Control of magnetic damping by introducing ultrathin nonmagnetic layer with varying spin-orbit coupling strength at CoFeB/MgO interface

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The performance of many spintronics devices are controlled by magnetic damping, one of the key parameters of magnetic materials. Hence, it is quite important to understand the origin of damping and to control the damping parameter in magnetic materials, especially in magnetic thin film heterostructures. The intrinsic component of damping can be optimized by engineering electronic band structure at the Fermi level [1]. Interestingly, the interfaces in magnetic heterostructures also has a significant contribution in magnetic damping [2]. Previously it was reported that the perpendicular magnetic anisotropy in CoFeB/MgO heterostructures can be enhanced by introducing an ultrathin nonmagnetic (NM) layer at CoFeB/MgO interface [3]. Therefore, it is quite possible that the damping constant can also be tuned by adopting the same strategy. However, no study have been reported to address this issue so far.

In the current study, we adopt Ta(10)/CoFeB(2)/MgO(10)/Al_2O_3(10) heterostructures deposited on Si/SiO_2 substrates as our model system. Five set of samples were prepared by introducing an ultrathin NM layer at CoFeB/MgO interface with varying spin-orbit coupling (SOC) strength: Ta(10)/CoFeB(2)/NM(0.12)/MgO(10), where NM = no layer, Ru, Ta, Pt and W. According to the literatures, the SOC strength varies as Ru<Ta<Pt<W. The damping parameters are characterized by measuring frequency dependent ferromagnetic resonance linewidth by a set up based on vector network analyser. In absence of ultrathin NM layer, the damping parameter comes out to be 0.0128. Surprisingly, the damping parameter significantly reduces to 0.0103 when Ru or Ta are introduced. In contrast, the damping parameter remains almost unchanged for Pt layer, and significantly increased to 0.0142 for W layer. We infer that the SOC strength of NM layer significantly influences the spin relaxation at CoFeB/MgO interface resulting in the reduction or enhancement of intrinsic damping parameter. Our results pave the way to tune the damping parameter in ultrathin ferromagnetic films by interfacial engineering, which will be very demanding from application point of view.

References:

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