

Influence of magnetic anisotropy and antiferromagnetic interlayer exchange coupling on magnetization dynamics in Co/Re/Co structures

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Synthetic antiferromagnetic (SAF) structures have recently attracted increasing interest due to their applications in high-frequency spintronic and magnonic devices, as well as the fundamental insights they provide into magnetic interactions at the nanoscale. Magnetization precession damping is strongly influenced by a number of factors, such as interfacial spin-mixing conductance ($\Delta g_{\text{eff}}^{\uparrow\downarrow}$), magnetic anisotropy and interlayer exchange coupling (IEC) in ferromagnetic (FM)/nonmagnetic (NM) trilayers FM/NM/FM [1,2]. However, layered systems in which the simultaneous influence of both magnetic anisotropy and IEC is systematically studied have rarely been investigated. In this work, we investigate the magnetization dynamics in symmetric antiferromagnetic Co/Re/Co trilayers as a function of Co and Re layer thickness d_{Co} and d_{Re} . Significant impact of NM heavy-metals on perpendicular anisotropy and damping has been previously reported in layered structures [3,4]. Magnetization precession was measured with the use of time-resolved TRMOKE method as a function of external magnetic field magnitude. The results revealed pronounced modifications of strongly hybridized magnetization precession modes for d_{Re} in the 0.4–0.6 nm range. The precession frequency and damping of the modes exhibit strong dependence on magnetic anisotropy, when it changes from perpendicular through mixed anisotropy, up to easy-plane anisotropy in both Co sublayers. The results were well explained by a macrospin precession model that includes different effective anisotropy fields for the Co-sublayers, as well as both antiferromagnetic bilinear J_1 and biquadratic J_2 IEC parameters. From the field dependencies of the effective damping parameters, intrinsic Gilbert damping parameter α_0 was determined as a function of d_{Re} . A giant increase in α_0 at the maximum antiferromagnetic coupling for the structure with mixed anisotropy, compared to the easy-plane one and uncoupled Co layers, was found. A well-defined correlation between the α_0 enhancement and IEC strength was found and discussed. We showed that the observed strong damping enhancement leads to a large increase in the effective spin mixing conductance $\Delta g_{\text{eff}}^{\uparrow\downarrow}$ within spin pumping model used, with $\Delta g_{\text{eff}}^{\uparrow\downarrow}$ values exceeding the ones for the uncoupled structures and typical values for Co-based layered systems by an order of magnitude.

References:

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