High mobility interface electron gas by defect engineering in a modulation doped oxide heterostructure

Prof. Dr. Ing. Guus Rijnders
Faculty of Science and Technology
MESA+ Institute for Nanotechnology

Contact details:
University of Twente
P.O.Box 217
7500 AE Enschede
The Netherlands
tel +31-53-489-2618
secr +31 53 489-2860
fax +31-53-489-2990
email a.j.h.m.rijnders@utwente.nl

Abstract:

The manifestation of quantum behavior in two dimensional electron gases in semiconducting heterostructures and their progressive complexity towards fractional quantum Hall effect went hand-in-hand with the efforts to remove the effect of impurity scattering. For oxide materials, history is repeating itself and to date sample quality is reaching levels where quantum behavior starts to become accessible. To really understand the ground state of two dimensional electron gases in oxide systems, where electron-electron correlation effects seem more important, a step towards modulation doping is necessary, removing dopants away from a conduction channel.
We will show that the impurity scattering of a 2DEG at the $LaAlO_3/SrTiO_3$ interfaces can be significantly suppressed by defect engineering, allowing the observation of quantum transport in a modulation doped oxide system. We used $SrTiO_3$-$LaAlO_3$-$SrCuO_2$-$SrTiO_3$ heterostructures, in which an $SrCuO_2$ layer is placed at the top interface.
RHEED analysis will be presented to show the highly controlled growth as well as magneto transport measurement, from 50 mK to 300 K and 0 to 30 Tesla, to demonstrate the dramatic increase of the mobility of the charge carriers in our system. In this high mobility regime, we are able to observe quantum oscillations from the 2-dimensional electron gas. Clear Shubnikov-de Haas (SdH) quantum oscillations can be observed in the transverse geometry with increasing amplitudes for higher magnetic fields.
Within the contribution, growth and properties of the complex oxide heterostructures will be presented, with a focus on the underlying mechanism of defect engineering.