Accumulative magnetic switching of FePt granular media by circularly polarized light

Y.K. Takahashi[1], R. Medapali[2], J. Wang[1], S. Kasai[1], K. Ishioka[1], S.W. Wee[3], O. Hellwig[3], K. Hono[1] and E.E. Fullerton[2]
(NIMS[1], UCSD[2], HGST[3])

Deterministic control of magnetization by light, often referred to as all-optical switching (AOS), is an attractive recording method because magnetization control becomes possible without the need of an external magnetic field[1-5]. The first demonstration of AOS was in ferrimangnetic GdFeCo film where the Gd and FeCo spin sub-lattices are antiferromagnetically exchange coupled. Since the mechanism determined for GdFeCo films required antiparallel exchange of two sublattice systems, it was believed that AOS occurs only in ferrimagnetic materials including synthetic structures[1-4]. However, recently Lambert *et al*. reported that the optical control of the magnetization occurs in ferromagnets including Co-based multilayer thin films and FePtAg-C granular thin film materials[5]. Therefore the potential mechanisms for AOS in ferromagnetic materials must be reexamined. Here, we report the observation of accumulative magnetic switching from multiple circularly polarized light pulses on FePt-C HAMR media.

The FePt-30vol%C (hereafter, FePt-C) granular film was deposited by co-sputtering of FePt and C targets on a MgO(001) single crystal substrate by DC magnetron sputtering at 600°C. 10-nm-thick C was deposited as a capping layer at RT. 15-μm-width Hall crosses were used for the measurement of the magnetization change by the light exposure and the applied magnetic fields.

Figure 1(a) shows the magneto-optical image of an initially demagnetized FePt-C granular film after scanning it with both right and left circularly polarized (RCP and LCP) light pulses. The optical pulses induce a net magnetization in the FePt-C and the sign of the magnetization is determined by the helicity of the light. To quantify the optically-induced magnetization changes, we exposed the laser over the Hall cross region. The initial state is remanence after applying saturating magnetic fields of -7 T (Fig. 1c)) and 7 T (Fig. 1d)). Figure 1(c) shows the normalized Hall resistance change after the exposure to RCP, linearly polarized and LCP. For RCP light, the normalized magnetization gradually decreases to zero, then reverses and saturates at about -0.5. This indicates that ~3/4 of the FePt grains switch to the opposite direction. On the other hand, the exposure to LCP light decreases the magnetization to about half of the initial value, corresponding to the switching of ~1/4 of the FePt grains. For exposure to linearly polarized light, the normalized Hall resistance gradually approaches zero. In the case of the opposite initial state (negative saturation) shown in Fig. 1d), RCP, LCP and linearly polarized light exposures result in the same final normalized magnetization of -0.5, 0.5 and zero, respectively. Thus, the magnetization state after exposure to polarized light only depends on the helicity of the light. Fitting Fig. 1(c) and (d) to a simple accumulative model, the switching probability by a single pulse is very small, less than 1%. However, accumulating the small switching probabilities results in a continuous change in the magnetization until the final equilibrium state[6].

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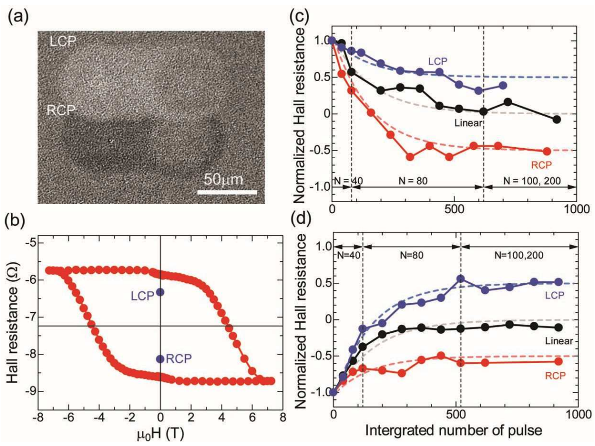

Fig. 1 Magnetization change observed from a FePt-C granular film by exposure to circular polarized light. (a) Magnetic image after exposure to RAP and LCP. (b) AHE curve for the FePt-C granular film. (c,d) Normalized Hall resistance after applying circular and linear polarized light.