

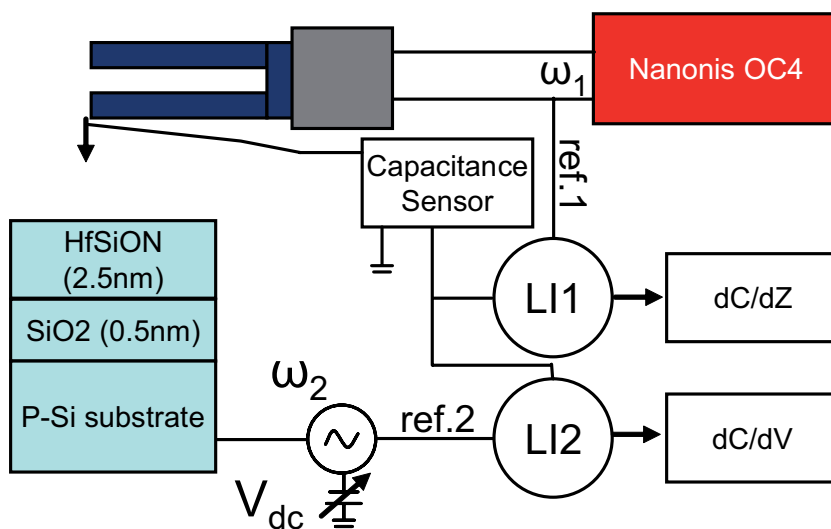
INTEGRATING EXTERNAL EQUIPMENT – USER CHANNELS IN THE NANONIS SPM CONTROLLER

We use the Nanonis SPM Control System and Oscillation Controller to operate our tuning fork-based JEOL microscope. The z-feedback runs on the frequency shift of the tuning fork. To make local capacitance measurements we attached a separately contacted metal tip to one prong of the tuning fork. In our effort to map local charge defects in Hf-based high-k gate films we had to integrate the signals from two external lock-in detectors with the data acquisition of the control system.

The first lock-in measures dC/dV at a frequency of 500 kHz. We use one of the user channels provided by the control system to acquire the demodulated signal of the lock-in detector. The advantage of this method is that we can give the signal a meaningful name and SI unit, making it transparently available throughout the system.

The second lock-in measuring dC/dZ is synchronized with the driving frequency of the tuning fork through the sync output of the Nanonis Oscillation Controller. The demodulated signal is again acquired by a second user channel. Both extra channels are acquired simultaneously with the topography and the four signals of the phase locked loop used to drive the tuning fork. All 7 channels can be displayed simultaneously in real-time.

Nanonis makes the integration of external instrumentation extremely easy. In particular attaching a meaningful SI unit and calibration to each signal is very convenient.



Schematic of experimental setup.

Reference:

Y. Naitou et al., *Spatial fluctuation of dielectric properties in Hf-based high-k gate films studied by scanning capacitance microscopy*, *Appl. Phys. Lett.* 87, 252908 (2005)
 Y. Naitou et al., *Investigation of local charged defects within high-temperature annealed HfSiON/SiO2 gate stacks by scanning capacitance spectroscopy*, *J. Appl. Phys.* 101 83704 (2007)

Author:

Y. Naitou, National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan

Nanonis Modules in Use:

- Base Package
- Oscillation Controller
- User Channels
- Generic Sweep
- JEOL Adaptation Kit

System:

- JEOL RT-AFM



Nanonis GmbH, Zürich, Switzerland
www.nanonis.com