NANONIS APPLICATION NOTE

AUTOMATED AMPLITUDE CALIBRATION IN non-contact AFM MODE

Calibration procedures are always very important for correct quantitative measurements in SPM. In the absence of an interferometer, acquiring an accurate calibration using nc-AFM is complicated. The routine also has to be repeated multiple times for an accurate determination of the amplitude calibration factor which requires a non-negligible amount of time.

We propose a practical and fast way to automate the amplitude calibration of a cantilever. We no longer record Δf vs z curves and manually select point (A_n, z_n) of equal interaction as in Fig. 1, but we optimized the procedure making use of the Nanonis *LabVIEW programming interface*. In our routine the amplitude of the cantilever is sequentially changed by a factor γ, as in eq. 2, over a selectable range around the initial amplitude. The corresponding Δf has to be changed accordingly to the relation (3) in order to preserve the interaction between the tip and sample [1]. For each set of value (A, Δf) the corresponding z piezo position is read out. Thus, it becomes possible to correlate the z position to the amplitude value and obtain the calibration factor [nm/V] from the linear fit of such a curve.

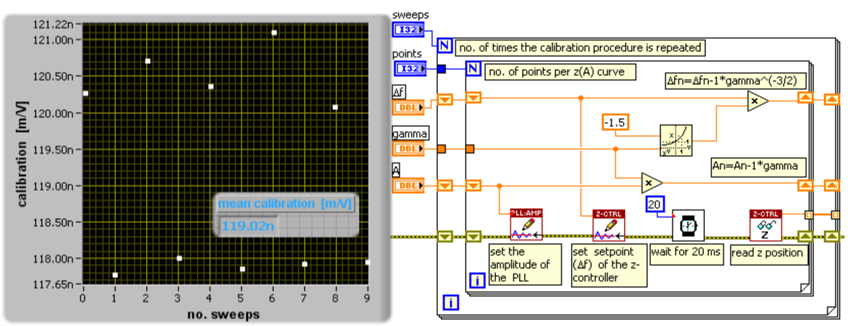

Fig. 2. Dispersed values of the calibration due to z piezo drift. The mean calibration after 10 sweeps is calculated. Silicon cantilever (k~40 N/m) with optical detection was employed.

For increased accuracy, sweeps of A and Δf are performed several times in both directions, and a mean value of the calibration factor is calculated (see Fig. 2). The sweeps must be performed quickly to minimize the drift in the z direction.

You can take advantage of this routine implemented now in the LabVIEW *programming interface* and you will have an accurate calibration of the amplitude in less than 1 min. The procedure can be applied to other types of sensors with careful choice of the input parameters.

[1] M. Guggisberg, Ph.D thesis "Lokale Messung von atomaren Kräften", 2000.

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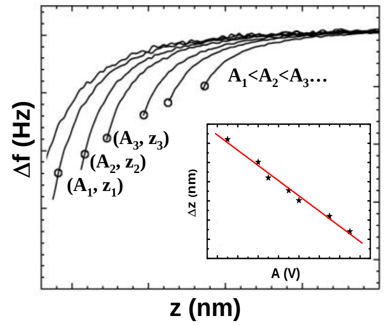

Fig. 1. Δf vs z curves for different amplitudes. The marked points on the curves are points of equal interaction between the tip and surface. Inset: Linear dependence of z(nm) position on the amplitude A(V).

Equations used for the amplitude calibration in nc-AFM:

(1) $\Delta f \propto A^{-3/2}$

(2) $A_2 = \gamma * A_1$

(3) $\Delta f_2 = \Delta f_1 * \gamma^{-3/2}$

Nanonis Modules in Use:

- Base Package
- Oscillation Controller OC4
- perfectPLL™
- LabVIEW Programming Interface

System:

- Any type of microscope suited for nc-AFM

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