

The multitude of mechanisms for all-optical switching of magnetization

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The incessant increase in the amount of digital data boosts the demand for faster, smaller, and energy-effective data-recording technologies. One viable possibility is the all-optical approach, which allows to control the magnetization of a medium using fs laser pulses only [1].

First of all, it has been demonstrated that the magnetization of ferrimagnetic RE-TM alloys and multilayers can be reversed by single fs laser pulses, without any applied magnetic field [2]. This switching is found to follow a very peculiar pathway, that crucially depends on the dynamic balance of net angular momentum, set by the two sublattices. The switching is of a toggle nature, where every next laser pulse switches the magnetization to the opposite direction.

Recently it has been shown, moreover, that the ferromagnetic Co/Pt and FePt layers can also be switched optically, with the unambiguous dependence on the light helicity [3]. However, the observed effect is multi-pulse in nature and proceeds via stochastic nucleation of reversed domains followed by a helicity-dependent deterministic growth [4].

Most exciting, recently an all-optical switching was demonstrated in transparent films of magnetic dielectrics [5]. A linearly polarized fs laser pulse resonantly pumps specific $d-d$ transitions, creating strong transient magneto-crystalline anisotropy. Selecting the polarization of the pulse, one could steer the net magnetization. This mechanism outperforms existing alternatives in terms of the speed (less than 20 ps) and the unprecedentedly low heat load.

Moreover, yet another mechanism of laser-induced switching was found in magnetic garnets in the presence of strong in-plane magnetic field [6]. This mechanism is based on an ultrafast heating of the lattice resulting in a rapid change of magneto-crystalline anisotropy.

In this talk various switching mechanisms will be considered and compared, with the goal to provide a clear picture of the processes accompanying the reversal at these ultrafast time scales.

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