FA03

Magnetic Soft X-ray Microscopy – imaging Spin Structures and Their Dynamics on the Nanoscale

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Nanoscale and multicomponent magnetic systems are attracting both fundamental interest and are widely used in technological applications such as high density magnetic storage and sensor devices. The challenge to modern magnetic microscopies is to image magnetic microstructures in such specimens with high spatial and time resolution and elemental specificity.

Magnetic soft X-ray microscopy is a novel technique combining a spatial resolution down to currently 15nm [1], elemental sensitivity due to X-ray magnetic circular dichroism used as huge magnetic contrast mechanism and a sub-ns time resolution limited by the current time structure of the synchrotron radiation used as source for circularly polarized soft X-rays [2].

We report on recent results and achievements in magnetic soft X-ray microscopy obtained at the full-field soft X-ray microscopy beamline 6.1.2 (XM-1) located at the Advanced Light Source in Berkeley CA. Magnetization reversal processes at the grain level in a nanogranular CoCrPt system were studied with 15nm spatial resolution to obtain insight into spin fluctuations on a fundamental length scale [3]. The inherent elemental sensitivity of XMCD contrast allows e.g. in (coupled) multilayered magnetic systems to explore their microscopic magnetization reversal process with layer resolution.

Spin dynamics in magnetic nanostructures can be addressed by a stroboscopic pump and probe scheme utilizing the inherent time structure of synchrotron radiation, where the pump is a fast electronic pulse launched into a waveguide structure to excite the spin dynamics of a magnetic nanoelement. Varying the delay time between the pump and the probing x-ray flash one can follow the time development of e.g local spin and vortex dynamics and relaxation phenomena, but also spin-torque driven domain wall displacements with sub-ns time resolution [4].

Current developments of X-ray optics aim to achieve better than 10nm spatial resolution. At upcoming high brillant ultrast X-ray sources snapshots of spin dynamics with fs time resolution recorded with magnetic soft X-ray microscopy can be foreseen.

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FA04

Observation of Nonlinear Phase Splitting of Spin-wave Packets Using Phase Sensitive Brillouin Light Scattering Spectroscopy

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We present results obtained with the new phase sensitive Brillouin light scattering spectroscopy (BLS) technique. This new technique in combination with space and time resolved BLS [1] gives us the possibility to directlymeasure phase quantities of microwave excited spin-wave pulses such as phase fronts or phase profiles (i.e. the time dependent phase difference between the exciting microwave signal and the spin wave at any given point of the sample). Space and time resolutions are 50μm and 1.7respectively.

The phase sensitivity is realized by interference between the light which is inelastically scattered by the spin waves and a coherent reference beam [2]. The reference is created by electro-optical modulation based on a Lithium Niobat crystal which is excited using the same microwave signal that is used to excite the spin waves. This not only ensures that both signals have an identical frequency but also the necessary coherency between them. Thermal and mechanical stability is improved by spatially combining signal and reference beam.

Using this new technology we were able to observe the phase accumulation forspin-wave pulses. By changing the power of the input microwave signal we could easily excite both linear and nonlinear pulses. In the latter case due to influence of nonlinear damping the created spin-wave pulse consists of two areas with different intensities and thus allows us to investigate the influence of the spin-wave amplitude on the spin-wave phase. Nonlinear phase splitting between the peak and tail area of the nonlinear spin-wave pulse was observed [3].

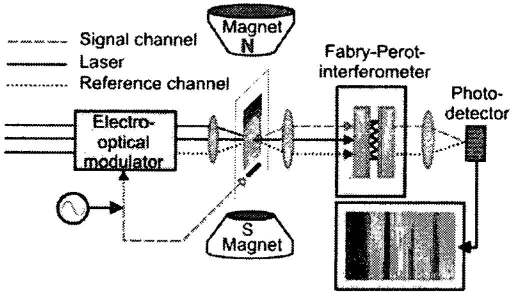

Fig. 1. Experimental setup: phase-resolvedBLS. Phase sensitivity is created by interference between the light inelastically scattered by the spin waves (dashed line) and a coherent reference beam (dotted line), frequency shifted by the electrooptical modulator [3].

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