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# Magnetization Compensation Point and All-Optical Switching

Understanding ultrafast all-optical magnetization switching (AOS), i.e. the permanent reversal of the magnetization by the sole action of a femtosecond laser pulse in the absence of any applied magnetic field, is a challenging issue which could have tremendous impact for the magnetic recording industry. While a qualitative agreement between spin atomistic simulations and experiments exists[1], the exact role played by the magnetization compensation point TM in the ultrafast demagnetization[2] and switching[3] in ferrimagnetic rare-earth transition-metal alloys is still not completely clear. By combining femtosecond X-ray transmission measurements with picosecond time-resolved photo-emission electron microscopy (PEEM), both using X-ray magnetic circular dichroism, we report on new insights into the AOS mechanism in GdFe based ferrimagnetic alloys. In agreement with previous experiments and theoretical predictions, AOS is seen below and above TM, and in particular against a 0.18 T magnetic field. However, at temperatures far from TM, no AOS is observable. Collapse of the reversed domain could be ruled out using time-resolved XMCD PEEM imaging. Static imaging of the magnetic domain configuration after AOS reveals that no domain wall (DW) motion occurs within the 100 nm spatial resolution, ruling out a nucleation and growth switching mechanism favored by the DW velocity divergence at TM. Furthermore, investigation of the formation speed of the transient ferromagnetic-like state as a function of TM shows very pronounced variations. These results provide evidence that the TM is somehow a more important condition for the formation of the transient ferromagnetic-like state[4] and the occurrence of AOS than initially thought.

[1] T. Ostler et al., Nat. Commun. 3, 666 (2012).
[2] R. Medapalli et al., Phys. Rev. B 86, 054442 (2012).
[3] K. Vahaplar et al., Phys. Rev. Lett. 103, 117201 (2009).
[4] I. Radu et al., Nature 472, 205 (2011).

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