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Local Structure of Ultrathin CMR Films

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Beamline(s): X19A

Introduction: Due to the large (colossal) magnetoresistance exhibited by perovskite manganites they have attracted a great deal of interest for the potential applications [1]. Many experiments have now show that the complex phase diagrams of CMR magnanites are driven by the close interplay between the charge, spin, and orbital degrees of freedom in the system, although the details of an active area of research. It is evident the lattice strain plays an important role in the properties of these materials, which opens up the possibility of optimizing the properties of CMR oxides for specific applications by growing thin CMR films on substrates with different lattice spacing [2, 3].

Methods and Materials: Epitaxial $\text{La}_{1-x}\text{MnO}_3$ ($x \sim 0.8$) films were grown on (001) LaAlO_3 substrates by metalorganic chemical vapor deposition (MOCVD) using a liquid-injection source delivery system [4]. Mn K-edge absorption spectra in fluorescence mode were measured on NSLS beamline X19A. Measurements were made for films within the beam E-vector nearly 45 degree to the surface. The near edge spectra were area normalized.

Results: We measured Mn K-edge absorption spectra of these films (Fig. 1 (a)). This spectrum shows a strong dependence in the width of the 1s to "4p" peaks with thickness. The broadest and most narrow ones correspond to the 60 Å and 1600 Å films, respectively. We note that the 300 and 1600 Å have similar profiles while the 60 Å film is distinctly more broad. In our recently work [5, 6], we have shown that in the Manganites the local distortions are manifested by the enhancement of the width of the main line.

In Fig. 1 (b), we show as examples the spectra for CaMnO_3 (no JT distortions), LaMnO_3 (with a JT distortion and Mn-O bonds with distances of 1.907, 1.968 and 2.178 Å [7]) and $\text{Bi}_{0.6}\text{Ca}_{0.4}\text{MnO}_3$ (with large JT distortions and Bi $6s^2$ induced *structural distortions* [8]).

Conclusions: The important point is that the 60 Å film has very large local distortions which are significantly larger than those present in LaMnO_3 (see references [5] and [6]). Yet this film is ferromagnetic and metallic. This result can be understood from the 60 Å diffraction data which show this film has a low amount of relaxed metallic film.

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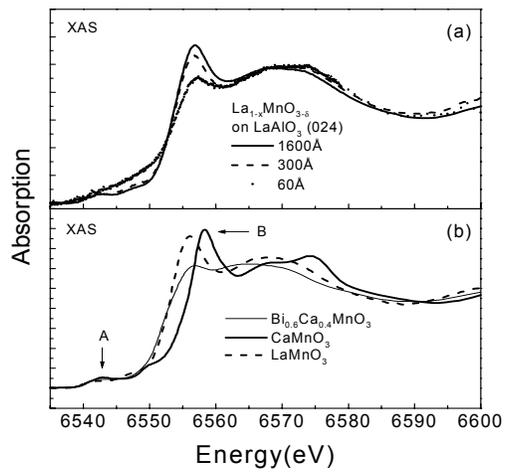


Fig. 1. (a) Near edge x-ray absorption spectra (Mn K) of $\text{La}_{0.8}\text{MnO}_3$ films for 1600 Å (solid line), 300 Å (dashed line) and 60 Å (solid dot) films in fluorescent mode. The spectrum measured when the incidence x-ray E-vector has 45 deg. to film surface. (b) Same XAS measurement with local distortion decreasing for powder $\text{Bi}_{0.6}\text{Ca}_{0.4}\text{MnO}_3$, LaMnO_3 and CaMnO_3 .