^{55}Mn NMR characterization of magnetic oxides thin films

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Half-doped manganites $La_{(1-x)}A_{(x)}MnO_3$ (where A is a divalent ion and x=0.5) recently attracted a renewed attention because their ground state (ferromagnetic or antiferromagnetic, metallic or insulator) can be easily modified by engineering the bandwidth or modifying the carrier density. The aim of this study is to explore how epitaxial strain affects the magnetic and electric ground state in films of $La_{0.5}Sr_{0.5}MnO_3$ (LSMO-05) by using ^{55}Mn NMR resonance as probe to local magnetism and charge localization. Various oxide substrates with a different lattice mismatch to LSMO-05 were used in order to induce different strain effect (tensile or compressive strain). ^{55}Mn NMR spin echo experiments have been carried out at 4.2 K on films with thickness of 20 and 35 nm. The NMR spectra consist of the Mn^{4+} line and the resonance line corresponding to Mn in a mixed valence state revealing the presence of hole localized and hole itinerant states, respectively. The analysis of NMR data leads to the following conclusions: (1) Strain induces a separation into antiferromagnetic and ferromagnetic phases rather than reducing an overall magnetization of a film, which could be suggested by the macroscopic magnetization measurements. (2) A degree of phase separation depends on the film thickness and on magnetic history of the film. (3) ^{55}Mn NMR frequency (^{55}Mn hyperfine field) observed at manganese ions participating in the double exchange interaction is surprisingly high compared to that expected for this composition (x=0.5) and similar to the frequency observed for the optimally doped composition (x=0.3). This observation strongly suggests that besides phase separation also the electronic charge redistribution takes place between the ferromagnetic and the antiferromagnetic phases.