The Magnetic Transmission X-ray Microscopy Project at BESSY II

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Magnetic transmission x-ray microscopy (MTXM) allows imaging magnetic domains and magnetization reversal processes in externally applied magnetic fields with a lateral resolution below 20 nm, and with a time resolution of 70-100 ps, in a quantitative and element-selective way [1,2]. A transmission x-ray microscope dedicated to this technique and to spectromicroscopy is currently being built at the beamline ID-10 of the synchrotron BESSY II in Berlin. The setup of this beamline, its expected features and possibilities will be presented.

The helical undulator UE46 provides photons with circular-, horizontal-, vertical, and linear polarization under various angles and enables thus x-ray magnetic circular dichroism (XMCD) as well as x-ray magnetic linear dichroism (XMLD) as a magnetic contrast to study ferromagnetic and antiferromagnetic domains. Special attention has been given to enable spectromicroscopy: An off axis condenser zone plate (OTZ) generates a spectral resolution E/Delta(E) of 4000, much higher than in conventional zone plate linear monochromators. To conserve this high value, condenser mirrors with slope errors below 0.05 arc seconds as well as computerized controlled ultra high precision movement of all axes are necessary. The energy can be tuned within 24% by shifting the OTZ with a stage on a polished granite plate. Within the total travel range of 1 m the measured vertical deviations are below 3 microns, ensuring a high linearity of the energy which is necessary for spectromicroscopy.
A condenser with dynamical aperture synthesis allows rotating two condenser mirrors with a speed of up to 800 rpm in ultra high vacuum. A new direct drive has been designed, using a divided stator coupled through a stainless steel vacuum tube to a permanent magnet at the rotor [3]. The measured ripples are below 0.1%, ensuring a homogeneous illumination of the object.

The sample will be in ultra high vacuum and can be transferred by a load lock system to a preparation chamber, which enables in-situ sample preparation. A telescope has been designed which allows simultaneous optical and x-ray imaging of an object. This is not only very helpful for alignment but enables excitation of the sample by femtosecond laser pulses and thus studying magnetization dynamics in pump-probe experiments.

[1] T. Eimüller, P. Fischer P., M. Köhler, M. Scholz, P. Guttmann, G. Denbeaux, S. Glück, G. Bayreuther, G. Schmahl, D. Attwood, G. Schütz, Appl. Phys. A **73**, 697-701 (2001)
[2] H. Stoll, A. Puzic, B. V. Waeyenberge, P. Fischer, J. Raabe, M. Buess, T. Haug, R. Höllinger, C. H. Back, D. Weiss, G. Denbeau, Appl. Phys. Lett., **84**, 3328-3330, 2004
[3] J. Merwerth, A. Oswald, M. Hörz, H.-G. Herzog, T. Eimüller, R. Vatter, H. D. Carstanjen: *Developing a brushless permanent magnet synchronous drive for an x-ray microscope condenser in ultra-high vacuum,* Proceedings of the International Electric Machines and Drives Conference, San Antonio, TX, May 15-18 (2005)