

Ultrafast magnetic domain dynamics studied by magnetic resonant scattering at X-FEL sources.

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The active field of experimental studies of ultrafast magnetization dynamics [1] develops nowadays using short X-ray pulses from slicing source [2] or laser sources [3] that allows both stroboscopic spectroscopies and spatially resolved microscopy techniques. The recently commissioned XFEL source at LCLS provides intense femtosecond x-ray pulses for single shot scattering experiments [4]. It offers unique opportunities to investigate irreversible transformation. Our experiment aimed at following with nanometer spatial and femtosecond temporal resolution the laser induced spin reorientation and modifications of the magnetic domains [5]. We investigated thin ferromagnetic CoPd films exhibiting out-of-plane anisotropy and a magnetic domain structure of aligned stripe domains. We recorded single-shot X-ray magnetic resonant scattering pattern (XMRS) at the SXR beamline of the Linear Coherent Light Source, using the magnetic circular dichroism at the Co L₃ absorption edge as magnetic contrast mechanism (Figure 1). A grating monochromator was used to select and stabilize a specific photon energy matching the dichroic absorption resonance. The delay

between the X-ray probe and the IR laser pump (60 fs pulse duration, 800 nm) was generated by electronic synchronization.

The time evolution of the initial magnetic stripe domain structure was followed using single x-ray pulse based snapshot pump-probe characterization. Our results show how the ordered stripe domain structure is lost and how magnetic order re-appears at delays of about 5 nanoseconds, ultimately evolving to a different magnetic domain configuration on the nanosecond time scale. Modeling the magnetic domains as a function of the temperature dependent anisotropy constant in CoPd, reproduces the time dependent transformation of the nanometer sized domain configurations in the presence of a static Oersted field [5].

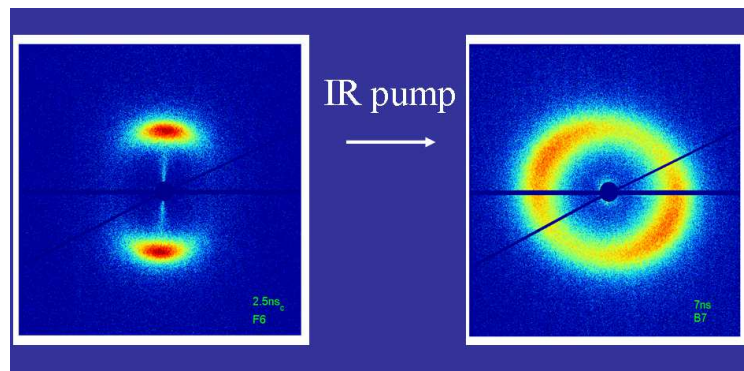


Figure 1: X-ray resonant magnetic scattering pattern obtained before and after a single IR laser excitation.

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