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Ultrafast Spin Dynamics

Ferrimagnetic Tb-Fe based heterostructures: Intriguing properties and applications

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Due to the increasing demand in high-density magnetic recording media, magnetic thin films with high magnetic anisotropy are widely studied in order to overcome the superparamagnetic effect. However, owing to the large magnetic anisotropy, the magnetic field required to reverse the magnetization of the media may become higher than the field provided by a conventional recording head. To solve this, so-called writeability issue, the concept of heat assisted magnetic recording (HAMR) was suggested, In this regard, a system based on ferrimagnetic TbFe/ferromagnetic Co/Pt/Ni heterostructures taking advantage of a so called compensation temperature of the ferrimagnetic layer, where the net magnetic moment vanishes, will be discussed.
Another intriguing property of ferrimagnetic/ferromagnetic heterostructures is the exchange bias effect. Here, the dependence of the interfacial exchange coupling on the stoichiometry of the ferrimagnetic TbFe layer was analyzed. A large exchange-bias field up to several Tesla is found to be accompanied by an interfacial domain wall as probed by element specific x-ray magnetic circular dichroism absorption measurements [1]. In addition, unexpected results on the exchange bias effect in two coupled ferrimagnetic TbFe layers will be shown [2].
Furthermore, ultrafast magnetization switching is at the heart of both modern information storage technology and fundamental science. In this regard, it was recently observed that ultra-fast magnetization reversal processes can be induced by circularly polarized laser pulses in ferrimagnetic GdFeCo alloy thin films [3]. This novel observation resulted in a broad range of exciting and challenging fundamental questions, and may enable new applications based on ultra-fast spintronics. An overview of our activities on all-optical switching in ferrimagnetic TbFe films [4-6] (see Fig. 1) will be presented.

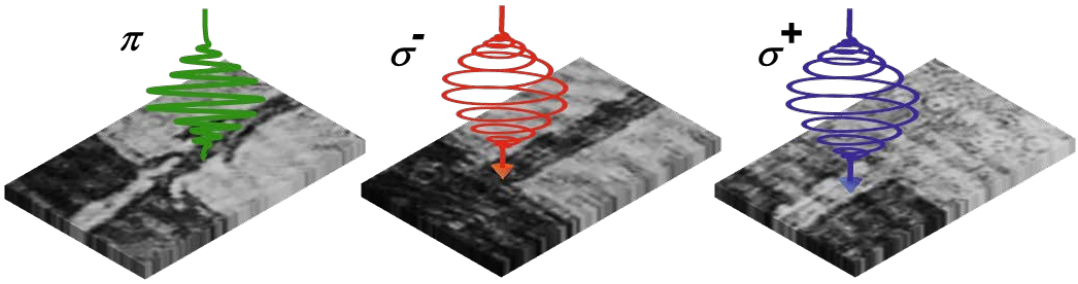

Fig. 1: *Demonstration of helicity dependent all-optical switching (AOS) in amorphous $Tb_{30}Fe_{70}$ thin films using circularly polarized (σ) laser pulses, causing magnetization reversal.*

[1] C. Schubert et al., Phys. Rev. B **87**, 054415 (2013)
[2] B. Hebler et al., Phys. Rev. B **95**, 104410 (2017)
[3] C. D. Stanciu et al., Phys. Rev. Lett. 99, 047601 (2007)
[4] A. Hassdenteufel et al., Adv. Mater. 25, 3122 (2013)
[5] A. Hassdenteufel et al., Phys. Rev. B 91, 104431 (2015)
[6] B. Hebler et al., Frontiers in Materials 3, 8 (2016)