Gilbert damping in Pt/Co films with different capping layers

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Co/Pt multilayers with perpendicular magnetic anisotropy (PMA) are popularly used for practical applications such as magnetoresistive random access memory (MRAM) [1]. For MRAM applications, Gilbert damping constant plays in various way; thus understanding of the physics behind is crucial. Early reports of Gilbert damping in Co/Pt films showed huge damping, about 0.1 [2], and those were discussed in terms of large spin-orbit interactions of Pt. However, a recent report indicated the moderate damping, about 0.02, even for the films with high PMA of about 10^6 J/m^3 and suggested that the damping could be further reduced [3]. To gain insight into the mechanism of Gilbert damping in Pt/Co, we revisit and investigate magnetization dynamics in Pt/Co with different capping layers.

The films were fabricated by a magnetron sputtering and their stacking structure was thermally-oxidized Si substrates/ Pt/Co(t_{Co})/X (X=Pt, Au, Ag). We prepared the films with various thickness t_{Co}. Magnetic properties were investigated by a polar magneto-optical Kerr effect (p-MOKE) as well as vibrating sample magnetometer (VSM). Magnetization dynamics were investigated using a time-resolved magneto-optical Kerr effect (TRMOKE). Figure 1(a) shows typical p-MOKE loops for Pt(15 nm)/Co(0.6 nm)/X (X=Pt, Au, Ag) films. Three films show well-squared hysteresis loops, indicating strong PMA. Figure 1(b) shows the effective damping constant evaluated from TRMOKE for the films as a function of the inverse of film thickness. Pt/Co/Au films possess the largest damping constant, while the damping constants of Pt/Co/Pt films and Pt/Co/Ag films were not significantly different. In addition, the effective damping constant for the films showed non-linear behavior against the inverse of t_{Co}. These dependences on thickness and materials cannot be simply explained as spin pumping [4]. Details will be discussed in the presentation. This work was partially supported by KAKNEHI (No. 21H05000). S. I. thanks to the Asahi Glass Foundation, the Murata Science Foundation and JST PRESTO (No. JPMJPR22B2). S.M. thanks to CSRN.

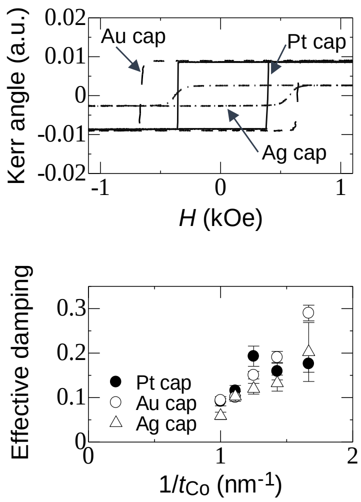

Fig. 1 (a) p-MOKE loops and (b) the effective damping constants as a function of the inverse of film thickness.

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