Teaching An Old Dog New Tricks: Modulation Of Dzyaloshinskii-Moriya Interaction And Perpendicular Magnetic Anisotropy In Pt|Co|Al

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Perpendicular magnetic anisotropy (PMA) and Dzyaloshinskii-Moriya interactions (DMI) are key interactions in modern spintronics. These interactions are thought to be dominated by the oxidation of the Co|Al interface in the archetypal Platinum-Cobalt-Aluminium oxide system. However, in this talk I will describe a double sign change in the anisotropy and about threefold variation in interfacial DMI, influenced not only by the oxidation, but also by the metallic Al thickness (see Fig. 1 and Ref. 1). Contrary to previous assumptions about negligible spin-orbit effects at light metal interfaces, we not only observe strong PMA with fully oxidised Al, decreasing and turning negative (in-plane) with less oxygen at the Co|Al interface, we also observe that the magnetic anisotropy reverts to positive (out-of-plane) values at fully metallic Co|Al interface. These findings suggest modification in Co *d*-band via Co|Al orbital hybridisation, an effect supported by X-ray absorption spectroscopy and *ab initio* theory calculations, highlighting the key impact of strain on interfacial mechanisms at fully metallic Co|Al interface. The structural aspects studied by X-ray diffraction, electron microscopy, and spectroscopy will also be discussed.

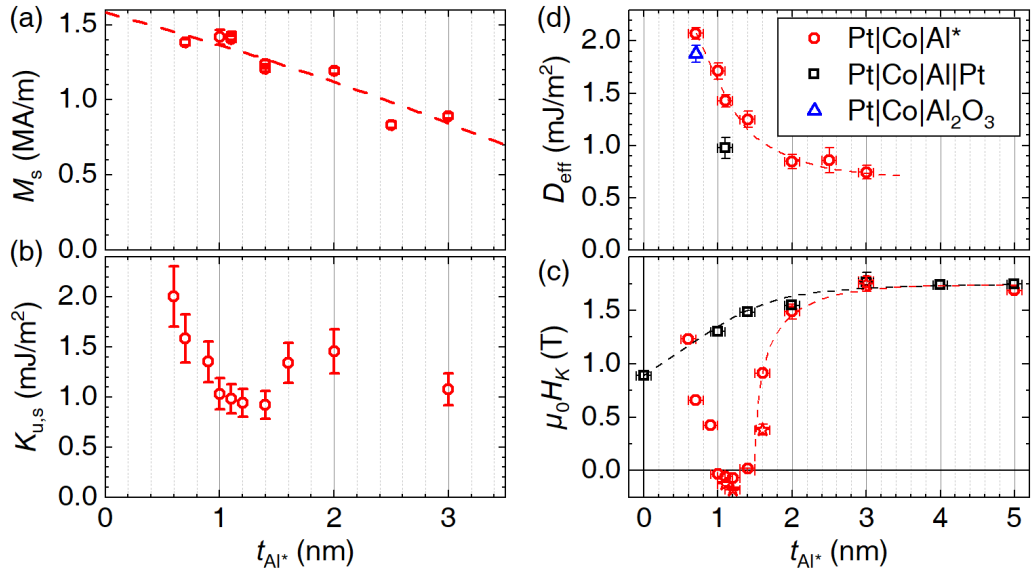

Figure 1. Magnetic properties of samples based on Ta(5)|Pt(8)|Co(0.9) (thickness in nm), capped by Al oxidised in air (Al*, red circles), Al|Pt(3) (black squares) and Al_2O_3 (blue triangle). (a) SQUID spontaneous magnetization; (b) Estimated interfacial anisotropy, assuming a purely interfacial effect (i.e. no bulk magnetocrystalline effect) measured by magnetotransport; (c) corresponding effective anisotropy field (positive means out-of-plane magnetization); (d) Effective Dzyaloshinskii-Moriya interaction measured by Brillouin light scattering.

References

[1] S. Krishnia *et al. arXiv*, **2024**, *2409*.10685v1.