

# ATOM MANIPULATION with NANONIS SPM CONTROLLER

Atom manipulation often attracts the interest of researchers, not only for observing artificial patterns on the surface [1], but also since it allows preparing ideal “samples” on surfaces, designed for a specific measurement [2]. At the same time, however, it often requires a complete custom made scanning probe controller. Although the first systematic atom manipulation was demonstrated in 1990s, it is still challenging for most researchers. This application notes shows how the fully-digital Nanonis SPM controller with its LabVIEW Programming Interface can significantly reduce the technical challenges and simplify the manipulation process.

We programmed a small LabVIEW protocol, which can control the tip X, Y, and Z position and its trajectory while monitoring the signals (tunneling current, frequency shift etc.) and performed a systematic Cu atom manipulation on Cu(111) in ultra-high vacuum at low temperature with the Nanonis SPM Control System. The figure below shows the name of our university written with 96 Cu atoms. The single Cu atoms were first obtained by deposition from the tip in a controlled manner by measuring the conductance [3], and then pre-aligned on the surface. After that, these atoms were precisely positioned on the surface by lateral manipulation [4]. Due to the creep of the scanner, moving an atom with large travel often induces an error in the positioning, therefore the atoms were first roughly aligned. Then, in order to increase the precision, the size was reduced step by step. Each step took about 40 min for 96 atoms.

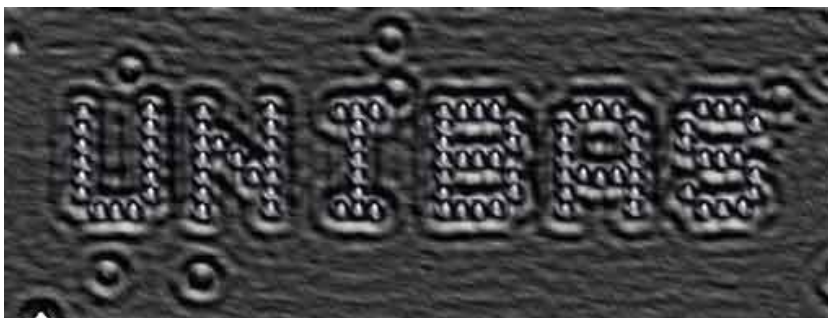


Figure 1. 96 Cu atoms manipulated on Cu(111) surface at low temperature (Image size: 60 nm x 23 nm)

Atom manipulation with the Nanonis SPM controller has become even easier, allowing researchers to focus on the preparation of a sample tailored to their needs.

#### References:

- [1] D. E. Eigler and E. K. Schweizer, *Nature*, **344**, 524 (1990).
- [2] A. J. Heinrich, C. P. Lutz, J. A. Gupta, and D. M. Eigler, *Science* **298**, 1381 (2002).
- [3] L. Limot, J. Kroeger, R. Berndt, A. Garcia-Lekue, and W. A. Hofer, *Phys. Rev. Lett.* **94**, 126102 (2005).
- [4] G. Meyer, L. Bartels, S. Zöphel, E. Henze, and K. Rieder, *Phys. Rev. Lett.* **78**, 1512 (1997)

#### Authors:

S. Kawai, and E. Meyer, University of Basel, Switzerland

#### Nanonis Modules in Use:

- Base Package
- Oscillation Controller OC4
- LabVIEW Programming Interface
- Atom Tracking

#### System:

- OMICRON LT-STM/AFM

