Application Note CI20

# Tuning Fork based AFM Measurements of uncapped, stacked InAs Quantum Dots in a GaAs matrix

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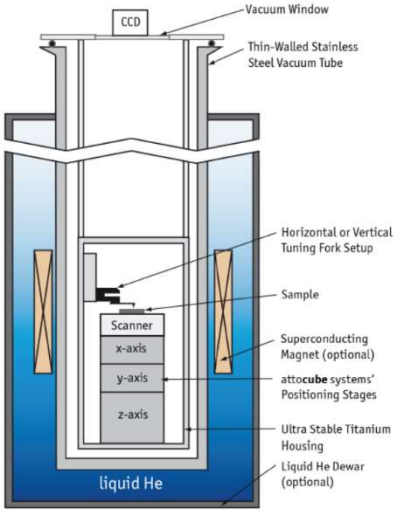
The attoAFM III is a tuning fork based setup for highly precise low temperature measurements. The non-optical design faciliates e.g. measurements on light-sensitive samples using conductive STM-type tips.

The distance feedback is done by detecting the tuning fork vibration using a Phase-Locked Loop (PLL) together with a feedback loop. The PLL tracks the resonance of the tuning fork, whereas the feedback loop keeps the z-distance in such way that the frequency shift (vs. the free oscillation) remains at a certain level. Deriving from the measurements which are presented in this application note, the z-noise (RMS) of such measurements is typically as low as 30 pm.




*Schematic drawing of the attoAFM III*

The sample under investigation features stacked, uncapped InAs quantum dots in a GaAs matrix [1]. As can be seen from the topography image (Figure 1a), the dots are about 300 nm x 100 nm in size while having a height of about 4 nm (the scan size is ~2x 2 µm²). Especially in the error image (Figure 1b), one can see atomic steps in the surrounding InAs.

On another spot of the sample, this has been investigated in more detail (Figure 2). Clearly spaced steps are visible in this graph. The height distribution is presented in Figure 3, showing atomic steps with a spacing of ~2.04 +/- 0.02 Ångstrøm. This corresponds to the atomic lattice constant of InAs of ~2.1 Ångstrøm. The small difference is most certainly due to the scanner calibration.

As mentioned above the roughness analysis yields an RMS roughness value of ~30 pm in this measurement, showing the excellent stability and low noise of the attoAFM III instrument.

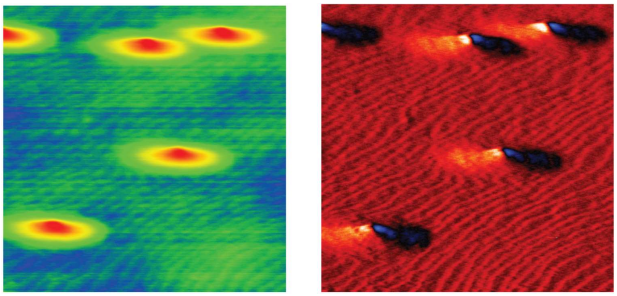


***Figure 1:*** *Tuning fork AFM measurements of uncapped, stacked InAs Quantum Dots in GaAs at ambient conditions.*

***Figure 2:*** *Detailed topographic image when performing a scan of 500 x 500 nm.*

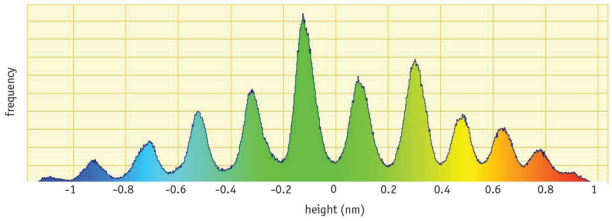



***Figure 3:*** *AFM height distribution data extracted from Figure 2 yielding the atomic step height.*

## References

[1] The InAs QD sample is courtesy of P. Petroff UCSB, Santa Barbara, USA.



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