Magnetic damping in $Pt/Co/Cr_2O_3/Pt$ stack films with perpendicular magnetic anisotropy

◦ T. V. A. Nguyen,[1, 2,3,4] Y. Shiratsuchi,[5] H. Sato,[1,2,3] S. Ikeda,[1,2,3] T. Endoh,[1,2,3,4] and Y. Endo,[1,2,4]

[1]CSRN, Tohoku Univ., [2]CSIS, Tohoku Univ., [3]CIES, Tohoku Univ.,

[4]Grad. School of Eng., Tohoku Univ., [5]Grad. School of Eng., Osaka Univ.,

E-mail: anh@ecei.tohoku.ac.jp

Magnetization dynamics in ferromagnetic (FM)/non-magnetic (NM) stack films with perpendicular magnetic anisotropy (PMA) is of increasing interest in a realization of spintronics devices with various enriched functionalities. One of the most dominant parameters for understanding the dynamics is the Gilbert damping constant (α), which determines the strength of damping torque in the system. Many reports focused on the investigation of the correlation between α and PMA [1]. However, the relationship is still controversial and the results are dispersed among the variation of the film stack. Thus, a systematic investigation is required. Herein, we choose perpendicularly magnetized Pt/Co stack films as a typical FM/NM system showing PMA, and we investigate the change in α and PMA with the thickness of Co (t_{Co}) and Pt (t_{Pt}) layers, and then discuss their correlation in these stack films.

$Pt(t_{Pt})/Co(t_{Co})/Cr_2O_3(200\ nm)/Pt$ stack films were deposited by DC magnetron sputtering onto α-$Al_2O_3(0001)$ substrates (Ar and O_2 gases were used for Cr_2O_3 sputtering). Cr_2O_3 is a typical insulator, which enabled us to focus on the magnetization dynamics at the interface between $Co(t_{Co})$ and capped $Pt(t_{Pt})$ layers. α and uniaxial magnetic anisotropy energy (K_U) were then investigated by a broadband ferromagnetic resonance and a vibrating sample magnetometer at room temperature, respectively.

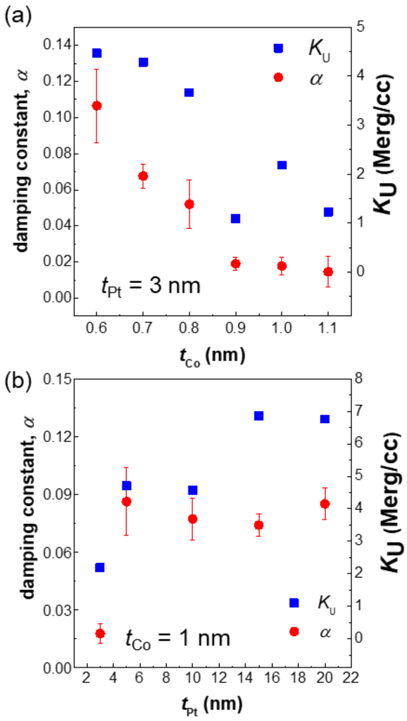

Fig. 1: The dependence of damping constant α and magnetic anisotropy energy K_U on (a) t_{Co}, and (b) t_{Pt}.

In Fig. 1(a), K_U decreases as t_{Co} increases because of the interfacial nature of PMA. α also decreases with t_{Co} accompanied with K_U. These results demonstrate that α is correlated with K_U in these stack films through the strong spin-orbit interaction. On the other hand, as shown in Fig. 1(b), α increases with the increase of t_{Pt} for $t_{Pt} < 5$ nm, and almost keeps constant for $t_{Pt} > 5$ nm, while K_U increases with the increase of t_{Pt}. The behavior of α can be explained by the spin pumping at the interface of the capped Pt and Co layers [2,3]. Details will be discussed in the presentation.

References: [1] S. Mizukami *et al.*, Appl. Phys. Lett. **96**, 152502 (2010). [2] Y. Tserkovnyak *et al.*, Phys. Rev. Lett. **88**, 117601 (2002). [3] E. Barati *et al.*, Phys. Rev. B **95**, 134440 (2017).

Acknowledgment: The authors acknowledge the Core Research Cluster program of Tohoku Univ. This work was also supported by JSPS KAKENHI Grant Nos. 17K18991, 16H03832, 16H02389.