Abstract for an Invited Paper
for the MAR10 Meeting of
The American Physical Society

Soft X-Ray Microscopy: Imaging Magnetism at Small Sizes[1]

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The manipulation of spins on the nanoscale is of both fundamental and technological interest. In spin based electronics the observation that spin currents can exert a torque onto local spin configurations which can e.g. push a domain wall has stimulated significant research activities in order to provide a fundamental understanding of the physical processes involved. 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 <12nm [1] thus approaching fundamental magnetic length scales such as the grain size [2] 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 [3] with elemental sensitivity [4]. 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 [5] and vortex dynamics in ferromagnetic elements [6]. Future 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.

References

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[1]This work is supported by the Director, Office of Science, Office of Basic Energy Sciences, Materials Sciences and Engineering Division, of the U.S. Department of Energy.