ESRF	**Experiment title:** Electronic properties of diluted Mn in Fe/GaMnAs interfaces studied by Hard x-ray PES	**Experiment number**: HE-3316
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Names and affiliations of applicants (* indicates experimentalists):

*G. Panaccione[a], *P. Torelli[a], *F. Offi[b], *F. Borgatti[c], M. Marangolo[d], *B. Salles[d]

a Laboratorio TASC, IOM-CNR, Area Science Park, S.S. 14, Km 163.5, 34012 Trieste, Italy
b Dip. di Fisica, Universita Roma Tre,Via della Vasca Navale 84, I-00146 Roma, Italy
c CNR-ISMN, via gobetti 101, I-40129, Bologna, Italy
d INSP, UPMC-Paris 6, CNRS UMR 7588, 140 rue de Lournel, 75015 Paris, France

Report:

We have measured HAXPES Mn 2p and 3s core level vs temperature, revealing the presence of a sharp well screened feature (d6 electronic ocnfiguration) in the low binding energy region of the Mn 2p main peaks. The intensity of the satellite peak increases below the Tc (60 K) of the (GaMn)As, in a reversible way, suggesting an important role played by electronic localization-hybridization in the ferromagnetic behavior of the system.

Main objectives of the experiment were:
i) a thorough description of the band structure resulting from the Mn doping,
ii) a reliable control of surface and interface effects (clustering, diffusion of Mn)
iii) a precise evaluation of electronic properties, and their possible link with the magnetic ones, as a function of Fe layer thickness.

Due to the reduced amount of beamtime allocated with respect to the requested one, we have addressed points ii) during the beamtime, as the measurement of valence band (point i) in HAXPES imply a very long acquisition time (12-14 hours per spectrum in average). Among the interesting outcomes of the beamtime, we have measured an intense extra peak (well-screened satellite) at the low binding energy side of the Mn 2p core level. Such peak, often measured with HAXPES in 3d-based transition metal oxides, is found for the first time for a metallic element in a semiconducting environment; the intensity of such peak is severely suppressed (if not absent) in soft X-ray PES, indicating that the bulk of the system holds different screening properties with respect to the surface. Model calculations, with the aim of a precise determination of the electronic configuration, are in progress (in collaboration with G. van der Laan (STFC, UK)). Preliminary results indicate a d6 electronic configuration for the well screened intensity.

We also observe a temperature dependence, fully reversible, in the extra-peak of Mn 2p ,suggesting the important role of electronic localization/hybridization in the ferromagnetic behavior. Fig.1 shows the Mn 2p core level as a function of temperature. The statistics (obtained in a few bunch mode) is not enough to reveal the details, and further measurement (new proposal) are needed to clarify this point, and in particular to follow, if any, a doping dependence of the extra peak.

Results of the present experiment, possibly supported by theoretical calculation will help in understanding the role of hole-electron screening and localization in diluted magnetic semiconductors. We plan to submit a continuation of the present proposal to complete the magnetic analysis in Fe/GaMnAs and Fe/MgO/GaMnAs interfaces

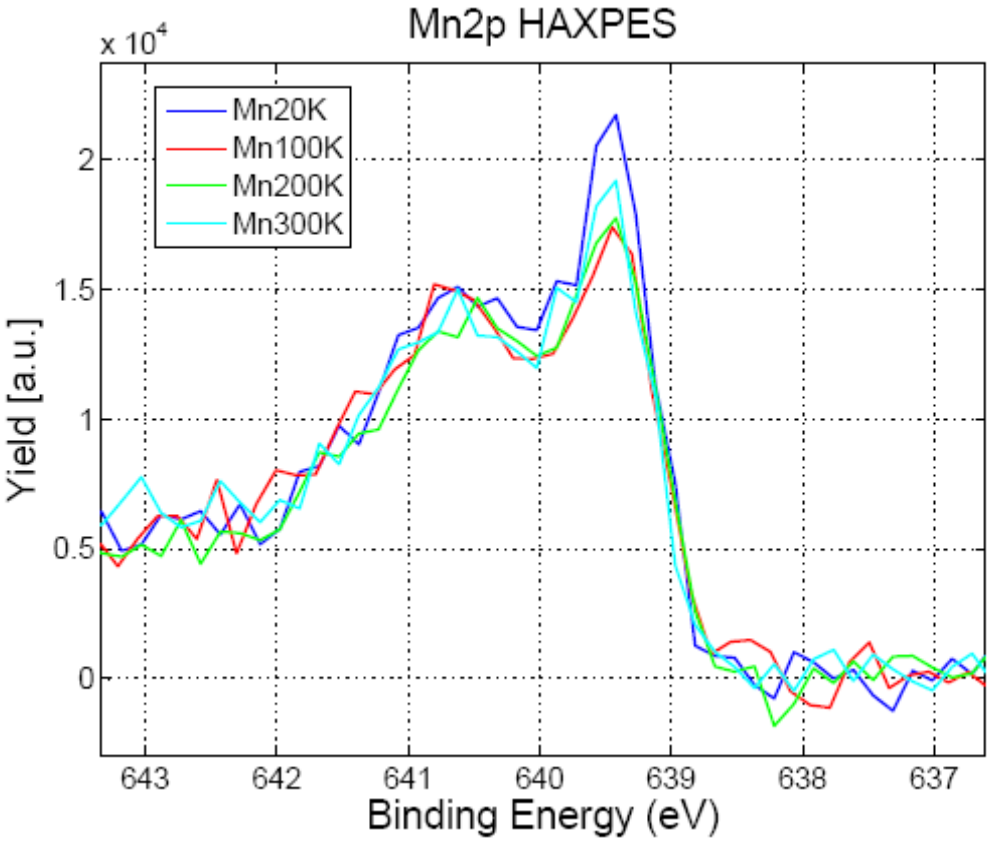

Fig.1: Evolution of the intensity of the well screened satellite vs. temperature in Mn 2p core level of GaMnAs (Mn = 5%). Tc of the present sample was 70 K.

A further set of HAXPES data has been obtained (in collaboration with UPMC-Paris6) on well characterizad samples with different content of Mn, namely GaMnAs, MnAs and Mn clusters inside the GaAs matrix. Fig.2 presents the HAXPES Mn 3s core level of the three Mn-based systems , where the exchange splitting of the satellite results to be different. Analysis of Mn 2p, als in this case, reveal differences in the lineshape and relative intensities of main and extra peaks.

We plan to submit two papers from the present set of data (one APL and one PRB).
Part of the present results have been already presented at international conference (VUVX-Vancouver, Magnet 2010 (Rome) and Magnet 2011 (Turin).

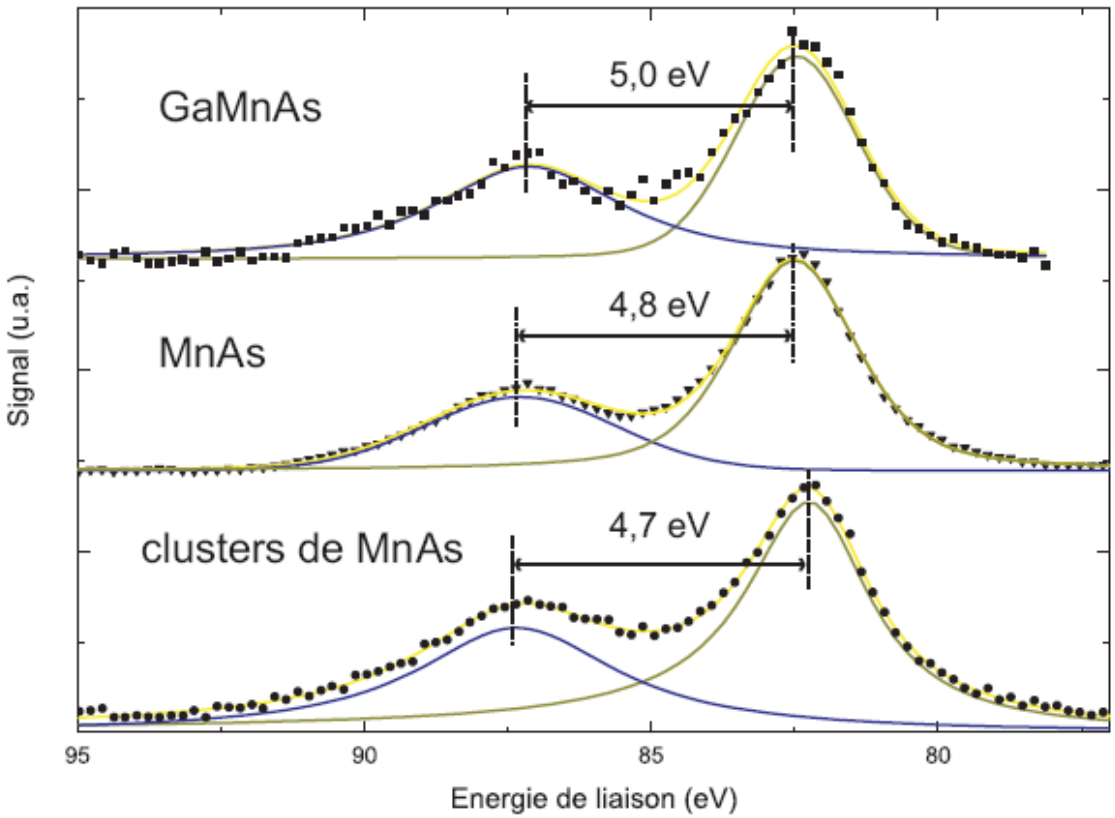

Fig.2: Evolution of the energy position of the exchange split satellites in Mn 3 s core level for the three Mn-related environment.