Amplifying Dzyaloshinskii-Moriya Interaction in Pt/Co/Pt with Dy Dusting

Caner Değer[1] and Mustafa Erkovan[2,3]

[1]*Marmara University, Physics Dept. 34722, Ziverbey, Istanbul, Turkey*
[2]*Instituto de Engenharia de Sistemas E Computadores—Microsistemas e Nanotecnologias (INESC MN), 1000-029 Lisbon, Portugal*
[3]*Instituto Superior Tecnico (IST), Universidade de Lisboa, 1040-001 Lisbon, Portugal*

Spintronic technology exploits both the spin and charge characteristics of electrons to design electronic devices that are characterized by rapid response times and low energy consumption. By analyzing magnetic materials and manipulating micromagnetic parameters, such as anisotropy and exchange stiffness, scientists have succeeded in creating small, energy-efficient spintronic devices that exhibit high magnetic stability. One area of interest in research has been the use of perpendicular magnetic anisotropy (PMA) in ultra-thin layers of ferromagnetic and heavy metals. The Pt/Co/Pt sandwich structure is a well-studied HM/FM structure that exhibits strong PMA at room temperature. Despite this, spintronics is a constantly evolving field of research that requires different phenomena besides PMA to operate effectively. To investigate the physical mechanism governing the interfacial Dzyaloshinskii-Moriya Interaction (iDMI), which stabilizes noncollinear chiral magnetic structures such as domain walls and skyrmions, a comprehensive understanding is needed in order to be able to control it precisely. Pt/Co/Pt trilayers would be ideal for iDMI research. However, the lack of inversion symmetry breaking prevents iDMI even if they have a high spin-orbit coupling (SOC).

In this present research, we explored the impact of Dy layer dusting on PMA, iDMI, and exchange energy in Pt/Co/Pt structure, utilizing experiments and first-principles calculations. By depositing 0.25 monolayer of Dy on the top Co/Pt interface, we were able to substantially enhance DMI while maintaining PMA. Additionally, we could adjust the exchange energy of the system. Our study is anticipated to provide a logical framework for controlling the strength of iDMI, PMA, and exchange energy, as well as inspiring future research on the effects of rare-earth element dusting on magnetic properties.