Broken inversion symmetry-induced enhancement of perpendicular magnetic anisotropy in Co/Pd/Pt-based multilayer

Mie Univ.[1], AIST[2], Kyoto Univ.[3], Uni Mainz[4], POSTECH[5], Korea Univ.[6]

○Abdul-Muizz Pradipto[1], Kay Yakushiji[2], Woo Seung Ham[3], Sanghoon Kim[3], Yoichi Shiota[3], Takahiro Moriyama[3], Kyoung-Whan Kim[4], Hyun-Woo Lee[5], Kohji Nakamura[1], Kyung-Jin Lee[6], and Teruo Ono[3]

E-mail: a.m.t.pradipto@gmail.com

Understanding the origin of magnetocrystalline anisotropy (MCA), i.e. the preferred magnetization direction along certain crystallographic axis, in magnetic materials has long become an outstanding scientific issue. A recent theoretical analysis of MCA within a Rashba model of spin-orbit coupling has shown that the MCA is strongly affected by the Rashba parameter [1]. Since the Rashba interaction only develops in systems with broken inversion symmetry, this observation indicates that the MCA can change or even be enhanced by the inversion symmetry breaking. In the present work, we investigate the effects of structural asymmetry to the MCA of Co-Pt/Pd-based multilayer systems by combining experimental magnetic measurements and first principles calculations. In our experiments, to study the effect of the symmetry of the stacking structure on the magnetic behavior, three variations of the multilayer structures were fabricated as follows: $[Co(0.2\ nm)/Pt\ (0.2\ nm)]_{10}$, $[Co\ (0.2\ nm)/Pd(0.2\ nm)]_{10}$ and $[Co(0.2\ nm)/Pd(0.2\ nm)/Pt(0.2\ nm)]_{10}$. Our magnetic measurement data shows that the asymmetric stacking, i.e. the Co/Pd/Pt-multilayer, has a significantly larger effective perpendicular magnetic anisotropy (PMA) compared to that of the symmetric Co/Pt and Co/Pd samples. We further support this experiment by first principles Density Functional Theory (DFT) calculations, and we confirm that the PMA in the Co/Pd/Pt system is stronger than the Co/Pt and Co/Pd counterparts. We analyze the electronic structure and the *k*-dependent MCA of both the symmetric and asymmetric systems, and we find that indeed the stronger MCA energy in Co/Pd/Pt asymmetric multilayer is likely related to the absence of inversion symmetry in this system. Details of the experimental and theoretical results will be further discussed in the presentation.

[1] K.-W. Kim *et al.*, Phys. Rev. B **94**, 184402 (2016)