ESRF	**Experiment title:** Interfacial properties of buried Fe/MgO/GaMnAs heterostructures studied by Hard X-ray PES.	**Experiment number**: He-3461
Beamline: ID16	**Date of experiment**: from: 20/10/2010 to: 26/10/2010	**Date of report**: 20-02-2011
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Report:

Main objectives of the proposal were:

a) to measure the electronic and magnetic properties at the interface between Fe/MgO/Fe thin film structures and (GaMn)As
b) to explore the magnetic coupling at the interface with GaMnAs by tuning MgO thickness
c) to disentangle the bulk and interface electronic properties of Mn.

Although XAS and XPS measurements have been carried prior the experiment at beamline APE (Elettra), all the Fe/MgO/Fe/GaMnAs and Fe/MgO/GaMnAs samples testes at ID16 with HAXPES revealed important contamination, corresponding to the absence of the typical bulk.-representative feature in the Mn 2p core level (extra-satellites). For this reason, the focus of the experiment has been changed to the properties of the pure GaMnAs system and its comparison with MnAs.

Selected results are outlined in Fig.1 and Fig.2 , where the extended valence band HAXPES spectra for GaAs, GaMnAs and MnAs are shown. For GaAs and GaMnAs, a chemical etching procedure (HCl) has been carried out; with this procedure, one removes contaminants of Mn but leaves a rough surface with residual Ga and As oxides. Though, being the contribution of the surface limited to 2-5% at maximum in HAXPES spectra, the emasured features are safely representative of the bulk electronic structure. In the case of MnAs, films of various thickness (20 to 100 nm) have been measured: in this case a GaAs capping layer preserved the samples from contamination.

The extended valence band show a redistribution of the spectral weight between pure GaAs and GaMnAs (fig.1). In particular, a small shift towards higher kinetic energy in the vicinity of the Fermi level is observed in GaMnAs (Mn 11%), indicative of the evolution from a semiconducting to a metallic character.

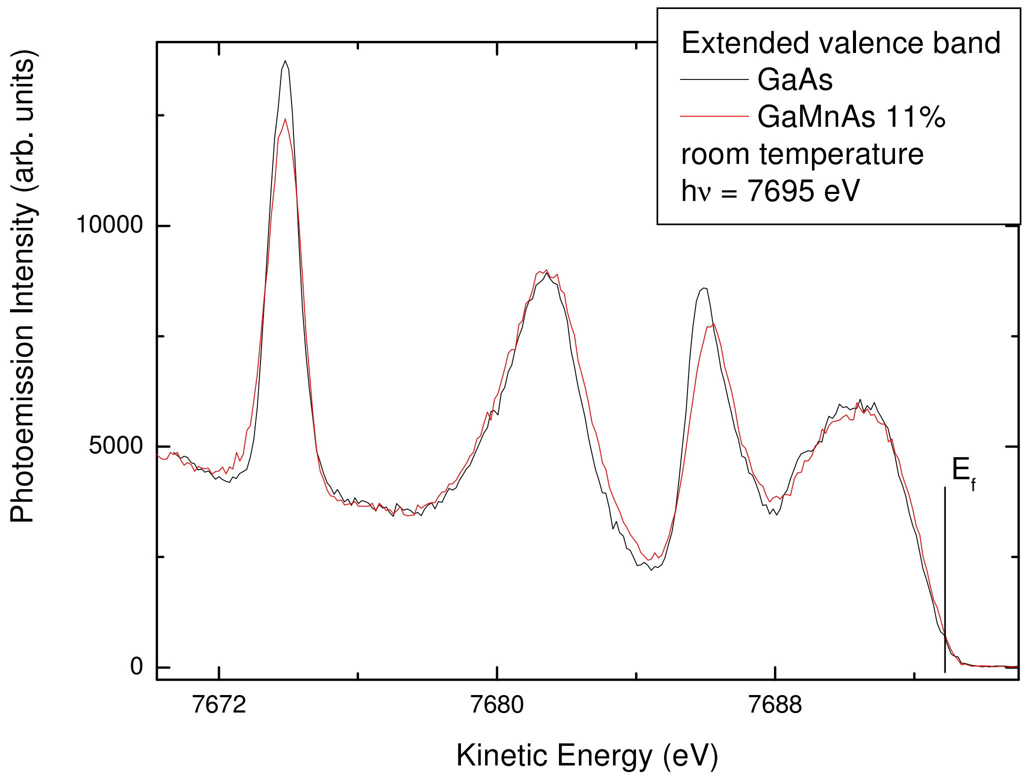

Fig.1: HAXPES sepctra of the extended valence band (Fermy energy region and GaAs shallow core level) from a pure GaAs sample and a GaMnAs film (30 nm) grown onto GaAs, with Mn 11%.

The issue of Mn-derived valence band states in GaMnAs is of particular importance in the field of diluted magnetic semiconductors: two models , both supported by experimental and theoretical results, have been apllied, without conclusive results, namely: a) the impurity band model, where the Mn states are expected to be completely detached from the GaAs substrate band, forming an impurity band and b) the conduction band model, where the Mn derived band is fully resident in the vicinity of the Fermi level and strongly modify, by a complete merging, the shape of the GaAs valence band. A detailed localization of the energy position and shape of the Mn derived states is then of utmost interest. An indirect way to locate the Mn-states is to measure a fully metallic system with similar environment, and in our case we have measured MnAs. Fig.2 shows the different valence band obtained from MnAs and GaMnAs, where one notices the increase of the photoemission intensity near the fermi level in the case of MnAs.

Comparison with calculation (J. Minar, H. Ebert, LMU, Munich) are currently under way, together with data analysis and we expect to prepare a paper to be submitted to PRL.

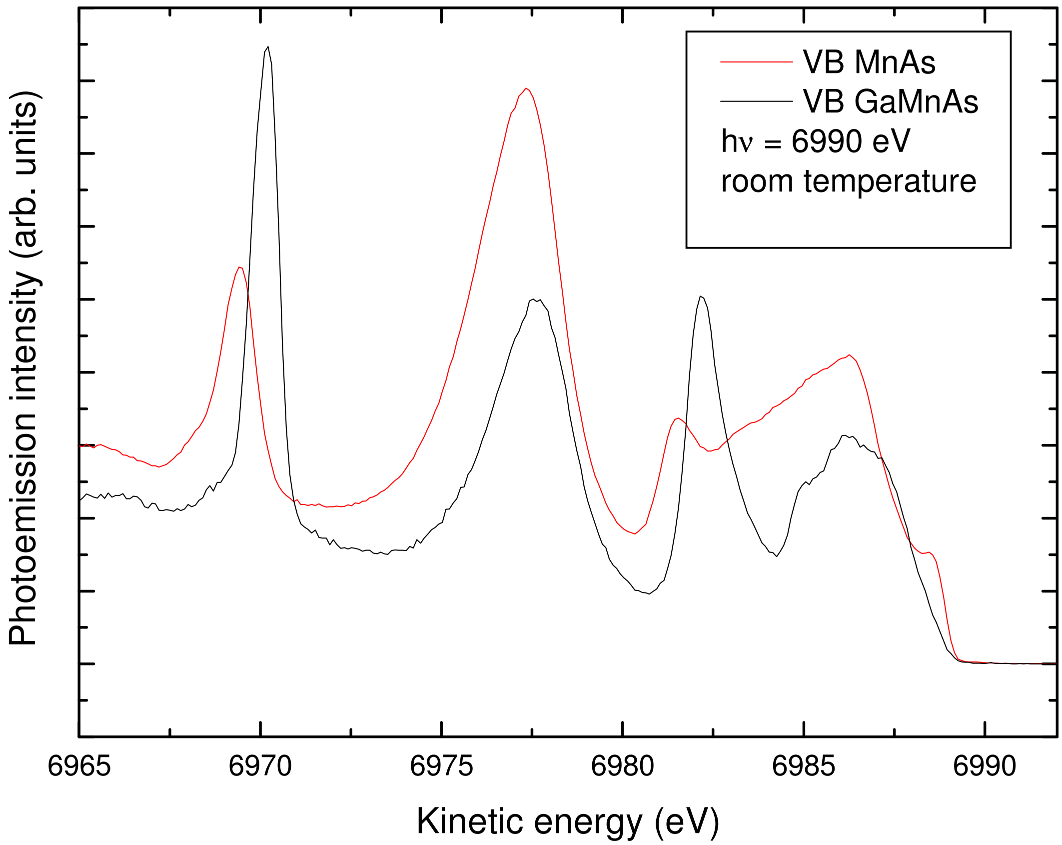

Fig.2: HAXPES sepctra of the extended valence band (Fermy energy region and GaAs shallow core level) from a metallic MnAs sample and a GaMnAs film grown onto GaAs, with Mn 5%. GaAs peaks are visible also in the MnAs-related spectrum, because the MnAs film is capped with GaAs.