Interactions across ferromagnetic/heavy metal thin-film interfaces: Proximity-induced magnetisation, spin transport and the Dzyaloshinskii-Moriya interaction

D. Atkinson[1]

[1] *Department of Physics, Durham University, UK*

Several physical mechanisms in magnetism are linked to electronic interactions that take place across the interface between magnetic (FM) and non-magnetic (NM) thin-film layers. These interfacial interactions mediate phenomena that are significant for spintronics applications, such as interfacial anisotropy, and are the subject of on-going research including interfacial Dzyaloshinskii-Moriya interactions (iDMI) and the proximity-induced-magnetization (PIM) of heavy metals in contact with a FM layer. The materials and physical structure at the interface are critical to these effects and also to spin transport through the interfaces. This is key in FM/NM systems for magnetic damping, via the pumping of spin current into NM layers, and spin-orbit torque (SOT) switching, resulting from the propagation of spin-current into a FM layer. The linkage between these interfacial phenomena has been the subject of debate, such as the relationship between DMI and proximity induced magnetisation and the role of PIM in spin transport across FM/NM interfaces. Further debate has surrounded the determination of the spin-diffusion length from spin-pumping analysis and spin-pumping through insulating layers. The focus here is on the relationships between these interfacial phenomena and spin-transport across the interface.

The relationship between interfacial proximity-induce magnetisation and iDMI is presented for the Co/Pt system [1], as a function of Au and Ir spacer layers. The nature of PIM in heavy metals layered with ferrimagnetic systems is then discussed for Pt in contact with rare earth:transition metal alloy films to understand the relationship between the Pt moment and the two ferrimagnetic sublattices [2].

Spin transport across FM/NM interfaces is introduced [3] and the effects of interface structure, NM thickness [4] and tunnelling through an insulating oxide layer [5] are discussed and descibed with an updated physical description for the analysis of spin-transport from spin-pumping in FM/NM systems [6] that shows a consistent understanding is obtained when a thickness dependent spin-diffusion length in the NM layer is used. Finally new results and analysis demonstrate a clear relationship between interfacial PIM, damping and the ease of spin current propagation across the interface.

References:

[1] Rowan-Robinson R. et al. Scientific Reports 7, 16835 (2017)
[2] Swindells C. et al. Phys Rev, Research 2, 033280 (2020)
[3] Azzawi, S. Hindmarch A.T. and Atkinson D. J Phys D Appl. Phys. 50, 473001 (2017)
[4] Azzawi M. et al. Phys Rev B 93, 054402 (2016)
[5] Swindells C., Appl Phys Letts 116, 042403 (2020)
[6] Swindells C. et al. Phys Rev B 99, 064406 (2019)