Magnetotransport Effects in Polar versus Non-polar $SrTiO_3$ Based Heterostructures

E. Flekser; M. Ben Shalom; Yoram Dagan (Tel Aviv University)

Introduction

The interface between oxides can exhibit electronic properties that are substantially different from those of its constituting materials. The most studied example is the conducting interface formed between $SrTiO_3$ and $LaAlO_3$.

We have studied this system in our former visits at NHMFL and showed that in addition to a gate controlled superconducting ground state, a tunable spin orbit interactions significantly affects the normal state transport. We suggested a "Rashba" type spin orbit mechanism and emphasized that further inspection is necessary. Portion of our results were observed in similar $SrTiO_3$ based heterostructures including the symmetric two-dimensional Nb doped $SrTiO_3$ thus questioning the "Rashba" mechanism. The aim of this experiment was to compare the transport properties of the two systems.

Experimental

This study compares the negative parallel magnetoresistance (nPMR) and anisotropic magnetoresistance (AMR) in the two-dimensional electron gas of Nb/$SrTiO_3$ and $LaAlO_3$/$SrTiO_3$ heterostructures. The measurements were performed in SCM1 at a temperature of 20 mK and magnetic field up to 18 T. We used the puck rotating option in order to examine the transport's properties as function of the angle between the heterostructure surface, the electric current and the magnetic field.

Results and Discussion

The large (nPMR) observed for in-plane magnetic fields in $LaAlO_3$/$SrTiO_3$ is absent in Nb/$SrTiO_3$ for the carrier densities under study. We found that the AMR observed when rotating the in-plane magnetic field with respect to the current direction and the nPMR have similar temperature, gate and magnetic field dependence and thus arise from the same mechanism. From the sign and magnitude of the AMR effect we concluded that polarized magnetic scatterers and a Rashba-type spin-orbit interaction are responsible for this effect. This scattering process is absent in the symmetric structure of Nb/$SrTiO_3$ where a smaller and opposite in sign effect was seen.

Conclusions

These results clarify contradicting transport interpretations in $SrTiO_3$ based heterostructures. Further information can be found in the published paper.[1]

References

[1] E. Flekser, *et al.*, Physical Review B 86, 121104(R) (2012).