Ultrafast Spin precessional Dynamics of $L1_0$-ordered FePt Alloy thin Film

J. W. Kim, K. T. Lee, H. S. Ko, H. S. Song, J. W. Jeong, J. W. Son* and S. -C. Shin
Department of Physics and Center for Nanospinics of Spintronic Materials,
Korea Advanced Institute of Science and Technology, Daejeon 305-701

Nowadays, much attention has been focused on the ultrafast manipulation of spin states in perpendicular magnetic anisotropy (PMA) materials as the demand for high-density recording has been increased intensively. It is because even nanosized bit of PMA materials has the advantage of excellent thermal stability due to the high anisotropy energy. Although the large magnetic anisotropy and the high coercivity characteristics of PMA materials make ultrafast switching difficult, their potentials for applications are considerable when combined with the optically induced ultrafast phenomena of spin demagnetization and optomagnetic spin switching. [1,2] Therefore, equiatomic FePt alloy films have been thought as one of the promising candidates, because of their large perpendicular magnetic anisotropy (K_u : 10^7 ~ 10^8 erg/cc, it corresponds to about 3-nm stable grain size) due to the presence of $L1_0$-ordered phase, high saturation magnetization (M_s : 800 ~ 1100 emu/cc), and high Kerr signal (~ 0.5 º) at 400 nm as well as 800 nm wavelength of probe beam. [3]

We first have investigated spin precessional motion of $L1_0$-ordered FePt alloy thin film with very high coercivity of 3.7 kOe by using time-resolved magneto-optical Kerr effect. As the Fig. 1 shows, since the precession is extremely small signal in this case, the polar and longitudinal signal need to be untangled. To achieve this, the external bias field H should be applied with the angle of ψ and $-\psi$ like the Fig. 2, then, the longitudinal signal is given by the difference of two signals. The Fig. 3 depicts the precessional motion only from the longitudinal component at conditions of the pump intensity of 1 mJ/cm2 and the angle of ψ = 80 º. The amplitude of the motion decays fast and the energy is almost dissipated with the time scale of ~ 200 ps. The resultant damping constant by the Landau-Lifshitz-Gilbert equation is extracted to 0.08 ~ 0.09. This value is higher than other in-plane anisotropy materials by several times. [4] This property would be very useful to enhance switching speed by suppressing the ringing.

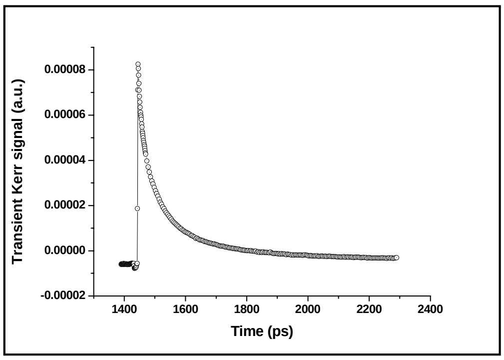

Fig. 1. Transient Kerr signal measured with the pump intensity of $1 mJ/cm^2$ and the angle of ψ = 80 º.

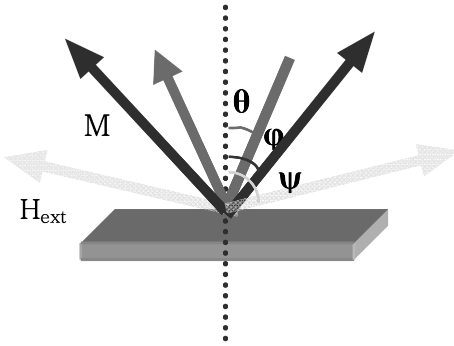

Fig. 2. Schematic geometry to untangle the polar and the longitudinal component. Θ is the incidence angle of probe beam, ϕ the equilibrium direction angle of magnetization, and ψ the direction of external bias field.

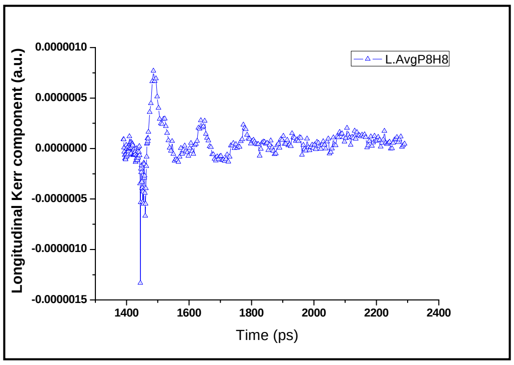

Fig. 3. Precessional motion extracted from the pure longitudinal Kerr signal.

References

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