Scientific report of the exchange visit at the University of Hannover

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The main goal of this exchange visit was the investigation of a previously in the gas phase observed decay of different isomers of Dinitrobenzene (DNB) with a low temperature STM. In gas phase we discovered, that the loss of a neutral NO unit from the parent anion of DNB (which occurs when DNB is ionized with an electron energy of about 100meV - 200meV) transfers nearly 1eV into the kinetic energy of the fragments, which is an enormous amount. With a Low-Temperature-STM we wanted to find out, if this reaction could also be triggered when the DNB is adsorbed on a surface.
In Hannover we tried to investigate the two different isomers, 1,2DNB and 1,4DNB.

Figure 1: Chemical structure of 1,2DNB (left) and 1,4DNB (right)

The chemical structure of both molecules is shown in Figure 1. Our first try where we wanted to deposit 1,2DNB on a gold Au(111) surface, showed that the DNB-molecules are forming rods along the 'Herring-Bones'. Furthermore, the molecules are very loosely

bound to the gold surface. An image of the deposited clusters on Au(111) is shown in Figure 2.

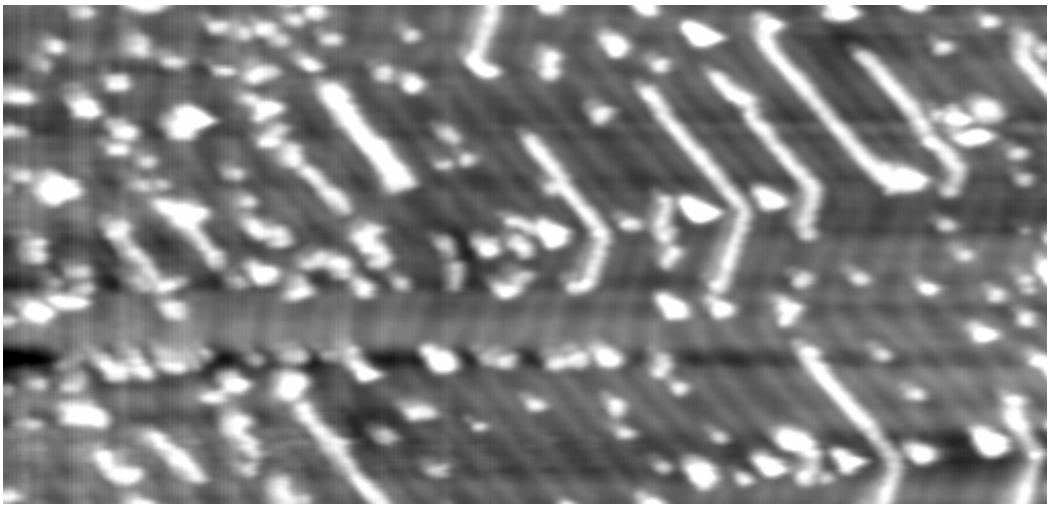

Figure 2: 1,2DNB deposited on Au(111) surface x-dimension 105nm

So we tried to deposit the 1,2DNB molecules on a copper Cu(111) surface. We faced several problems with the sample holder itself and thus we had to prepare the samples several times. But in the end we were successful and could deposit 1,2DNB also on Cu(111). Like on Au(111) we were also not able to identify individual molecules of DNB easily. By time our sample got dirty again and we observed not only 1,2DNB but also a lot of CO on the surface. Figure 3 shows 1,2DNB deposited on Cu(111). Like in the case of Au(111) we see that the molecules form clusters most of the times. So it turns out to be a real challenge to do enough experiments on single molecules. This cluster formation might be driven by the high dipole moment of 1,2DNB.

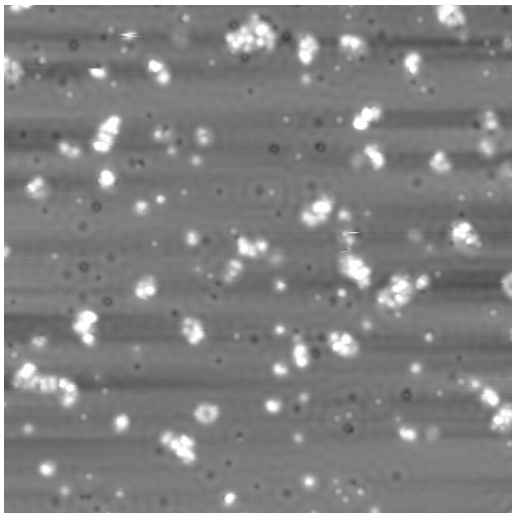

Figure 3: 1,2DNB on Cu(111) x-dimension 58nm

By doing electron induced manipulation (this means that the tip is staying at a specific position above the molecule, the gap-voltage is varied in a given range and the tunneling current is measured) we could find for 1,2DNB that there is a dissociation-channel at approximately 2.1V. But we could not find a resonance at smaller voltages! Due to the fact that the 1,2DNB is difficult to distinguish from other things (molecule fragments or impurity molecules) we decided to prepare on the same surface with less deposition time (to avoid clustering) with 1,4DNB which has no dipole moment. For 1,4DNB it was then easier to find single molecules, and we think that we were able to distinguish the 1,4DNB from other adsorbant molecules or 'dirt'. Figure 4 shows a single 1,4DNB molecule on the left (you can see that it could consist out of 2 bright circles) and a CO (this we know for sure because of earlier measurements)

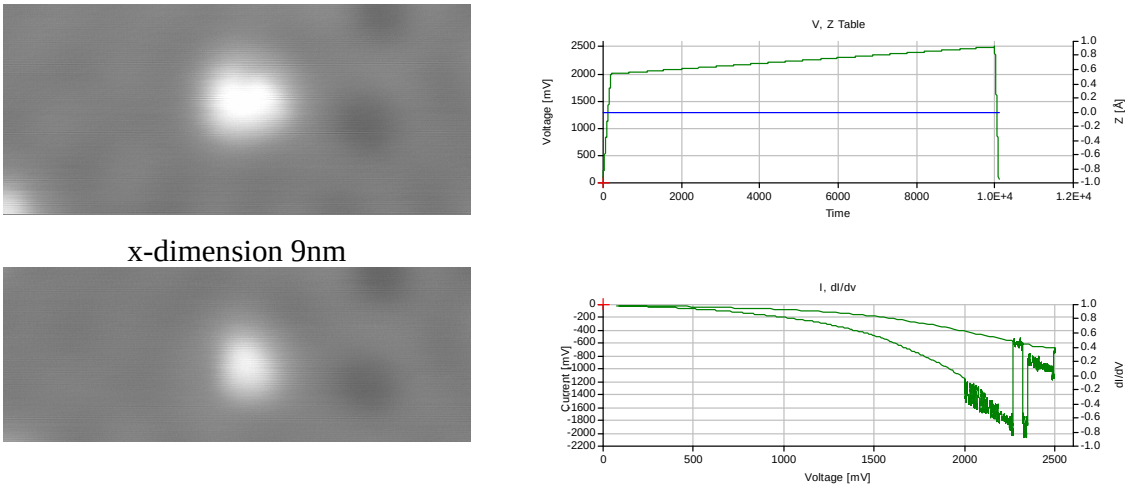

Figure 4: Vertical manipulation of 1,4DNB which leads to dissociation

For 1,4DNB I did several vertical manipulations, but the only resonance we could find was located at gap-voltages around 2.1V up to approximately 3.0V. But for much more exact measurements on 1,4DNB it would be necessary to have more stable conditions to perform spectroscopy on these molecules that are expected to be 1,4DNB. Also to see the dissociation products spectroscopy would be needed.

The 4 weeks in the group of Prof. Karina Morgenstern were really exciting, and I saw the first time really professionally built Low-Temperature-STM's and handled liquid helium. I learned a lot about vibrational dampings, STM-techniques, tip and sample preparation, tricks to improve the resolution, and I also saw a lot of very useful minor things that will help us in our lab in Innsbruck to work much more efficient and make life easier.

Hereby I would also like to thank all the members of Prof. Morgenstern's group, especially Michael Mehlhorn and Heiko Gawronski who supported me the most with solving the technical problems that occurred.