

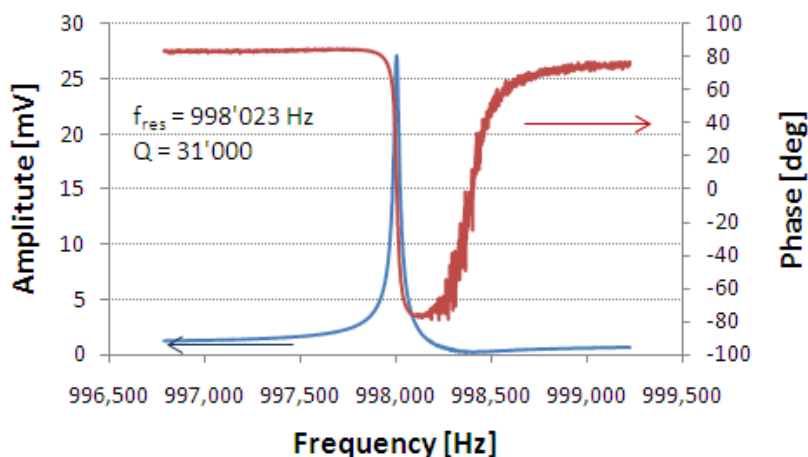
# NEEDLE SENSOR OPERATION IN non-contact AFM MODE

Needle sensors are becoming increasingly popular to measure the tunneling current while not depending on the current for the distance feedback. A resonance frequency of 1MHz insures a fast response of the sensor while interacting with the surface, but it requires a highly accurate Phase Locked Loop (PLL) to perform non-contact AFM measurements, especially with low frequency shift set points.

We use the Nanonis Control System to operate an Omicron STM equipped with a needle sensor to investigate variation of the surface potential and carrier density across MOS devices. The needle sensor is directly driven by the Nanonis OC4. The sensor signal is amplified using a standard FEMTO IU-converter which is directly connected to the input of the OC4.

Finding the correct PI parameters for Amplitude and Phase of the PLL can be a cumbersome procedure, but the perfectPLL™ setup tool makes finding the resonance and setting up the system a matter of minutes

The image to the right shows the topography of one of our samples, acquired in non-contact mode. The frequency shift was  $\Delta f=500\text{mHz}$  at  $f_0=1\text{MHz}$ .

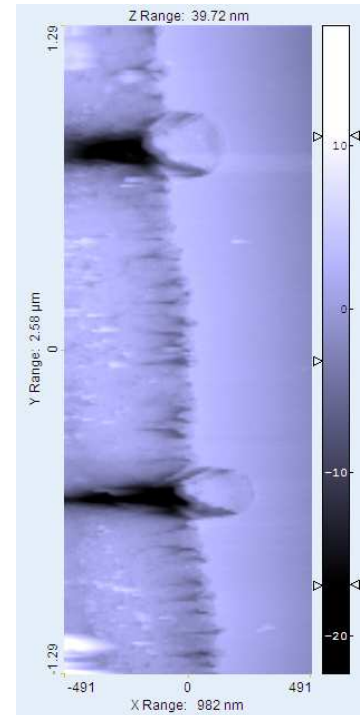


Resonance curve of a Needle Sensor excited with a drive amplitude of 1mV.

*L.Bolotov, et al., Carrier concentration profiling on oxidized surfaces of Si device cross-sections by resonant electron tunneling scanning probe spectroscopy, J. Vac. Sci.& Technol. B26, 415-419 (2008).*

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Topography of polished and oxidized Si(100) cross-sectional surface (right) with two poly-silicon trenches beneath a cap layer (left).

Frequency Set-point: 500mHz.

**Nanonis Modules in Use:**

- Base Package
- Oscillation Controller OC4
- perfectPLL™
- Omicron Adaptation Kit

**System:**

- Omicron LT-STM



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