Evolution of Damping and Resonance Field-Shift in Finemet/Pt Thin Film Bilayers

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KEY WORDS: ferromagnetic resonance, spin pumping, damping magnetic proximity effect.

Evolution of FMR spectra in Al doped (7 at. %) Finemet thin films with the mean thickness $<d_F>$ = 9, 15, 20, 30, and 40 nm, respectively, covered by Pt wedge layers (0 to 7 nm) is studied. Vector network analyzer ferromagnetic resonance (VNA-FMR) is applied for measurements of FMR absorption spectra for various positions along wedge-shaped bilayers. The Finemet films with the effective magnetization M_{eff} of 770 − 800 G, and the Gilbert damping of 4 - 5 $\times 10^{-3}$, comparable to that of CoFeB, reveal a low inhomogeneous broadening ΔH_0 of only 2 - 4 Oe. This makes Finemet/Pt bilayers suitable to search for subtle effects accompanied by spin pumping. The dependencies of damping on d_{Pt} are carefully analyzed by taking into account thickness profiles of Finemet films and discontinuous microstructure of Pt for d_{Pt} < 1.5 nm. The inhomogeneous broadening ΔH_0 scales roughly with discontinuous Pt topography. The experimental data yield the values of $g^{\uparrow\downarrow}_{eff}$ = 30 nm^{-2}, the spin-diffusion length λ = 1.5 nm, comparable to those obtained for Permalloy/Pt or CoFeB/Pt bilayers.

The most characteristic new feature seen in the Finemet/Pt structures is that the changes in the Gilbert damping α vs. d_{Pt} due to spin pumping are accompanied by a clear negative resonance field shift δH_r which tends to saturation for d_{Pt} >2-3 nm. We find that both changes in $\delta\alpha$ and δH_r have a linear dependence on $1/d_F$. Therefore, δH_r has interface origin like an increase in damping $\delta\alpha$ due to spin pumping. Moreover, we provide experimental evidences that the negative resonance field shift δH_r mainly results from an increase in M_{eff} and, in scant account, on variations in g-factor. We attribute this effect to the presence of induced moments in Pt via the magnetic proximity effect. The experimental data are discussed in the framework of recent theories on spin pumping.

We acknowledge support from Project NANOSPIN PSPB-045/2010 under a grant from Switzerland through the Swiss Contribution to the enlarged European Union and from the project "Marie Skłodowska-Curie Research and Innovation Staff Exchange (RISE)" Contract No. 644348 with the European Commission, as part of the Horizon2020 Programme.