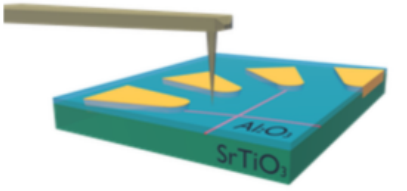
Masters Student Projects:

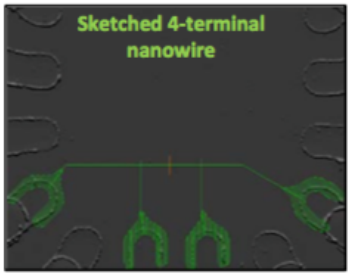
Mesoscopic electronic devices at the interfaces of complex oxides

Center for Quantum Devices, Station Q Copenhagen

We have available master projects in the sub-group working on the physics of complex oxides heterostructures. The research focuses on understanding a new type of electronic system which has recently been discovered at the interfaces of the complex oxides strontium titanate ($SrTiO_3$) and lanthanum aluminate ($LaAlO_3$) – Fig 1. While the materials themselves are very good electrical insulators with a large band-gap, if the two materials are assembled into a sandwich, a high quality two-dimensional electron system appears at the interface. This system has remarkable properties: In some aspects it behaves as a semiconductor with properties that can be tuned by electrical fields (the basic property enabling all modern semiconductor technology). However, in contrast to semiconductors, the electrical field not only changes the conductivity, but can also drive quantum phase transitions into superconducting or magnetic regimes. These properties belong to the realm of correlated materials and are completely unheard of in conventional semiconductors. The overall aim of our research is to understand and exploit these properties through fabrication of nanoscale electronic devices and detailed electronic measurements at ultralow temperatures (below 0.1Kelvin) where the quantum properties of the materials stand out.

Fabrication of devices from the oxide heterostructures is a nontrivial problem. We have recently implemented a new method where the tip of an atomic force microscope can be used to “draw” electronic wires and devices at the nanometer scale – see figure. This allows a wide range of new possibilities and we have an opening for a highly motivated student in physics or nanotechnology to supplement the team. You should have a strong interest in condensed matter physics / material science / nano-physics / quantum physics, and like hands-on experimental work. You will learn the techniques of nanofabrication and the art of oxide device sketching and low level electric measurements at cryogenic temperatures.





Our research is in a close collaboration with the material synthesis group at the Technical University and while the present project focuses on the electronic device aspects you will also have the possibility to learn material synthesis and follow the samples from the very beginning where the crystals are grown by Pulsed Laser Deposition to making the devices and performing the electrical measurements.

If you find this interesting and would like to know more, contact Thomas Sand Jespersen, (tsand@nbi.dk)

Want to read more? Start here: http://arxiv.org/ftp/arxiv/papers/1401/1401.1772.pdf.