ultrathin films. SRTs are caused by the interplay of magnetic anisotropy of different origin, for example perpendicular magnetocrystalline anisotropy and inplane magnetic shape anisotropy in the case of ultra-thin Fe films on Cu(001). Qiu determined in detail complex domain structure in this system near the reorientation transition by combining magneto optical Kerr effect measurement with photoemission electron microscopy. Kai Liu (UC Davis) discussed his research on exchange biased thin films and nanostructures. He fabricated Fe nanodots and nanoporous Fe networks and studied the effect of nanostructuring on the magnetic characteristics of the system. The final presentation of the session by

Larry Sorensen (University of Washington) completed the diverse array of talks by discussing aspects of coherent x-ray magnetic scattering. Sorensen used this technique to study return point memory in CoPt systems.

The afternoon session on "Future Perspectives of Spin-Resolved Photoemission" was held jointly with the workshop on "Future Scientific Opportunities with Ultra-High Resolution Soft X Rays" and was chaired by Neville Smith. The first two talks by Lamberto Duò (Politecnico di Milano, Italy) and Gyorgy Snell (formerly Western Michigan University, now Syrrx) focused on the design and construction of electron polarimeters whereas the following talks turned to the discussion of applications of spin-resolved photoemission. Duò described the development of a high efficiency electron polarimeter based on exchange scattering from a magnetic target. His choice of the magnetized oxygen covered Fe(001) surface as a scattering target allows him to exploit the large spin dependence of the absorbed and reflected current of low energy electrons and results in high values of the analyzing power and of the efficiency for the polarimeter. Snell presented design and characteristics of a compact Mott polarimeter for time of flight studies. He emphasized that Mott polarimeters when combined with time of flight electron analysis allow very efficient data acquisition since all electrons are energy and spin analyzed simultaneously. Next Boris Sinkovic (University of Connecticut) presented his research using spin-resolved resonant photoemission with polarized radiation as probe of correlation effects in solids. As one example he discussed the case of CuO where he showed that electron states at the top of the valence band are of pure singlet character suggesting the existence of Zhang-Rice singlet in high temperature cuprates. After a short break, Alexei Fedorov (ALS) reported on his investigation of photohole lifetimes in ferromagnetic gadolinium using spin resolved photoemission. He was able to show that at low temperatures the majority-spin life-time is limited by electron phonon scattering whereas the minority-spin life time is determine by electron-magnon scattering. Jim Tobin (Lawrence Livermore National Laboratory) presented his initial progress towards determining the electronic structure of plutonium. Plutonium has a rich phase diagram and the complex interplay of electronic and geometric structure is poorly understood even today. Simon Mun (LBNL) led the discussion to probing buried interfaces with soft x-ray standing waves produced by a B_4C/W multilayer. The standing wave was tuned through the interface of a wedge shaped Cr/Fe bilayer grown on top of the standing wave generator leading to novel information about the magnetic structure of the Cr/Fe interface. The workshop participants then heard a talk by Norman Manella (UC Davis). He described a new high temperature electronic phase transition in a colossal magnetoresistive oxide $La_{1-x}Sr_xMnO_3$ that he observed by combining photoemission, x-ray absorption, and x-ray fluorescence spectroscopy. Eli Rotenberg (ALS) followed with a presentation on the spin-resolved band structure of hydrogen on W(110). He used spin- and angle-resolved photoemission to demonstrate that the surface states in this system show a 100% in-plane spin polarization which is due to spin-orbit interaction. The workshop concluded with a brief presentation by Yi-De Chuang (ALS) on the characteristics of the proposed ultra-high resolution beamline

that would provide exciting new capabilities for high-resolution photoemission and resonant inelastic scattering experiment at the ALS.

Elke Arenholz, Anthony Young, and Neville Smith
Advanced Light Source, Berkeley Lab