Atomic Interactions Lab

Exploring the atomic world

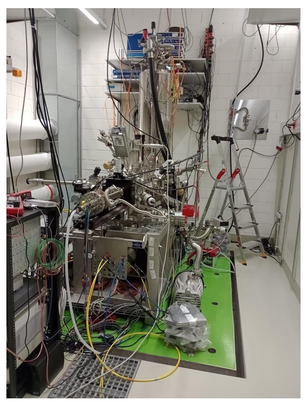
Fabian D. Natterer Group

Silvan Huber

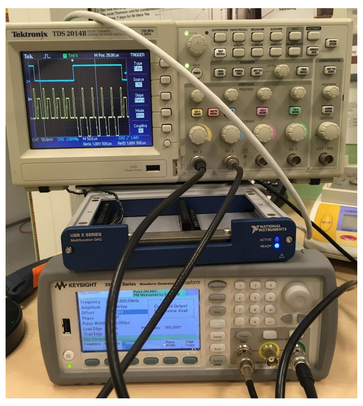
Julie Teerink

Student projects:

From lab...



to electronics...



to simulations!

Contact resistance of Copper

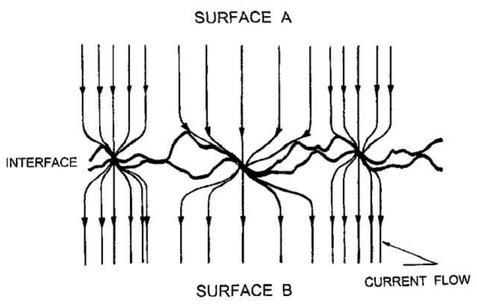
Bachelor thesis of Silvan Huber

Goal

- Mesurement of the contact resistance of metal electrodes (Cu, Nb) in dependence of pressure and temperature.
- Design of an experimental setup to measure contact resistance of metals at cryogenic temperatures.

Contact Resistance

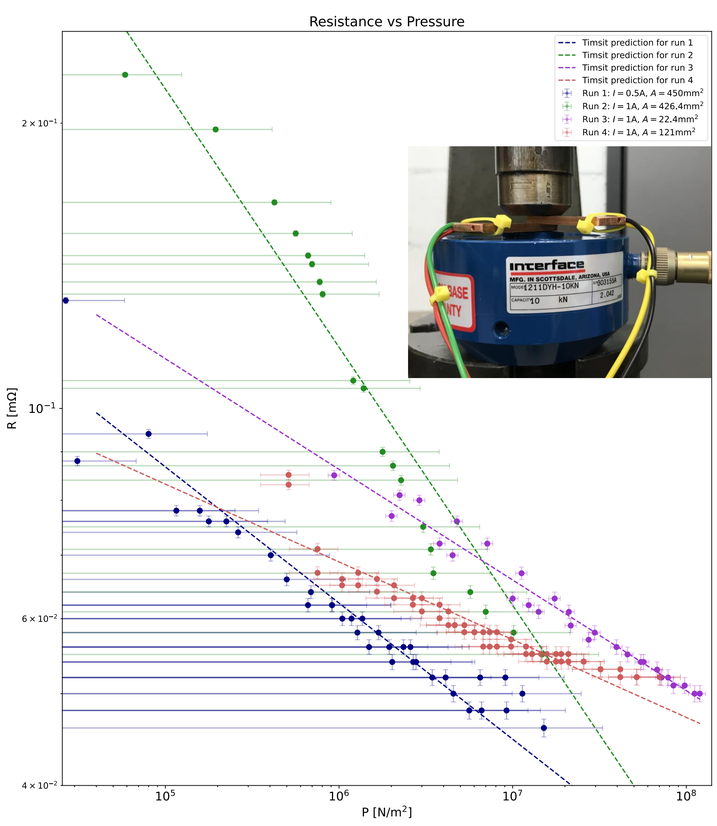
- Contact resistance is everywhere (plugs for your smart phone, electric connectors of removable parts of an STM)
- Resistance creates Joule Heating (resistance causes heat dissipation) which is problematic in environments that need to be kept at cryogenic temperatures
- Contact resistance can be reduced by applying pressure to the connecting metals



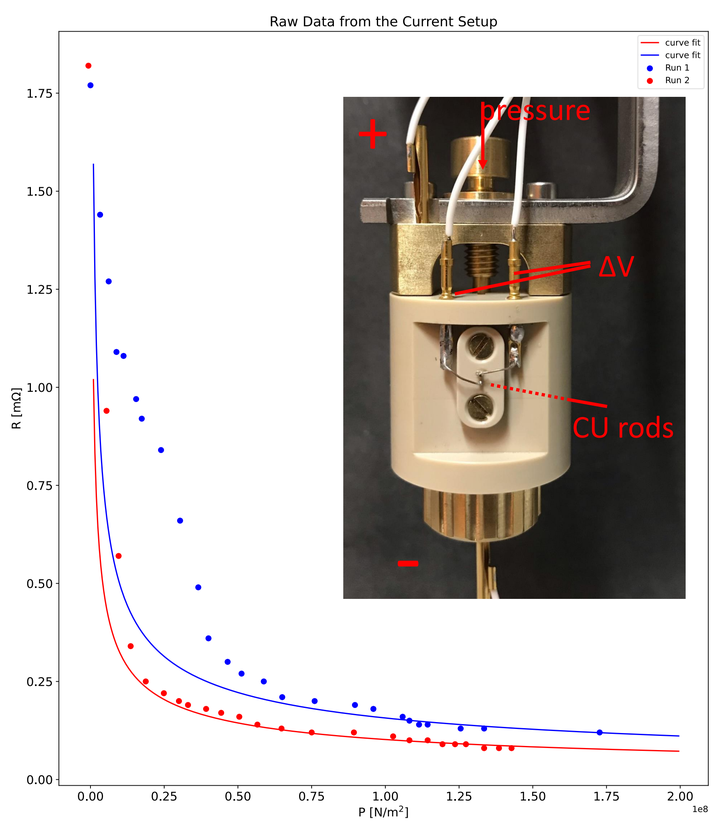
The interface between two materials is never truly flat which results in an electrical contact resistance.

(R.S. Timsit. "Electrical Contact Resistance: Properties of Stationary Interfaces)

Preliminary Experiment: Two copper plates between a mechanical press and a pressure cell.



Current Setup: Setup used for the measurement of the contact resistance. The screw on top increases the pressure on the rods.

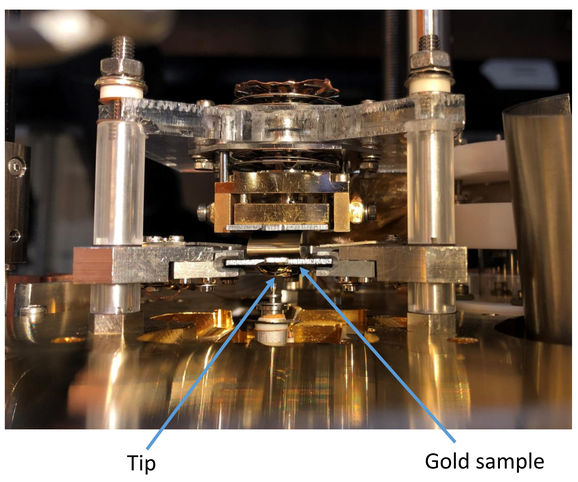


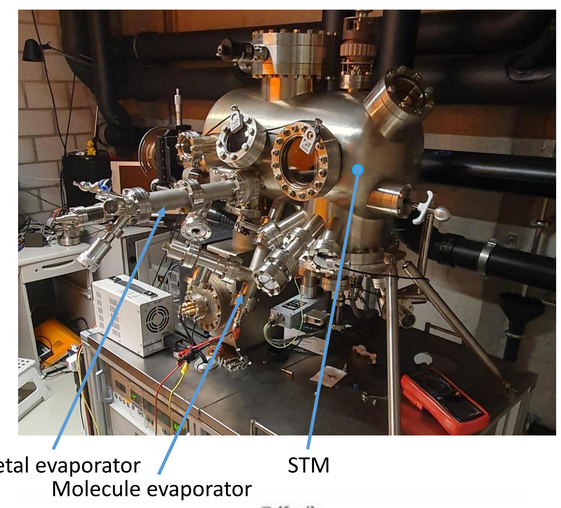
Measurements with the preliminary (left) and the current setup (right). The theoretical model used to fit the data follows R. S. Timsit. The new pressure setup is compatible with cryogenic environments and will be used to test the contact resistances between rods made from dissimilar materials (Cu-Cu, Cu-Nb, Nb-Nb, …).

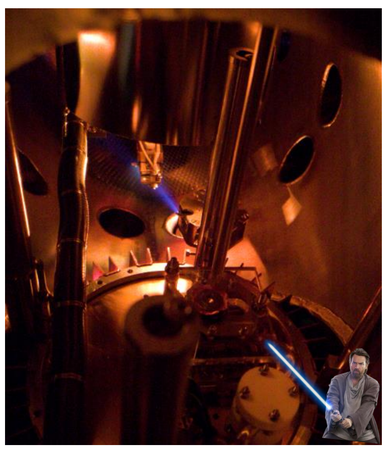
Next steps: *Measurements at cryogenic temperatures and interpretation of results within Timsit model*

Metal-molecule interaction using STM

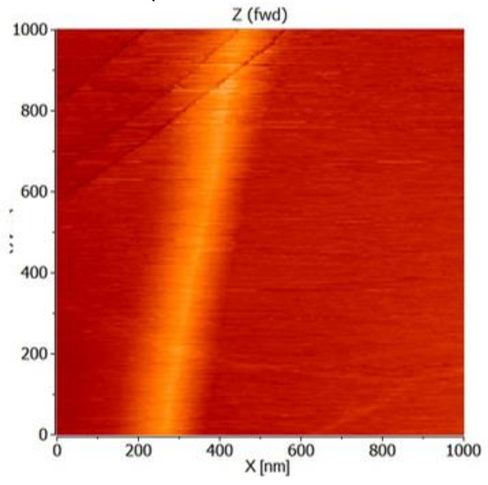
Bachelor thesis of Julie Teerink







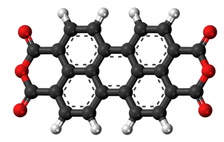
Sample cleaning Au crystal by ion sputtering



My first scan of HOPG (Highly oriented pyrolytic graphite). Top left: atomic layer step edges. Bright vertical column: material bulges on nano-scale

Motivation

- Discovery of spiral formation of silver steps on Ag(111) after co-deposition of Ag atoms and PTCDA (Perylenetetracarboxylic dianhydride)
- What causes curved step edges? Can we control curvature with different molecules?

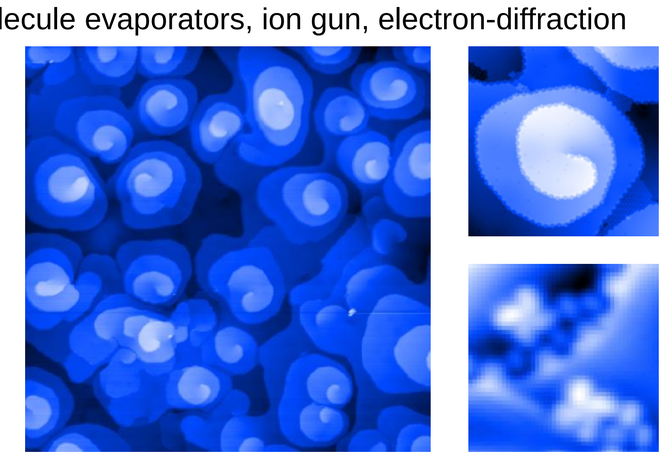


Goal

- Reconstruct spirals with smaller molecule
- Learn how to use STM to investigate size and structural phase of metal-molecule systems

Techniques

- STM: atomic resolution of molecules on surfaces using the tunneling effect
- In ultra-high vacuum: vacuum generation, metal and molecule evaporators, ion gun, electron-diffraction



Spiral shape after 10 minutes of co-deposition of silver and PTCDA on a silver(111) surface with high substrate screw dislocation density. The step edges are decorated with PTCDA molecules and occasionally coexist with pinwheel phase.

Danyang Liu, Scanning tunneling microscopy of molecules at metal interfaces. Doctoral thesis at university of Zurich, 2023