

Exchange bias of a ferromagnetic semiconductor by a ferromagnetic metal

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(III,Mn)As ferromagnetic semiconductors offer the attractive possibility of combining storage and logic operations in a single device. The large scale applicability of semiconductor spintronics is however, limited by the Curie temperature, which for GaMnAs stands at a maximum 186K. A recent x-ray magnetic circular dichroism (XMCD) study showed that an Fe overlayer may produce an above-room-temperature proximity polarization in an interface layer of GaMnAs, with antiparallel alignment to the Fe [1]. Such a material may have the potential to offer non-volatile spin polarization in a semi-conductor at room temperature. However until now no information was known about the coupling below the interface layer.

Here we investigate the magnetic coupling of Fe and GaMnAs layers grown in the same molecular-beam epitaxy chamber to ensure a clean interface [2]. Using XMCD and bulk magnetometry, we find that, below an exchange bias field of up to 240Oe, the GaMnAs layer is homogeneously magnetized antiparallel to the Fe layer. Furthermore, by comparing XMCD spectra measured in fluorescence and electron yield modes, we identify an interface Mn layer which is strongly exchange coupled to the Fe film. The interface polarization is shown to persist above room temperature.

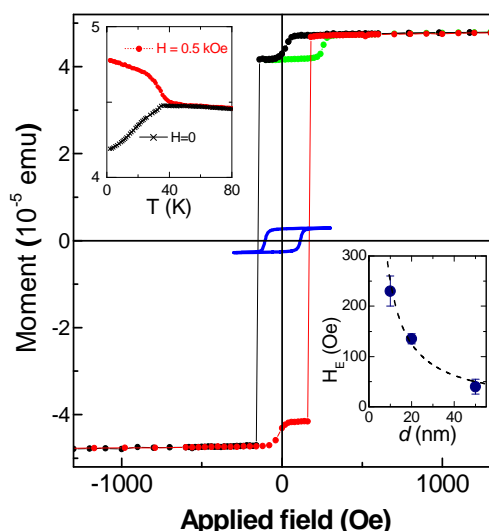


Figure 1. Magnetometry measurements of an Fe/GaMnAs bilayer (thin line + circles) and an uncapped GaMnAs film (thick line).

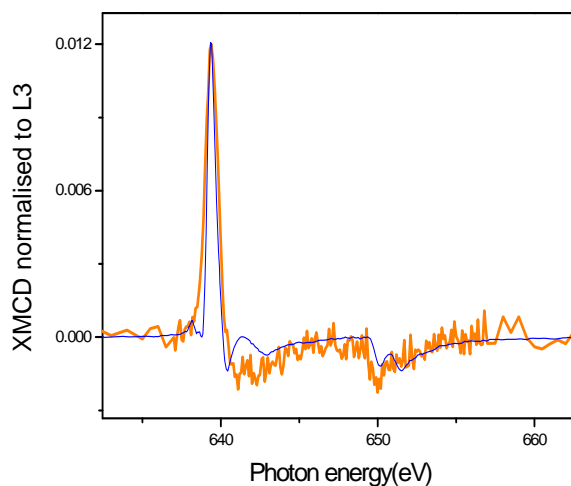


Figure 2. Fe/GaMnAs(20nm) room temperature XMCD (thick) plus GaMnAs low temperature XMCD scaled to the size of the Fe/GaMnAs XMCD for comparison (thin)

[1] F. Maccherozzi *et al.*, Phys. Rev. Lett. **101**, 267201 (2008).

[2] K. Olejnik, P. Wadley, J.A. Haigh, K.W. Edmonds, R.P. Campion, A.W. Rushforth, B.L. Gallagher, C.T. Foxon, T. Jungwirth, J. Wunderlich, S.S. Dhesi, S.A. Cavill, G. van der Laan, E. Arenholz, Phys. Rev. B **81**, 104402 (2010).

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