Growth and characterisation of antiferromagnetic/ ferromagnetic heusler alloy films

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Further improvement of spintronic devices depend on the development of a new half-metallic ferromagnetic film. Heusler alloys are one of the most promising candidates to exhibit the half-metallicity (100% spin polarization) at room temperature with a large bandgap at the Fermi level. Even though such properties have been demonstrated in the bulk Heusler alloys, they are yet to be demonstrated in a film form unambiguously. According to the IEEE Magnetics Society Roadmap on Spintronic Materials , over 100% giant magnetoresistance (GMR) should be demonstrated based on the half-metallicity of the Heusler alloy films. Especially, those with perpendicular magnetic anisotropy is very important to be achieved. We have recently reported the perpendicular anisotropy using a body-centred cubic seed layer, such as vanadium and tungsten. For the Si//W/Co_2FeSi structures, significant reduction in crystallisation energy is also achieved down to the annealing at 200°C for 2 min. Such low temperature annealing with perpendicular magnetisation should be very useful for future device implementation. To characterise their interfacial properties of such devices, we have developed a new method using scanning electron microscopy. The beam is then decelerated using a negative bias on sample stage so that the beam penetrates only to the depth of an embedded junction (see Fig. 1). The generated backscattered electrons are selected by an energy filter attached near the detector to map conductance information from the junction. An energy dispersive X-ray spectroscopy is also used to identify the chemical compositions of the defects. Using this method, we have imaged Heusler alloy junctions to correlate their defects with their transport properties. This technique can be used for design and process optimisation of these junctions and can sustain an improvement in the density and functionality. This work was partially supported by the EPSRC (EP/M02458X/1), Royal Society Industry Fellowship, EC (NMP3-SL-2013-604398) and JST-PRESTO.

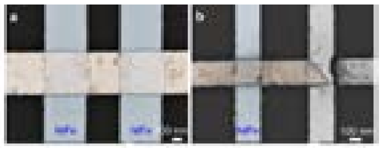

Figure 1: (a) SEM image of a lateral spin-valve (b) SEM image of a damaged junction [4].

Biography

Atsufumi Hirohata is a professor at the Department of Electronic Engineering in the University of York and has over fifteen-year experience. He has published 119 refereed works, 2 works in press with over 1,300 citations (H index=21 by Thomson Reuters), 20 patents granted (7 pending) and 5 book chapters (2 edited books). He was originally graduated from Keio University for his BSc and MSc studies in Physics. He received his PhD in Physics at the University of Cambridge in 2001 and then served as a research associate at the Cavendish Laboratory, MIT, Tohoku University and RIKEN. He is an editor of the Journal of Magnetism and Magnetic Materials (Elsevier) and on the editorial board members of Journal of Physics D: Applied Physics (IoP), Spin (World Scientific) and Frontiers in Condensed Matter Physics (Nature Publishing Group). Researcher ID: B-4595-2009 / ORCID: 0000-0001-9107-2330.

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