MI 3: Scanning probe microscopy

Chair: H. S. Leipner

Time: Monday 12:45–13:45 Location: EMH 225

MI 3.1 Mon 12:45 EMH 225

Chemical nano-imaging of thin surface layers by combining AFM with tip-localized infrared spectroscopy — Sergiu Amarie and •Fritz Keilmann — MPI für Quantenoptik, Garching

We have extended the scattering near-field microscope (s-SNOM) that returns an optical image together with topography, both at <20 nm resolution, by operating with broadband infrared illumination. Thus a continuous infrared spectrum from 4 to 15 micron wavelength can be recorded at each scanned pixel. As this covers the "molecular fingerprint" region one can determine the local chemical composition. The probing depth is about equal to the spatial resolution, of the order of the tip radius of typically 20 nm. Our new method should find many applications requiring a quantitative material analysis at the nanoscale, be it in general analytical chemistry, nanofabrication, mineralogy or condensed matter physics.

Results of imaging hard biological matter will be presented, where phosphate and carbonate nanocrystals evoke especially bright contrasts due to infrared phonon resonance, and where new insights into biomineral growth and decay mechanisms of biological and even medical interest can be expected.

MI 3.2 Mon 13:00 EMH 225

New generation micro vacuum gauge for ultra high vacuum measurements using modified AFM tips — •Amra Avdic, Anna-Maria Lausch, Alois Lugstein, and Emmerich Bertagnolli — Solid State Electronics Institute, Vienna University of Technology, Floragasse 7, 1040 Vienna, Austria.

Every modern high vacuum and ultrahigh vacuum system relies on ionization gauges for pressure measurements under 10E-3 Torr. For the first time we present the micro vacuum gauge (MVG) fabricated by modification of commercial available metall-coated Si Atomic Force Microscopy (AFM) tips with the lateral resolution < 1um. As any cold-cathode based vacuum gauge, our MVG consist of two properly insulated electrodes integrated on the AFM tip, forming coaxial embodiment. The conductive AFM probes are insulated with a Si3N4 layer using plasma enhanced chemical vapour deposition and subsequently coated by a second metallic layer, which later forms a ring shaped collector around the tip. Our self aligned approach for MVG formation comprises focused ion beam (FIB) machining and isotropic Reactive Ion Etching (RIE). The RIE is used to selectively etch the insulation and expose the conductive tip, thereby forming the cavity between the immediate tip (emitter) of about 60 nm in diameter and the ring (collector) separated by a cavity of about 600nm. After the modification the MVG is mounted into the Crossbeam Neon40EsB and tested upon the gas injection available at this system.

MI 3.3 Mon 13:15 EMH 225

All-Metal Cantilevers for Kelvin Force Microscopy — •Raul D. Rodriguez, Franziska Lüttich, Susanne Müller, Daniel Lehmann, and Dietrich R. T. Zahn — Semiconductor Physics, Chemnitz University of Technology, Reichenhainer Str. 70. Chemnitz, 09126, Germany

Kelvin force microscopy (KFM) has become a key analytical technique in several research areas from organic optoelectronic devices to single biomolecular interactions. Ultra sharp, wear-proof, electrical conductors and tapping-mode compatible are key characteristics of cantilevers for KFM. In this work we introduce a new class of all-metal cantilevers that meet all the requirements mentioned above. From metallic microwires as precursors gold and silver probes have been fabricated using a dedicated device for tip fabrication which enhances reproducibility and control of the cantilever dimensions. The resonance frequency of the cantilevers could be tuned in a range from 10 to 400 kHz in air. Such probes were characterized by scanning electron microscopy and their performance was evaluated by analyzing organic semiconductor devices and commercial probe characterizers. The advantages and limitations of these novel probes are discussed and compared to conventional metal-coated silicon and silicon nitride cantilevers.

MI 3.4 Mon 13:30 EMH 225

Extracting intrinsic cantilever properties from thermal noise — •Jannis Lübbe[1], Matthias Temmen[1], Philipp Rahe[2], Angelika Kühnle[2], and Michael Reichling[1] — [1]Fachbereich Physik, Universität Osnabrück, Barbarastraße 7, 49076 Osnabrück, Germany — [2]Institut für Physikalische Chemie, Johannes Gutenberg-Universität Mainz, Jakob-Welder-Weg 11, 55099 Mainz, Germany

We describe a method to determine the eigenfrequency f_0, the intrinsic quality factor Q_0 and the stiffness k from the cantilever deflection noise spectral density $d^z_{\mathrm{th}}(f)$ of a thermally excited cantilever in an ultra-high vacuum environment. The precision of the f_0 value as derived from the peak position is of the order of 0.1% and solely limited by thermal drift. The Q_0 value can be determined from a fit with a precision of 10%. Most delicate is the determination of k derived from the fit of the $d^z_{\mathrm{th}}(f)$ curve. This measurement requires a calibration of the deflection measurement and utmost care has to be taken to avoid any excitation of the cantilever other than by thermal noise. An alternative approach is to determine dynamic stiffness from a measurement of the spectral density $d^{\Delta f}_{\mathrm{th}}(f)$ of the frequency demodulated thermal noise signal. This approach can easily be extended to a measurement of higher order eigenmodes as the spectral analysis of $d^{\Delta f}_{\mathrm{th}}(f)$ can mostly be restricted to frequencies below 100 Hz and does not require high spectral resolution. Results obtained from the two methods are in good agreement with each other.