AUTOMATED SWITCHING BETWEEN *Non-Contact* AND *Contact* MODES OF AFM

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The study of plasticity by means of atomic force microscopy (AFM) is a fascinating experiment, as it is possible to observe the nucleation of single dislocations directly in the indentation force curve and image the resulting deformed surface structure with high resolution.

We use the Nanonis SPM Control System and Dual OC4 setup in our home-built UHV Friction Force Microscope. The surface topography is imaged with non-contact AFM using frequency modulation detection for topography feedback and Kelvin Probe Force Microscopy to detect localized charging on the surface, see Figure 1. During indentation, a measurement of the static deflection of the cantilever as a function of the extension of the piezotube (a normal force vs. distance curve in contact mode AFM) must be recorded, see Figure 2. The creation of dislocations in the crystal is observed in the normal deflection of the cantilever as sudden jumps in the force. The Nanonis Programming Interface allows for the easy scripting of repetitive functions required for switching between non-contact and contact modes, such as switching off the PLL and the bias modulation, recording the force curve, and then switching on the non-contact devices so that the surface can be imaged.

Figure 1. Image of the KBr(100) surface after indentation, obtained in non-contact AFM, using frequency shift for topography feedback control.

Nanonis Modules in Use:

- Base Package
- Dual OC4 configuration
- High Voltage Amplifiers
- Kelvin Probe Module
- Labview Programming Interface
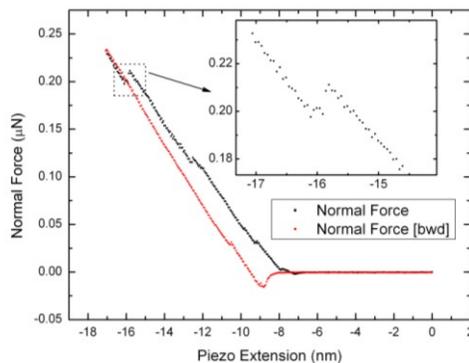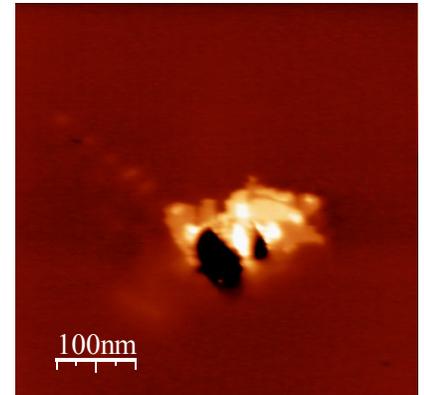
System:

- Home-built UHV AFM

Figure 2. Force vs. distance curve, obtained in contact mode. Zoom in of a discontinuity in the force curve, caused by the nucleation of dislocations in a KBr(100) single crystal.

Furthermore, the scripting of the force curve allows one to perform quick, accurate, and repeatable measurements. What used to be the task of clicking and switching between 10 to 20 buttons/dials, is now done in 2 clicks!

References:
[1] T. P. Egberts, T. Filleter, and R. Bennewitz, *Nanotechnology*, **20** (2009) 264005.
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[3] T. Filleter, S. Maier, and R. Bennewitz, *Physical Review B*, **73** (2006) 155433.

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