# COMPENSATING FOR CPD IN NC-AFM: AM-KPFM IN UHV USING DUAL-OC4

Single pass Kelvin probe imaging (KPFM) gives information on the electronic structure of materials by measuring contact potential difference (CPD) while simultaneously acquiring topography. Under vacuum condition the Q factor is higher than in air, leading to higher resolution for both Kelvin and topography images.

With the use of the Nanonis controller to operate our home-built UHV microscope, we investigate heterogeneous surfaces in nc-AFM mode. The Kelvin controller allows to dynamically compensate for the electrostatic interaction between tip and sample, often a cause of topographical artifacts for true height determination. The first resonance (f_1) of the cantilever is used to control tip height, while the second flexural mode (f_2) for contact potential measurements. Two oscillation controllers OC4 are used, one as PLL for tracking the frequency shift at f_1, and the second as a lock-in to measure the amplitude of the cantilever second resonance. A Kelvin controller feedback loop minimizes the amplitude of the second resonance by adjuting the applied DC bias voltage. This voltage is the direct CPD measurement between tip and sample.

Since we use rather stiff cantilevers, with f_2 in MHz range, we had to choose a bandwidth of 3MHz for the photodetector. The Nanonis Dual OC4, with the integrated Kelvin probe module, allows us to perform such complex measurements in a very accessible and precise manner.
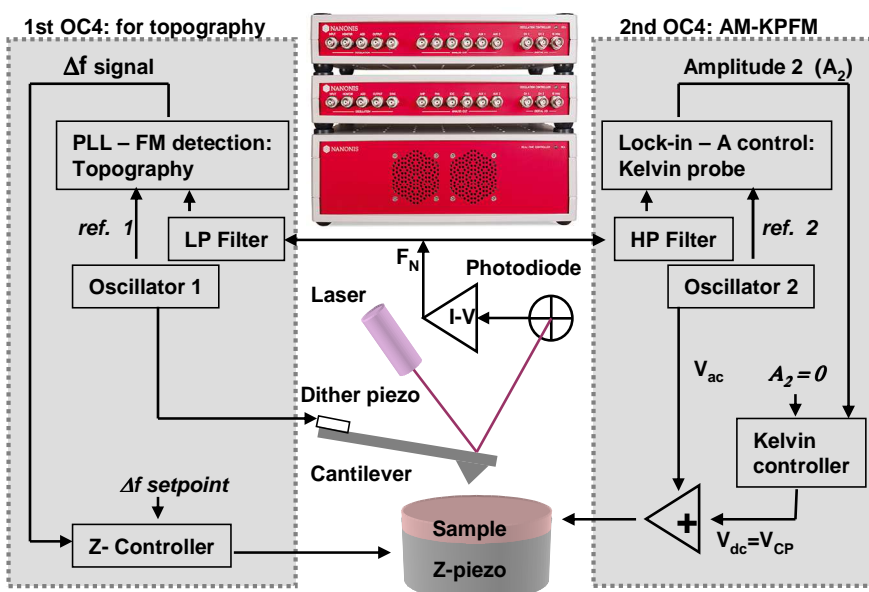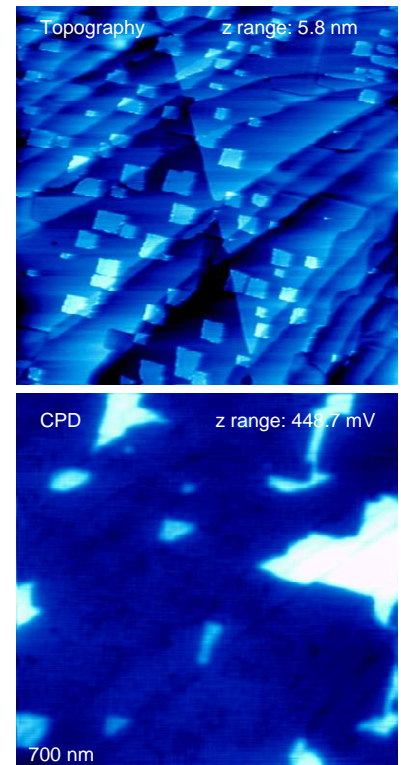

Schematic of the experimental setup. The same vertical deflection signal from the photodiode is fed into both OC4 controllers.

Reference:
http://nanolino.unibas.ch/pages/intro.htm

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Topography and CPD images of NaCl islands on Cu(111). The measurements are done with Dual OC4 setup, one running in constant Δf mode at f_1 =150 kHz and the other in AM-KPFM mode at f_2 = 900 kHz.

Nanonis Modules in Use:

- Base Package
- Function generator
- OC4-Dual Add-on
- Kelvin controller – software module

System:

- Home–built RT AFM

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