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Fe-doping Effect on Morphologic and Magnetotransport Properties of $La_{2/3}Ca_{1/3}Fe_{1-y}M_yO_3$ Thin Films

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Abstract – In this work we have performed magnetotransport measurements as a function of temperature of $La_{2/3}Ca_{1/3}Fe_{1-y}Mn_yO_3$ (y = 0, 0.01 and 0.03) thin films, that present different morphologies depending on the ^{57}Fe-concentration and the substrates. The morphology was studied by atomic force microscopy (AFM) at room temperature in air and the mean grain sizes were obtained.

A series of manganites thin films with low iron doping were growth by dc magnetron sputtering on LaAlO3 (LAO) and SrTiO3 (STO) single crystal substrate at high O2- pressure (500mTorr), have been used as samples, with thickness between 50 and 80nm.

AFM images of the low iron doped manganies thin films shown a surface smoothing effect was noticed for undoped sample (rms between 1 and 3 nm), and a direct grain size (15 - 65nm) dependency regarding to Fe concentration was observed on doped films in both substrate. The films consists of numerous grains of rather rounded shape (see Fig. 1). This rounding effect is more pronounced in the 3% Fe doped sample on STO. During the Fe doping increase, the size and shape of the grains are changing (see Fig. 2a).

On the other hand, the results of the magnetoresistance (MR) of LCMO, LCMFO-1% and LCMFO-3% films on STO and LAO, presented an increase of the MR in Fe doped samples regarding to the biggest Fe concentration and grain size (see Fig. 2b). Probably, this increasing should be due to the fact that close to Curie temperature, the connectivity between grain, the disorder of spins and Fe doping effect at the grain surface, produces a significant increase of the resistance, but when a magnetic field is applied, this one suppresses the magnetic disorder causing in this way a decrease in the resistance, thus it is contributed that the MR reaches high values close to the transition metal-insulator temperature. The maximum MR is still very sensitive to the substrate, even for the highest doping or grain size, although all magnetic properties are essentially similar. The maximum MR for the 3% sample is almost twice as high for sample grown on LAO compared to sample grown on STO.

In summary, we observed a direct grain size dependency and magnetoresistance vary non-monotonically with increasing of Fe concentration. This behavior can be understood in terms of competing influences from the strain relaxation, which enhance the tendency to order ferromagnetically, and reduce the double-exchange interaction.

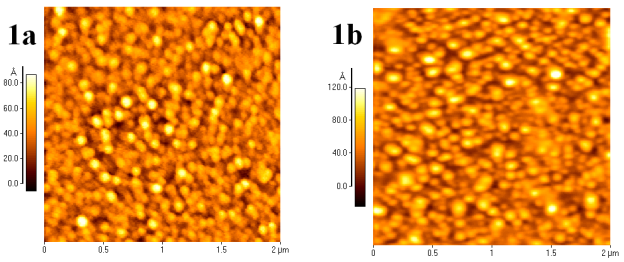

Figure. 1. AFM images of thin films **(a)** LCMFO-3% / LAO. **(b)** LCMFO-3% / STO.

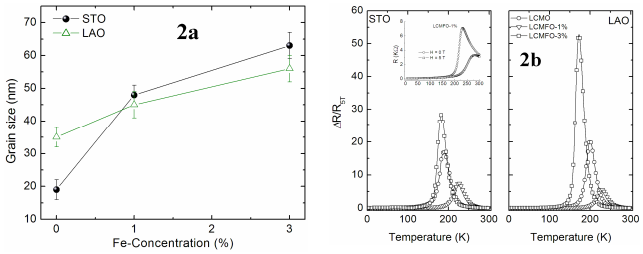

Figure. 2(a). Grain size as a function of Fe concentration of thin films on STO and LAO substrates. **(b)** Magnetoresistance as a function of temperature for LCMO, LCMFO-1% and LCMFO-3% thin films grown on STO and LAO substrate.