Nanopatterned Complex Oxides – Key to New Physics

Georg Schmidt

[1] Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Von-Danckelmann-Platz 3, 06120 Halle, Germany
[2] Interdisziplinäres Zentrum für Materialwissenschaften, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow Straße 4, 06120 Halle, Germany

Georg.schmidt@physik.uni-halle.de

Complex oxides are promising materials for future electronic applications, especially because of the large variety of properties. They can be ferromagnetic, ferroelectric, conducting, insulating, piezoelectric and much more. In order to use them for future nanoelectronics it is necessary to develop suitable patterning processes. For many of these materials the latter is quite a challenge because they are much more stable to standard dry etching techniques than for example II/VI, III/V, or group IV semiconductors and unlike most metals they may lose or change their relevant properties if patterned by simple physical patterning techniques. A good example is insulating $SrTiO_3$ which is often used as a substrate and by most dry etching techniques is turned conducting. Because of this lack of suitable nanopatterning techniques the investigation of interesting physics is often limited to macroscopic structures.

One of our main research topics concerns the development of reliable nanopatterning processes for various oxides. The applications are widespread and range from the tuning of magnetic properties in ferromagnetic $La_{0.7}Sr_{0.3}MnO_3$ by shape anisotropy[1] in large areas of nanostructures to the investigation of magnetotransport in nanostructures patterned from the well known electron gas in $LaAlO_3/SrTiO_3$ heterostructures[2]. In the latter for example we have observed a resistance anomaly which is undetectable in large area structures and which points out that the low temperature transport in this material system is entirely based on filaments which appear at structural domain walls in the substrate while the larger part of the interface is completely insulating[3].

References

[1] M. Wahler et al., Appl. Phys. Lett. 104, (2014) 052408
[2] M.Z. Minhas et al., AIP advances, 6, (2016) 35002
[3] M.Z. Minhas et al., arXiv:1610.07382 (2017)

Figures

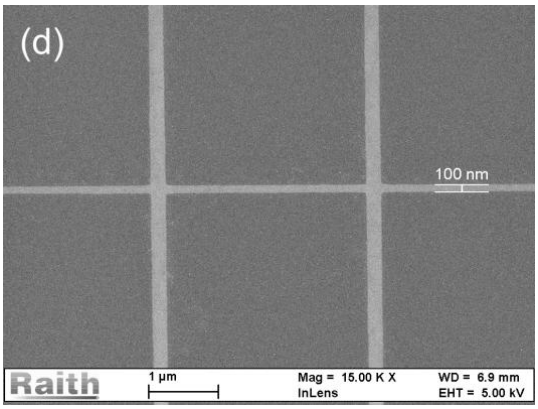

Figure 1. Nano-Hall bar patterned from $LaAlO_3/SrTiO_3$

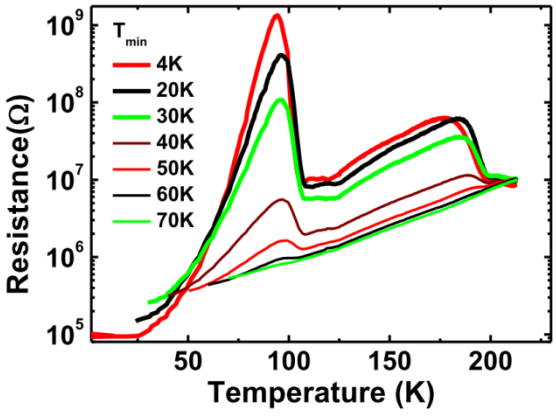

Figure 2. Resistance of an LAO/STO nanostructure measured during warm-up from low temperature. For the different curves the minimum temperature is varied.