EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

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.

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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.

87User 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.

	Experiment title:	**Experiment number:**
ESRF	**Correlation between magnetic properties and atomic structure at the interface in $LaMnO_3$ based heterostructures**	**HE 2443**
Beamline: BM25B	**Date of experiment:** from: 18-04-2007 to: 26-04-2007	**Date of report:** 4-3-2008
Shifts: 21	**Local contact(s):** Juan Rubio Zuazo	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

In recent years heterostructures combining complex transition metal oxides are focusing increasing research effort. Interface effects such as charge transfer (1), electronic reconstruction (2) and epitaxial strain (3), have been proposed to be the driving force for the nucleation of new phases with different behaviours not found by either of the individual compounds in their bulk form. In experiment H-2443, using synchrotron radiation diffraction experiments with a wavelength of 0.855 Å, we have chacterized the crystalographic structure of $YBa_2Cu_3O_7$ (YBCO) and $LaMnO_3$ (LMO) thin layers of $(YBCO_{X\ nm}/LMO_{3.2\ nm})_9$ superlattices epitaxially grown on SrTiO3 (STO) (100) substrates. We have evaluated in- and out of plane lattice parameters of the different layers to elucidate the effects of epitaxial strain in the growth modes. In plane lattice parameters of LMO and YBCO layers have been obtained from layer characteristic hkl reflections (i.e., forbidden for the other layer and for the STO substrate). The out of plane parameters have been obtained from conventional θ-2θ (Bragg configuration) experiments.

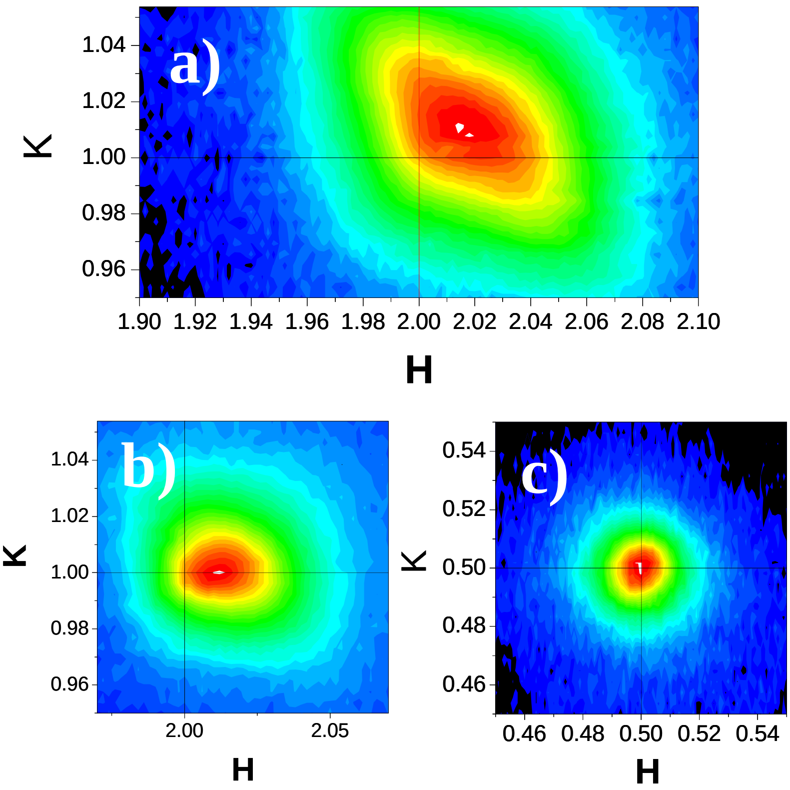

Figure 1. Out of plane X ray diffraction of the YBCO layers of $(YBCO_{16nm}/LMO_{3.2nm})_9$ (a) and $(YBCO_{4.8nm}/LMO_{3.2nm})_9$ (b) superlattices. The reciprocal space maps (RSM) of the LMO layers of $(YBCO_{4.8nm}/LMO_{3.2nm})_9$ superlattice are displayed in (c). The RSM have been obtained around the (2, 1, 2.67) (a), (2 1 0.67) (b) and (0.5 0.5 1.5) (c) Bragg reflections. Note that the notation is referred to the reciprocal space units of the STO substrate.

A set of samples has been investigated with constant LMO thickness (3.2 nm). We have found that the nucleation of the LMO phase strongly depends on the structural distorsions of the YBCO layers. Superlattices with the thickest YBCO layers (16 nm) show an almost relaxed YBCO structure with lattice parameters close to the bulk values (a=3.87 A, b=3.84 A and c=11.678 A) (see figure 1 (a)). Meanwhile a significant orthorhombic distortion is found in the LMO layer (a=3.887 A, b= 3.873 A and c=3.839 A). When the YBCO thickness is reduced (4.8 nm YBCO layer thickness superlattices) the LMO layers present a fully cubic structure (a=b=c=3.905 A) (see figure 1 (c)) and a highly strained YBCO layer (a=3.884 A, b=3.905 A and c=11.587 A) (see figure 1 (b)). Our results evidence that the YBCO unit cell volume is preserved for the different layer thickness and, accordingly, the epitaxial (tensile) strain causes elastic distortion (compression) of the c lattice parametter. In the case of LMO layers on the other hand, the unit cell volume is not preserved evidencing that the nucleation of different LMO phases occurs to save elastic energy. As can be expected from the complex phase diagram of manganites, the stabilization of cubic or distorted LMO phases is accompanied by deep changes in the electronic structure. In fact, squid measurements reveal (4) that the LMO cubic phase layers present a ferromagnetic moment while in the distorted ones this ferromagnetism is absent.

(1) *A. Hoffmann, S. G. te Velthuis, Z. Sefrioui, J. Santamaría, M. Fitzsimmons, S. Park and M. Varela. Phys. Rev. B 72, R140407 (2005)*

(2) S. Okamoto and A. Millis, Nature 428, 630 (2004)

(3) Y. Tokura and N. Nagaosa, Science 288, 389 (2000)

(4) J. Garcia-Barriocanal et al. to be published