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Probing surface magnetism with a spin-polarized metastable helium beam

An understanding of the surface magnetic properties of nanoparticles and thin films is becoming increasingly important as the demonstration of devices based on these materials continues apace. Of the techniques available to investigate these properties, spin-polarized metastable de-excitation spectroscopy (SPMDS) is one of the most surface sensitive allowing a probe of the spin-split local density of states distributed on the vacuum side of the outermost layers. As such, SPMDS is ideal for studying many of the technological and fundamental issues currently associated with the field of surface magnetism [1].

As a first example of this, I will present results from a study of the surface spin-polarization of organic/ferromagnetic (FM) interfaces. Spin-injection across such an interface is one of the key mechanisms that requires a deeper understanding for organic spintronic devices to compete with their more established, inorganic counterparts. Engineering this interface to optimise spin injection is also attracting a great deal of attention and with regard to this, we have measured a significant enhancement in the spin-polarization of Fe3O4(001) thin films terminated with hydrogen [2].

As a second demonstration of the applicability of SPMDS I will focus on the surface magnetic order of rare-earth metal films. Magnetism in these structures displays a variety of complex phases including helical antiferromagnetism (AFM) below a critical magnetic ordering temperature, TN. In the bulk of this phase, moments in consecutive neighbouring basal planes rotate yielding long-period AFM order. However at the surface, the influence of neighbouring planes is reduced leading to FM alignment, an effect that is enhanced for decreasing film thickness [3]. Using a spin-polarized He* beam, we have investigated these structures and identified several temperature-dependent critical phase changes in the surface magnetic order.

[1] M. Kurahashi, X. Sun, S. Entani, and Y. Yamauchi, Appl. Phys. Lett. 93, 132505 (2008).
[2] M. Kurahashi, X. Sun, and Y. Yamauchi, Phys. Rev. B 81, 193402 (2010).
[3] E. Weschke *et al*., Phys. Rev. Lett. 93, 157204 (2004).

Host:
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