ESRF	**Experiment title:** Thickness induced metal insulator transition in $La_{1-x}Sr_xMnO_3$ thin films.	**Experiment number:** HE-828
Beamline:	**Date of experiment:** from: 03-May-00 to: 08-May-00	**Date of report:** 01-09-00
Shifts: 18	**Local contact(s):** Paolasini Luigi	*Received at ESRF:*

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Report:

X-ray scattering experiments have revealed the presence of an in-plane superstructure, which corresponds to a substrate induced coherent strain modulation of ~223 Å in $La_{1-x}Sr_xMnO_3$ thin films epitaxially grown on a $SrTiO_3$ (100) substrate, for film thicknesses ranging between 100 Å and 500 Å. The modulation is due to a distortion of the lattice in order to accomodate the discommensuration between film and substrate. Resonant scattering experiments performed near the Mn K-absorption edge at the (003) forbidden reflection has demonstrated that, for films less than 500Å, the cooperative Jahn-Teller (JT) order, which is equivalent to the static order of the Mn^{+3} e_g electrons, is destroyed by the presence of the long period substrate induced modulation. The absence of the MnO_6 tilts adds to the release of the JT distortions and increases the Mn-O bond angle, thereby resulting in larger electron hopping matrix elements between the Mn sites and give rise to the observed metallic behavior. The temperature dependence of the structural modulation, reveals a strong correlation between lattice distortion and the temperature dependence of the resistivity.

For thicker films (~ 1,000 Å) a clear resonant signal (Fig.1) is measured at the (003) reflection in orthorombic notation (if the film is grown on the [100] oriented $SrTiO_3$ cubic substrate) or at (300) reflection in orthorombic notation (if the film is grown on the [110] oriented $SrTiO_3$ substrate). The azimuthal dependence for two films with a different crystalline orientation is shown in Fig.2. The film with the c axis normal to the film surface shows no azimuthal dependence. The film with the c axis parallel to the film surface shows the two-fold azimuthal dependence similar to the one observed in bulk samples. The presence of this strong resonance at the (003) is quite puzzling, since if we assume that the orbital configuration is the same as in the equivalent (same composition) bulk sample no resonant signal should be present. Along the c axis the orbitals are arranged in a ferro-like

fashion and no unequal sites are present. This unusual resonant behavior needs further investigations and might shed some new insight in the basic understanding of resonant phenomena.

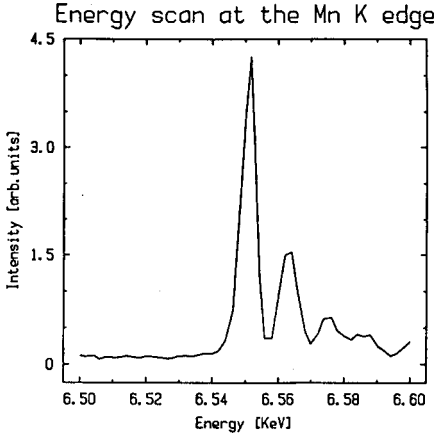

Fig. 1

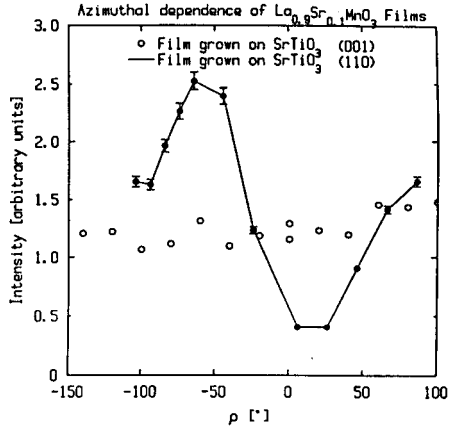

Fig. 2

In Fig.3, we report the temperature dependence of the (100) reflections for the film with the normal oriented along [100]. The decrease in intensity around T=50K could be due to the onset of charge order, as observed in bulk.

Another interesting result was the strong resonance measured at the L_{II} and L_{III} absorption edges of La in the same film. At present, we think that these resonances are connected with the tilting of the MnO_6 octahedra, but more experiments need to be done in order to clarify their origin.

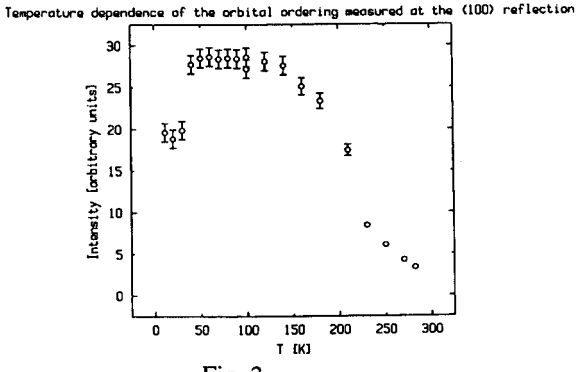

Fig. 3

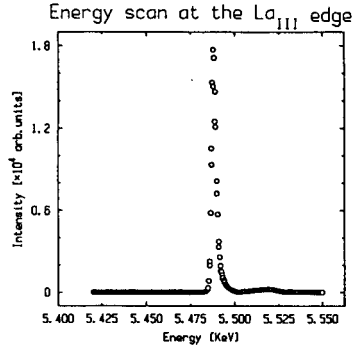

Fig. 4

References:

1. F. S. Razavi et al. Appl. Phys. Lett. 76, 155 (2000).
2. A. Vigliante et al (submitted to PRL).