

# **Carnegie Mellon**

## **Materials Science and Engineering Seminar Series**

**Peter Fischer**

Lawrence Berkeley National Laboratory  
Center for X-Ray Optics

*“Magnetic Soft X-Ray Microscopy  
Towards imaging nanoscale magnetism at fundamental time scales”*

**Friday, November 5, 2010  
10AM Seminar in Baker Hall 136A**

The manipulation of spins on the nanoscale is of both fundamental and technological interest. Advances in synthesis of magnetic nanostructures and analytical tools are key to provide a fundamental insight into the physical processes involved. Magnetic microscopies are faced with the challenge to provide both spatial resolution in the nanometer regime, a time resolution on a ps to fs scale and elemental specificity to be able to study novel multicomponent and multifunctional magnetic nanostructures and their ultrafast spin dynamics. Magnetic soft X-ray microscopy is a unique analytical technique combining X-ray magnetic circular dichroism (X-MCD) as element specific magnetic contrast mechanism with high spatial and temporal resolution. Fresnel zone plates used as X-ray optical elements provide a spatial resolution down to currently 10nm [1,2] thus approaching fundamental magnetic length scales such as the grain size [3] and magnetic exchange lengths. Images can be recorded in external magnetic fields giving access to study magnetization reversal phenomena on the nanoscale and its stochastic character [4] with elemental sensitivity [5]. Utilizing the inherent time structure of current synchrotron sources fast magnetization dynamics with 70ps time resolution, limited by the lengths of the electron bunches, can be performed with a stroboscopic pump-probe scheme. In this talk I will review recent achievements with magnetic soft X-ray microscopy with focus on current induced wall [6] and vortex dynamics in ferromagnetic elements [7].

The potential of soft X-ray microscopy to push the spatial resolution below 10nm with improved X-ray optics will be outlined and soft x-ray microscopy at future high brilliant fsec X-ray sources makes snapshot images of fsec nanoscale spin dynamics feasible.

### References

- [1] W. Chao, et al., Optics Express 17(20) 17669 (2009)
- [2] W. Chao, et al (2010) in preparation
- [3] M.-Y. Im, et al, Advanced Materials 20 1750 (2008)
- [4] M.-Y. Im, et al., Phys Rev Lett 102 147204 (2009)
- [5] M.-Y. Im, et al., Appl Phys Lett 95 182504 (2009)

[6] L. Bocklage, et al., Phys Rev B 78 180405(R) (2008)

[7] S. Kasai, et al., Phys Rev Lett 101, 237203 (2008)

Dr. Peter Fischer is staff scientist at the Center for X-ray Optics within MSD at Lawrence Berkeley Natl Lab and in charge of the high resolution soft X-ray microscope beamline at the Advanced Light Source. His scientific interest is dedicated to use polarized X-rays to study magnetism at short length and time scales. He pioneered soft X-ray microscopy for magnetic imaging in 1996. He received his PhD in 1993 from the TU Munich/Germany. He has published 120+ papers and has presented 130+ invited talks at international meetings. Member-at-Large of GMAG within APS, member of AdComm of the IEEE MagSoc, chair of MML2010 in Berkeley in Sep 2010.