Magnetotransport of LSMO grown on various buffer layers on STO

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$La_{2/3}Sr_{1/3}MnO_3$ (LSMO) is very promising for application in full oxide spintronics due to its colossal magnetoresistance, ferromagnetism at room temperature and half metallic properties. However, its properties are very sensitive to changes in stoichiometry (oxygen, La/Sr ratio), interface structure, temperature, as well as to the substrate and its crystallographic orientation, buffer layers and strain in the case of thin films. In particular, understanding and controlling magnetic properties of LSMO films are critical for implementation in the high speed and low power memory as a tunnel junction. It is proposed to create a tunnel junction with a large tunneling electroresistance (TER) and tunneling magnetoresistance (TMR), using a composite tunnel barrier of $BaTiO_3$ (BTO) and MgO between two LSMO electrodes. In such a case, the properties of upper LSMO layers may change due to their growth on MgO/BTO and BTO/MgO composite buffer layers. In this work, we present the influence of such buffer layers on the magnetotransport properties of an LSMO electrode. Our experiments were performed for the following set of buffers: MgO, BTO, MgO/BTO, BTO/MgO and a reference sample with no buffer layer, i.e. LSMO on $SrTiO_3$ (STO). We measured magnetoresistance, anisotropic magnetoresistance (AMR) and coercivity vs. temperature. For epitaxial LSMO grown directly on an STO or on a BTO buffer layer, magnetoresistance is relatively small. Double-buffer layers (with MgO) results in a polycrystalline structure. In the case of polycrystalline LSMO, scattering at the grain boundary is an additional source of magnetoresistance, which causes an increase in the magnetoresistance effect, especially at low temperatures. As expected, we measured higher low field magnetoresistance values for the buffer samples with respect to the reference sample. Regarding the dependence of magnetoresistance on temperature, the highest value of magnetoresistance was observed at a low temperature for LSMO/MgO/BTO/STO and LSMO/BTO/MgO/STO samples. The polycrystalline LSMO layers had a higher coercivity than the epitaxial reference sample [1]. Magnetoresistance vs. the applied magnetic field is qualitatively different below and above Curie temperature, and it is also different for epitaxial and polycrystalline LSMO. Interestingly, it correlates with the coercivity of the films. The AMR effect is predicted to occur for epitaxial LSMO samples and its absence indicates a polycrystalline structure. Consequently, we observed the AMR effect only for the LSMO/STO and LSMO/BTO/STO samples.

References:

[1] J. Pawlak et al., Acta Physica Polonica A 133, 3 (2018)