Study on Magnetization Dynamics of Polycrystalline YIG Films by Broadband-FMR Measurement: Effect of Seed and Capping-layer

Tohoku Univ. ECEI[1], Tohoku Univ. CSRN[2], ○Satya Prakash Pati[1], and Yasushi Endo[1,2]
Email: sppati@ecei.tohoku.ac.jp

Recently, the influence of different seed and capping layer on the damping parameter of adjacent ferromagnetic (FM) layer has been attracted numerous research interest. In such systems, several mechanisms that may lead to the enhancement of damping e.g. spin-orbit coupling, interfacial d-d hybridization, spin-pumping, two magnon scattering etc. Moreover, for device application, it is also required to fabricate FM thin films over a metallic electrode without affecting its damping parameter. Yttrium iron garnet (YIG, $Y_3Fe_5O_{12}$) is one of the well-known FM for magnonics and spintronics applications [1] because of its very small intrinsic damping parameter (~3×10^{-5}) and electrically insulator. Herein, we study the effect of seed and capping-layers on Gilbert damping parameter of various thick polycrystalline YIG films.

Fig. 1(a) shows thickness dependence of Gilbert damping parameter (α) in YIG films without and with the Pt seed layer. In every case, α increases as the film thickness decreases. Pt-seed films have both larger grain size and lower roughness, thus lower α, while due to a high structural inhomogeneity in the films without seed layer have higher α [2]. Fig.1(b) shows frequency dependent linewidth of FMR spectra of 400-nm thick YIG film with different capping layer of thickness 5 nm such as SiO_x, Al and Pt. The slope for a Pt capped film is steepest in all films, indicating α becomes large as compared with other capped films. This huge change in α is mainly originating from the spin pumping effect [3], which arises at the interface of a rare earth heavy metal such as Pt. Fig.1(c) represents YIG inverse thickness dependent enhanced Gilbert damping in Pt-capped YIG films in comparison with the non-capped YIG films. A large spin mixing conductance was observed in case of films with the Pt capping layer. These results demonstrate the spin-pumping effect at the YIG/Pt interface play an important role for the enhancement of Gilbert damping.

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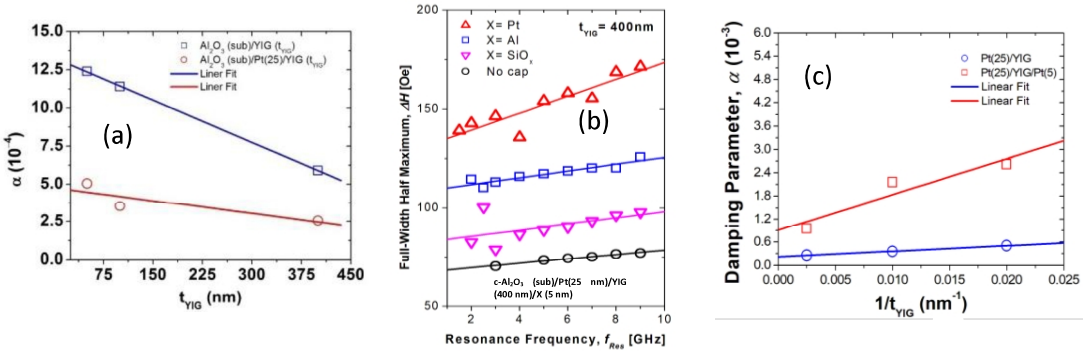

Fig. 1. (a) Effect of Pt seed layer on damping parameter of YIG, (b) Effect of different capping layer on FMR linewidth of YIG, (c) Inverse YIG thickness dependent damping parameter with and without Pt capping layer.