Empirical correlation between Dzyaloshinskii-Moriya interaction and Work function in Pt/Co/X trilayers

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Dzyaloshinskii-Moriya interaction (DMI) has been extensively studied nowadays due to academic curiosity as well as technological opportunity toward spin-based nanodevices. It is now well known that the DMI appears at interfaces with inversion symmetry broken structure [1,2]. However, detailed relation between the DMI strength and the nature of the interface remains elusive. Here, we examine an empirical relation between the DMI strength and the work function W of the materials at interfaces, since a large difference of the work function between the interfacial materials may generate a large DMI due to a large electric field at the interface. For this examination, we fabricate a series Pt/Co/X (X=Pt, Pd, Au, Ru, Al, Ta, W, Ti, and Cu) films. The films basically have the same structure except the upper layer material X and thus, one can compare the contribution from the upper Co/X interfaces among the films. Figure 1 plots measured H_{DMI}, DMI-induced effective magnetic field, with respect to W, where W is from the material table in Ref. [3]. The figure shows a clear correlation between H_{DMI} and W. Though the exact value of H_{DMI} in real films largely depends on the crystalline structures and orbital mixing, the present observation provides a good guideline to design the film structure for optimal H_{DMI}.

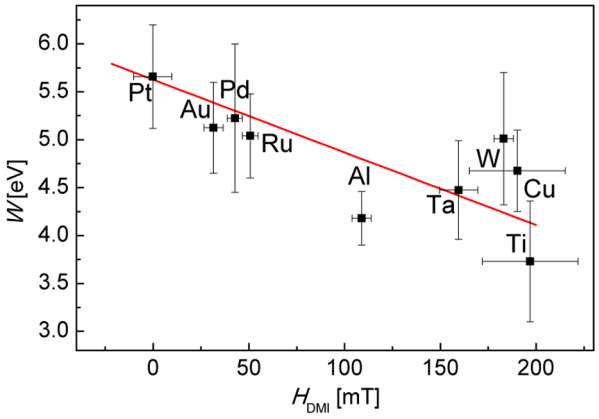

Fig. 1. Plot of the work function with respect to measured H_{DMI}, for Pt/Co/X films with various materials X as denoted in the figure.

References

[1] I.Dzyaloshinsky, J.Phys.Chem.Solids 4,241(1958).

[2] T.Moriya, Phys.Rev. 120, 91(1960).

[3] David R. Lide, Handbook of Chemistry and Physics, 75th ed., CRC Press, Boca Raton, Florida, 1994.