Competing IMA-PMA of ultra-thin Pd/Co magnetic biltilayers: Spin-orbit torque method

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The recently discovered perpendicular magnetic anisotropy (PMA) at the ferromagnetic meta (FM)l/oxide and FM/heavy metal interfaces plays a crucial role in magnetoresistive random-access memories (MRAMs). As long as the thickness of FM layers is down to few atomic layers, the interfacial/surface anisotropy energy domnates the magnetic anisotropy and is no longer to be a constant. Although first-principles calculated total energy and fitted experimental data have been widely used to estimate the surface magnetic anisotropy energy (K_{eff}), however, it still remains difficult but important to precisely distinguish its contributions either from surface layers or interior atomic layers.

In this study, the newly-developed DFT-based spin-orbit torque (SOT) method [1] has succeed in building up a picture to enrich the fundamental knowledge about the posibility of IMA-PMA competition in ultra-thin Pd/Co magnetic bilayers. The calculated layer-resolved SOT's highlight the competing features between PMA region (Co thinfilm, and Pd/Co interface) and IMA region (interior part of Pd layers). This allows us, for the first time, not only to precisely distinguish K_{eff} but also to efficiently differentiate the roles of PMA layer and IMA layers. Finally, the macrospin dynamics simulation of IMA/PMA monodomains, i.e., mumax3 software [2], is employed to well know the crucial role of IMA in competing IMA-PMA scenario by tuning interlayer exchange coupling. The IMA region in the magnetic bilayers can significantly reduce the coercivity field of magnetic bilayers, and also can let the critical point of hysteresis loop become more smooth. These features will give a bunch of benefit of MRAMs. This work is supported by the National Science and Technology Council (NSTC 113-2112-M-008-007).

References

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