Journal & Proceedings of the Royal Society of New South Wales, vol. 152, part 1, 2019, pp. 143–144. ISSN 0035-9173/19/010143-02

Thesis abstract

Functional magnetic interface phenomena in nano-architectures

Grace L. Causer

Abstract of a thesis for a Doctorate of Philosophy submitted to University of Wollongong

The work embodied in this thesis aims to investigate the occurrence of magnetic interface phenomena in low-dimensional thin-film systems which have conceivable utility in future condensed-matter technologies. Namely, the magnetic interface quality of an $FePt_3$ nano-magnet formed via ion-induced chemical disorder will be critically analysed, in addition to a Co/Pd bilayer which features modifiable magnetic surface anisotropy upon exposure to hydrogen gas. The studies are enabled chiefly through advanced X-ray and neutron scattering techniques specifically chosen to probe interface structure as well as chemical and magnetic orders, and supplemented by traditional lab-based characterisation tools.

To begin, a much-anticipated experimental confirmation of the intrinsic sharpness of magnetic interfaces formed by locally driving magnetic phase transitions in materials using ion beams is presented. This is achieved through a unique experimental design whereby a room-temperature ferromagnetic nano-layer is encoded with depth-control onto a paramagnetic $FePt_3$ film by inducing chemical disorder using energy-specific He^+ ions. The magnetic transition is investigated through theoretical modelling, whereby the first density functional theory results for the entire suite of potential long-range magnetically ordered states of $FePt_3$ are presented. In doing so, the energetically favourable ground-state spin structure is identified. By analysing several localised defect structures which may form in $FePt_3$ under ion irradiation, the fundamental mechanism of the disorder-driven magnetic transition is revealed and shown to be caused by an intermixing of Fe and Pt atoms in anti-site defects above a threshold density.

In a second study, hydrogen-induced modifications to the layer-averaged static magnetisation and macroscopic magneto-dynamic behaviours of a Co/Pd heterostructure are investigated. The modifications are observed and examined in detail through simultaneously probing the magnetic anisotropy energy and studying the changing chemical and magnetic depth-profiles across the entire bilayer during primary hydrogen gas absorption. It is revealed that the in-plane interfacial magnetisation of the Co/Pd bilayer irreversibly increases after primary hydrogen-gas absorption, indicating a weakening of the perpendicular magnetic anisotropy energy. To aid in conducting this analysis, an original experimental method is first developed which innovatively combines neutron scattering and microwave spectroscopy; equipment is then commissioned, and feasibility studies are performed.

Dr Grace L. Causer,
Institute for Superconducting and Electronic Materials and School of Physics,
University of Wollongong,
Wollongong NSW 2018

E-mail: grace.causer@tum.de
URL: https://ro.uow.edu.au/theses1/411