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Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** XAS study of Mn environment in ferromagnetic multilayers based on tin oxide	**Experiment number**: 25-01-655
Beamline: BM25A	**Date of experiment**: from: 12 February 2008 to: 18 February 2008	**Date of report**:
Shifts: 18	**Local contact(s)**: Dr. Felix JIMENEZ-VILLACORTA	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Dr. Alicia DE ANDRES

Ana ESPINOSA

Eva CESPEDES

Report:

According to the project proposal, this study is included within the framework of magnetic semiconductors that exhibit room temperature ferromagnetism (RTFM). So far, an intensive research have been focused on diluted systems where a transition metal atoms (as Mn, Co, Cr, V, etc) are introduced in a wide gap oxide matrix as ZnO and SnO_2. Since its FM is still under debate, a serie multilayers based on SnO_2 and Mn were grown in order to study the role of interface effect in its magnetic properties. This effect, together with the existence of defects (oxygen vacancies), seem to be relevant in the origin of FM.

The samples under study were Mn/SnO_2 multilayers (2 nm SnO_2/ x nm $Mn)_N$ deposited on Si(100) and R-cut sapphire by magnetron sputtering. Some of them were annealed in air. As-grown films presented a FM phase with Tc>300K detected using SQUID measurements while annealed samples presented no significant FM at T>50 K. We also faricated several series of Mn based multilayers (Mn/Al, Mn/Si and $Mn/SiO_2)_N$ which presented a paramagnetic behaviour, in order to compare with the the above samples. [1-2]

The experiment consisted of a X-ray absorption spectrometry study at the Mn K-edge (6539 eV) in fluorescence mode. The samples were placed at 45º with the incident beam and the detector. Firstly, we performed an accurate characterization in the XANES regime in order to obtain all the possible valence states of Mn as a function of the number of bilayers, the growth conditions and the thermal treatment. The energy range was selected in order to have a good resolution in the pre-edge, edge and 50 eV after the energy threshold. Considering some Mn oxides as references, the results revealed that Mn has an oxidized state (between +2 and +3) in the as-grown samples, the same for both substrates.On the other hand, for the annealed samples, we deduced that Mn has an combined valence state of +3 and +4 (Fig.1). Mn/Al, Mn/Si and Mn/SiO_2 multilayers presented a percent of Mn metallic with an +2 valence in the case of SiO_2 based film (Fig.2).

Measurements in the EXAFS regime were also performed in order to determine the local structure information of Mn and the possible fraction Mn substitucional that can be introduced in the tin oxide matrix. This part of the experiemnt were limited to a reduced number of samples, since the multilayers are relatively thin and the diffraction peaks from the substrate are difficult to eliminate. The scans were collected till 7200 eV in the energy range. Due to the lack of a multidetector, these measurements were not very conclusive since the ration between background and signal was not for a reliable analysis of the EXAFS signal.

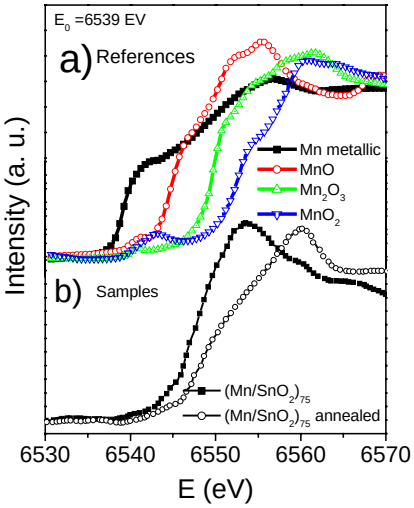

Fig.1

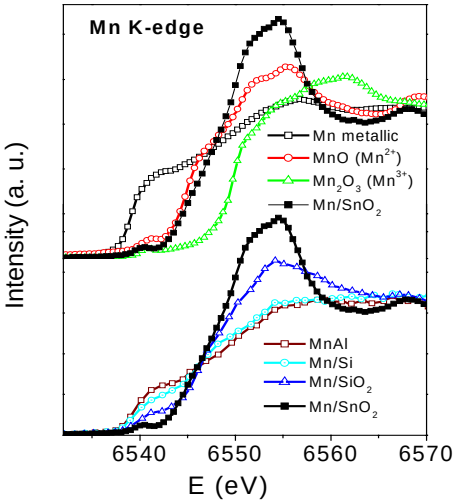

Fig.2

[1] A. Espinosa, E. Céspedes, C. Prieto, M. García-Hernández, J. Rubio-Zuazo, and A. de Andrés. J. Appl. Phys. 103, 07D129 (2008).
[2] A. Espinosa, E. Céspedes, C. Prieto, M. García-Hernández and A. de Andrés. J. Korean Phys. Soc. 52 1394 (2008)