

# Proximity effects across Fe/(Ga,Mn)As interfaces revealed by site selective X-ray Magnetic Circular Dichroism

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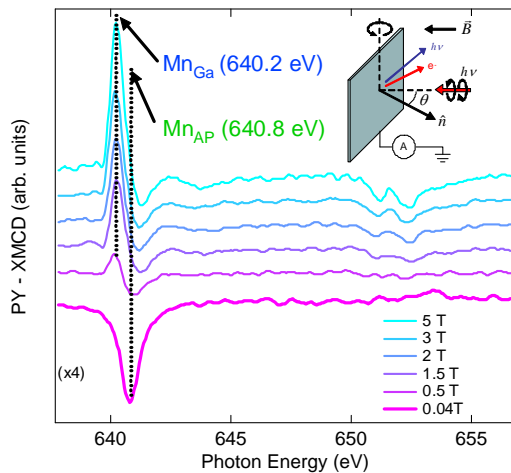
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The presence of thin films of ferromagnetic metal at semiconductor (SC) interfaces, such as Fe/GaAs and MnAs/GaAs, can induce an effective magnetic field inside the SC through proximity effects. The understanding of the magnetic coupling at these interfaces should lead to a deeper insight in the physics of magnetic semiconductors and new approaches in the design of spintronic devices working at room temperature. We have recently found a similar effect across the Fe/(Ga,Mn)As interface<sup>1</sup>, in which the Fe induces magnetic order in part of the diluted Mn in the GaAs which persists above room temperature. The Curie temperature of the (Ga,Mn)As film, measured with SQUID, increases linearly with the Fe overlayer thickness, thus proving the macroscopic nature of an interaction between the Fe layer and the (Ga,Mn)As film. By means of X-ray Absorption Spectroscopy (XAS) and X-ray Magnetic Circular Dichroism (XMCD) we have been able to selectively probe the magnetic behaviour and the electronic configuration of the substitutional ferromagnetic Mn sites and the Mn sites that are magnetically coupled to the Fe layer<sup>2</sup>. X-ray Resonant Magnetic Scattering results will also be presented which show the depth resolved magnetization profile of the Mn coupled with the Fe.



**Figure 1** Evolution of the XMCD line shape of a Fe/(Ga,Mn)As sample at increasing magnetic fields, above the  $T_c$  of the (Ga,Mn)As film. The low field spectrum with negative sign of the  $L_3$  edge is due to the Mn coupled with the Fe by proximity effect. At higher magnetic field it appears the shifted component of the bulk  $Mn_{Ga}$  that is responsible for the ferromagnetism of the (Ga,Mn)As.

## References

<sup>1</sup>M. Sperl, et al. **Identifying the character of ferromagnetic Mn in epitaxial Fe/(Ga,Mn)As heterostructures.** Phys. Rev. B **81**, 035211 (2010).

<sup>2</sup>F. Maccherozzi et al. **Evidence for a Magnetic Proximity Effect up to Room Temperature at Fe(Ga,Mn)/As Interfaces.** Phys Rev Lett. **101**, 267201 (2008)

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