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Magnetization Precession with Low Damping for Perpendicularly Magnetized $L1_0$-FePd Films Grown on $SrTiO_3$ Substrates

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Large perpendicular magnetic anisotropy (PMA) is necessary to achieve high memory capacity. On the other hand, critical current density of current-induced magnetization reversal is proportional to both PMA constant K_u^{eff} and Gilbert damping constant α. Thus, low α materials with keeping large PMA are important. $L1_0$ ordered alloys such as $L1_0$-FePt and $L1_0$-FePd are promising materials to achieve large PMA. However, relatively large precessional damping α of as large as 0.06 was observed in the case of $L1_0$-FePt film[1]. α of $L1_0$-FePd is thought to be small as compared with that of $L1_0$-FePt, because Pd is lighter element than Pt. In this study, we investigated magnetization dynamics and damping for $L1_0$-FePd films, which is expected to have both a large K_u and low α.

Samples were prepared by using ultrahigh vacuum magnetron sputtering method. The $SrTiO_3$ (001) single crystal substrates were used to improve the lattice mismatch. Stacking structures are substrate /FePd (20 nm)/Ta. Films were deposited with different substrate temperature T_s, and then annealed with different annealing temperature T_a. Magnetizations were measured using vibrating sample magnetometer (VSM), and structural characterizations were carried out with x-ray diffraction and atomic force microscopy. Fast magnetization dynamics was measured using time-resolved magneto-optical Kerr effect (TRMOKE).

Films deposited at T_s more than 300°C showed PMA. Additionally, the annealing at T_a more than 500°C improved PMA with keeping smooth surface roughness. Figure 1 shows magnetization dynamics for the $L1_0$-FePd films fabricated at T_s = 300°C and T_a = 500°C. Long life-time of magnetization precession was observed. Precession frequency f and life-time τ were obtained from the fittings, as shown in the dashed curves. The effective PMA fields were evaluated from θ_H dependence of f. Estimated K_u (K_u^{eff}) was about ~15 (7) Merg/cm^3. Effective damping constant α_{eff} was evaluated by the relation: $\alpha_{eff} = 1/2\pi f\tau$. Minimum value of α_{eff} was about 0.006, which is small compared with those for other PMA materials.

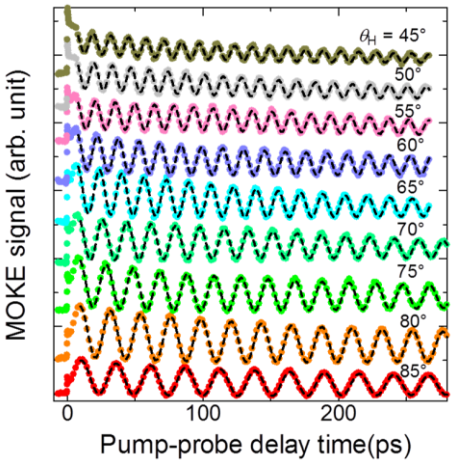

Fig. 1 Typical TRMOKE signals with different field angle θ_H which is angle between film normal and external field at fixed external field of 20 kOe for the films with T_s = 300°C, and T_a = 500°C.

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