Synthesis and characterization of antiferromagnetic $La_{1-x}Sr_xMnO_3$ epitaxial thin films by polymer-assisted deposition

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Apart from its inherent rapid dynamics in the terahertz (THz) range, antiferromagnetic (AF) materials also possess several characteristics such as stability, immunity against external magnetic interference, conservation of spin angular momentum, and the absence of stray fields. These traits highlight the potential of AF materials in advancing spintronics for a multitude of technological applications such ranging from high-speed data processing to fundamental enhancements in information storage and device performance, all while maintaining low power consumption[1].

On the other hand, complex oxides exhibit a fascinating interplay among electronic, orbital, structural, and magnetic degrees of freedom. This interplay results in a broad spectrum of structural, magnetic, and transport phases that either compete or coexist, leading to significant responses to external stimuli[2]. In particular, the $La_{1-x}Sr_xMnO_3$ system demonstrates a complex phase diagram, including AF ordering for x values around and higher than 1/2[3].

Our research focuses on producing high-quality thin films of $La_{1-x}Sr_xMnO_3$ manganite with AF ordering, leveraging the versatility of the polymer-assisted deposition (PAD) technique to control stoichiometry[4]. Thin films of the $La_{1-x}Sr_xMnO_3$ system, varying in composition from 0.5 to 0.65, were deposited using the PAD method on $SrTiO_3$ (100) substrates. Our main objective was to stabilize the A-type AF phase associated with x~ 1/2.

However, the electronic and magnetic properties of the samples with different levels of La substitution with Sr diverge from the anticipated behavior based on the bulk phase diagram. Through X-ray absorption spectroscopy, we found that the effective Mn3+:Mn4+ ratio of 0.5:0.5 is actually achieved in the sample with x= 0.65, indicating an alternative charge compensation mechanism.

Additionally, our investigation revealed with high oxygen pressure annealing techniques that oxygen vacancies were formed to alleviate epitaxially structural strain. These oxygen vacancies play a crucial role in partial charge compensation and deviations from the bulk phase diagram[5].

References

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Figures

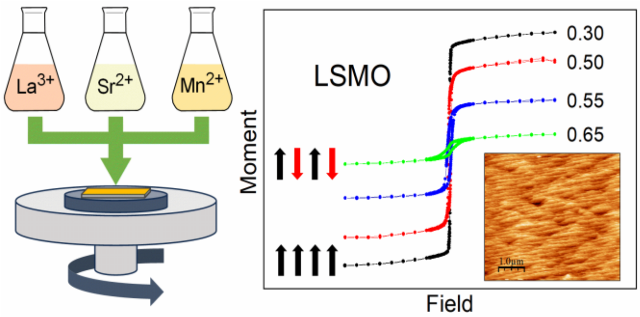

Figure 1. Scheme of PAD technique for preparing the different LSMO x thin films and its magnetization (x= 0.30, 0.50, 0.55, 0.65).