Strain relaxation mechanisms in epitaxial ultra thick LAO/STO films

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Since more than a decade, the $LaAlO_3/SrTiO_3$ (LAO/STO) system has gained the attention of researchers world wide, as an intriguing example of the fascinating properties stemming at the interface between complex oxides compounds. There is general agreement on the fact that two-dimensional electron gas at the interface between such two insulators occurs in samples in which the LAO critical thickness is above 4 u.c., below this value the samples being insulating. On the contrary, the value of the maximum thickness for conducting LAO/STO samples changes noticeably from sample to sample. The disappearance of the interface conductivity is generally ascribed to defects induced by the gradual relaxation of the tensile strain related to the relatively large lattice mismatch between LAO and STO (~ 3% at room temperature) but the growth mechanisms and the transport properties of thick LAO films is a topic scarcely investigated.
In this work we present our results on thick LAO film, with thickness varying between 60 nm and 180 nm, characterised by stable layer-by-layer growth as confirmed by longstanding RHEED intensity oscillations. While the maximum thickness reported in literature for conducting LAO films is around 30 u.c., our growth conditions allows to obtain conducting interface in much thicker films. We analyse the role of the film growth kinetic in the formation of dislocations, strain relaxation or cracks and try to correlate the electrical and structural characterization in order to highlight the mechanisms hampering the persistency of the interface conductivity above a certain thickness.