The Spin dynamic properties on the Pt/CoFeB/Ta structure

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I. Introduction

The CoFeB is possible candidate materials for the spin-transfer torque magnetic random access memory application due to the large tunneling magneto-resistance (TMR) and perpendicular magnetic anisotropy (PMA). Moreover, the heavy metal(HM)/ferromagnet layer structure is actively studied because they are key structure of the spin-orbit torque phenomena.[1),2)] Especially, the magnetic properties of HM/CoFeB are interesting due to interaction at the interface. In this study, we investigated the magnetic properties of Pt/CoFeB/Ta structure using Brillouin light scattering (BLS).

II. Experiment

We prepared CoFeB thin film sandwiched by 4-nm Pt and Ta, with various CoFeB thickness (1.0 ~ 2.4 nm) by DC magnetron sputtering system. The magnetic properties of the samples were studied by Brillouin light scattering with a Sandercock (3+3) type Fabry-Perot interferometer.[3),4),5)] The light source is a single frequency 532 nm a DPSS laser with output power of about 300 mW. Back scattering geometry used to observe the light scattered by thermal excitations with an in-plane wavenumber $q_{\parallel}=1.67\times10^{5}$ cm^{-1} with the angle of incident as 45^{o}. Magnetic field of up to 0.98 T were applied parallel to the film plane and perpendicular to the scattering plane.

III. Results and Discussion

The dependence of spin waves on the applied field has been used to obtained the surface anisotropy and saturation magnetization with the spin wave frequencies as follow[6)] :

$$f_0=\frac{\gamma}{2\pi}\sqrt{[Hcos\theta-(4\pi M_s-\frac{4k_s}{M_s})\sin^2\theta][Hcos\theta-(4\pi M_s-\frac{4k_s}{M_s})(\cos^2\theta-\sin^2\theta)]}$$

where, γ is the gyromagnetic ratio ($=2.37\times10^{11}$ T^{-1}s^{-1}), θ is the angle between the magnetization and the sample plane, k_s is the perpendicular uniaxial anisotropy constant, H is the applied magnetic filed, M_s is the saturation magnetization, respectively. In this equations, the contributions of dipolar field and exchange energy have been neglected for the ultrathin limit.

To determine the magnetic constant, we plot the anisotropy energy density ($K\times t_{CoFeB}$,) as a function of t_{CoFeB} in Figure 1. In this plot, we obtain slope and y-cross section, which corresponds to the volume anisotropy and the surface anisotropy, respectively. The obtain k_s value is 0.37 ± 0.04 mJ/m^2 and M_s is 15.48 ± 0.83 *k*Oe.

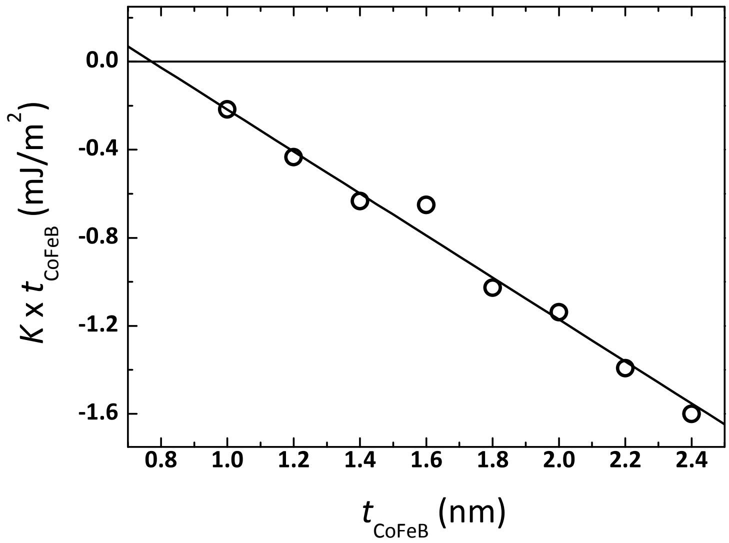

Fig. 1. $K \times t_{CoFeB}$ vs t_{CoFeB} as a function of CoFeB thickness.

IV. References

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