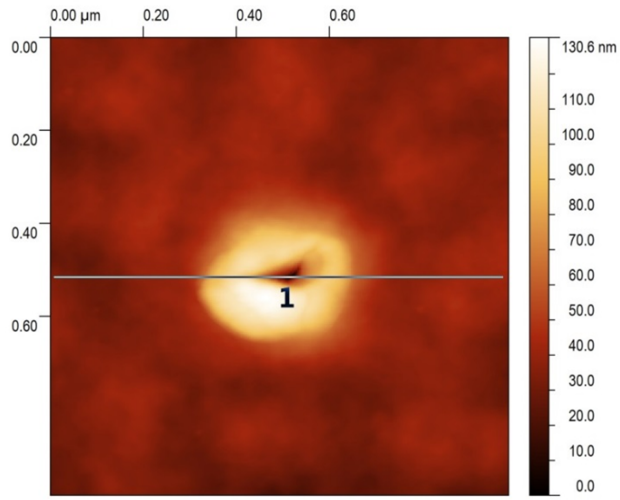
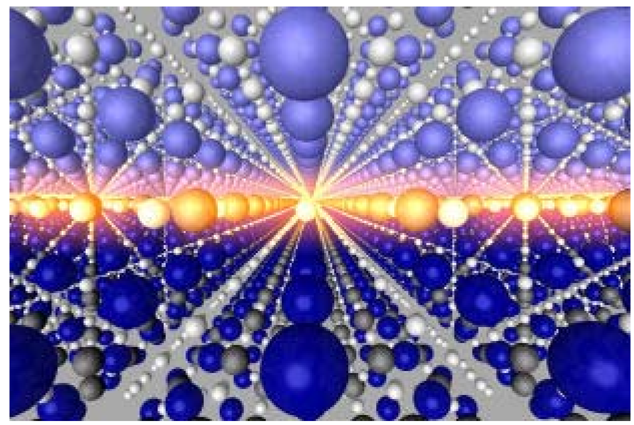
BSc/MSc project

NanoElectronics Group www.nano-electronics.nl
Interfaces and Correlated Electron systems Group www.utwente.nl/tnw/ice

Title: Fabrication and measurement of nanoscale tunneling devices in oxide electronics
Supervisor: Sander Smink (PhD student NE/ICE)





Nano-indentation created by point-and-shoot AFM technique, enabling creation of nanoscale devices. Courtesy Bojian Xu, NE group.

Artist impression of conduction at the $LaAlO_3$-$SrTiO_3$ interface, showing the 2DEL confined in a very narrow region. Courtesy J. Mannhart, MPI Stuttgart.

Goal and motivation

Oxide materials exhibit a wide range of physical phenomena, e.g. high-temperature superconductivity, ferroelectricity and -magnetism and extremely high dielectric constants, making them important candidates in the search for new functionality in electronics. The interface between the two insulators lanthanum aluminate ($LaAlO_3$) and strontium titanate ($SrTiO_3$) hosts a highly conducting two-dimensional electron liquid (2DEL) and serves as a model system for oxide electronics. For example, it shows superconductivity below 300 mK with the characteristics of a high-temperature superconductor and possesses electrically tunable spin-orbit coupling, making it interesting for spintronic applications.
A complete explanation for the phenomenology has not yet been given, and direct measurement of the band structure of the system can provide many clues towards this explanation. Tunneling experiments can reveal the density of states as function of the applied bias voltage, enabling a reconstruction of the band structure. Application of external electric and magnetic fields can then provide a solid base for understanding the phenomenology, ultimately leading to functional electronic and spintronic devices.

The assignment

The MSc student will fabricate and measure devices for tunneling between the $LaAlO_3$-$SrTiO_3$ interface and a metal top electrode. The first step is to optimize the fabrication procedure for large-scale (tens to hundreds of microns) tunneling devices and perform characterization of those, optimizing material growth. After this minimization of the tunnel junction can be realized by nano-indentation, to achieve nanometer-scale tunnel junctions.

Measurements will be done in a dilution refrigerator, with temperatures down to 15 mK. During the assignment, the student will learn to grow the samples using Pulsed Laser Deposition and sputtering, to design microscopic electronic devices, to pattern the samples using photolithography, to create nanoscale tunnel junctions using nano-indentation and to perform sensitive electronic measurements.

Profile

Students with preferential background in electrical engineering, physics, nanotechnology and material science are encouraged to apply.

Graduating in NE

As a student in NE you are a full group member and expected to give an active contribution to ongoing research. You are involved in specific aspects of research (device fabrication, measurements and analysis) and your work is likely to be part of a scientific publication. Besides you are also encouraged to participate in the regular social activities.

Contact

Prof.dr.ir. Wilfred van der Wiel
W.G.vanderWiel[at]utwente.nl