MI 10: Scanning Probe Microscopy

Time: Thursday 9:30–11:15 Location: H5

MI 10.1 Thu 9:30 H5

Interaction Imaging with Amplitude-dependence Force Spectroscopy — •Daniel Platz[1], Daniel Forchheimer[1], Erik Tholén[2], and David Haviland[1] — [1]Royal Institute of Technology (KTH), Nanostructure Physics, Albanova University Center, SE-106 91 Stockholm, Sweden — [2]Intermodulation Products AB, Vasavägen 29, SE-169 58 Solna, Sweden

The ultimate goal in atomic force microscopy (AFM) is the combination of imaging with accurate force measurement. Dynamic AFM offers only qualitative information about the tip-surface interaction while imaging, because the sharp cantilever resonance efficiently filters out the high frequency components of the tip-surface. Traditional force measurements are based on slow, point-wise surface approaches and are incompatible with imaging. Here, we present a method called amplitude-dependence force spectroscopy (ADFS) that enables quantitative dynamic force reconstruction at every point of an AFM image, while scanning at normal speeds [1]. ADFS breaks with the paradigm of constant tip oscillation amplitude, as the oscillation amplitude is rapidly modulated at every image point. The measured response gives the amplitude-dependence of the Fourier component of the force at the resonant frequency, which allows for a model-free reconstruction of the tip-surface. We have made rigorous tests of ADS using numerical simulations and have used it for a detailed study of the mechanical properties of polymer surfaces.

[1] Platz et al., accepted for publication in Nature Communications

MI 10.2 Thu 9:45 H5

Adapting the Principle of Atomic Force Microscopy for Highly Resolved Measurements of Atmospheric Turbulence with the 2D-Atmospheric Laser Cantilever Anemometer — •Ingrid Neunaber, Jaroslaw Puczylowski, Joachim Peinke, and Michael Hölling — ForWind - Center for Wind Energy Research, Institute of Physics, University of Oldenburg, Germany

Using the principle of atomic force microscopy, we developed a sensor for characterization of atmospheric turbulent flow. As there are various applications in wind energy research and fundamental research, the demand for high resolving and reliable sensors is very high. With the 2D-Atmospheric Laser Cantilever Anemometer (2D-ALCA) we provide a sensor, which satisfies these requirements: The 2D-ALCA is capable of collecting data with sampling rates in the kHz-range, which allows for a spatial resolution in the millimeter range according to Taylor's hypothesis for typical atmospheric wind velocities of 10 m/s. Therefore the detection of very small turbulent structures is possible. The 2D-ALCA is a redesigned version of the successfully proofed 2D-LCA, an anemometer designed for laboratory use only. It is adapted to match the hostile operating environment off-shore. The 2D-ALCA is a drag force based sensor; the sensing element is a tiny microstructured cantilever made of stainless steel. When exposed to airflow it experiences a drag force and deflects. This deflection is detected by means of the laser pointer principle. Depending on the inflow direction the cantilever experiences two deformation modes (bending and twisting), thus enabling simultaneous measurements of 2 velocity components.

MI 10.3 Thu 10:00 H5

Chemical Resolution with nc-AFM in InSn Mixed Atomic Chains on Si(100) — Martin Setvín[1,2], Pingo Mutombo[1], •Martin Ondráček[1], Zsolt Majzik[1], Vladimír Chán[1], Ivan Oštádal[2], Pavel Sobotík[2], and Pavel Jelínek[1] — [1]Institute of Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic — [2]Faculty of Mathematics and Physics, Charles University in Prague, Prague, Czech Republic

Although scanning tunneling microscopy (STM) and atomic force microscopy (AFM) are very successful in probing atomic and electronic structure of surfaces, achieving chemical sensitivity at the atomic level is still a challenge. Sugimoto *et al.* [Nature **466**, 64 (2007)] demonstrated a method of single-atom chemical identification on a surface alloy of IV-group elements on Si(111) using a frequency modulation atomic force microscope (FM-AFM). In our present study, we combine room-temperature (RT) FM-AFM measurements with DFT simulations to explore atomic and chemical structure of heterogeneous atomic chains composed of III and IV-group atoms (In and Sn) grown on the Si(100) surface. These chains consist of dimers of either the same or different atomic species. We demonstrate that in contrast to STM, the FM-AFM technique is able to resolve individual atoms in such structures even at RT. We also show that chemical identification of single atoms is possible when the force-site spectroscopy is combined with DFT simulations. The unambiguous chemical identification could be achieved even though the force measured on top of a particular atom could strongly depend on the neighboring atoms in the chain.

15 min. break

MI 10.4 Thu 10:30 H5

Kelvin Probe Force Microscopy in Liquids — Anna Domanski, Esha Sengupta, Karin Bley, Stefan Weber, Maria Untch, Clemens Weiss, Katharina Landfester, Hans-Jürgen Butt, and •Rüdiger Berger — Max-Planck-Institut für Polymerforschung, Mainz, Ackermannweg 10, Germany

Thin organic films on metal surfaces lead to a significant shift in the electronic work function Φ of the metals. Typically ultraviolet photoelectron spectroscopy (UPS) is used to determine work functions of materials. UPS measurements require areas > 1 mm^2 and thus, variations on a nanometer scale cannot be investigated directly. Kelvin Probe Force Microscopy (KPFM) is a powerful tool to investigate local surface potential changes with high spatial resolution. Often ultrahigh vacuum conditions are required to keep surfaces clean. Here, we will discuss KPFM measurements in unipolar liquids and present an in-situ study of the self-assembly process of hexadecanethiols on gold in decane (1). As test structures, we prepared nanostructured Au surfaces by colloid monolayer lithography. Our study revealed a work function shift for hexadecanethiols on Au by -1.5 eV which is in excellent agreement with UPS data. The lowering of the work function is induced by the formation of an interfacial dipole layer which is directed towards the metal surface, i.e. the negative charges are positioned at the metal/sulfur interface and the positive charges to the decane interface. Our study shows that electrical methods such as KPFM benefit largely by performing measurements in liquids.

(1) A.L. Domanski et al., Langmuir 28 13892-13899 (2012)

MI 10.5 Thu 10:45 H5

k-space Imaging of the Eigenmodes on a Sharp Gold Taper for Near-field Scanning Optical Microscopy — •M. Esmann, B. B. da Cunha, S. F. Becker, J. H. Brauer, P. Gross, and C. Lienau — Carl von Ossietzky Universität, 26111 Oldenburg, Germany

Adiabatic nanofocusing of surface plasmon polaritons on tapered metallic waveguides bears great potential as a novel method for apertureless near-field scanning optical microscopy (NSOM) [1,2]. Plasmon polariton wavepackets are launched on a grating-coupler and ideally come to a complete halt at the taper apex where a single point-dipole like light source is formed. This however only holds for the lowest rotationally symmetric eigenmode of the taper [3]. Higher modes that are also excited on the coupler may disturb the imaging process as they radiate into the far field before reaching the taper end. Thus, they only contribute to background signals.

We have therefore developed and implemented a k-space imaging technique to analyze the different eigenmodes emitted from tapered metallic nanowaveguides. Higher order eigenmodes in the emission of adiabatically nanofocused plasmon polariton modes on ultrasharp gold tapers are identified and filtered. Our approch allows us to use the spatial symmetry of the re-radiated light as an indicator for the tip-sample coupling and presents a step forward towards background-free NSOM imaging with ultrahigh resolution.

[1] M. I. Stockman, Phys. Rev. Lett. **93**, 137404 (2004)
[2] S. Schmidt et al., ACS Nano **6**, 6040 (2012)
[3] J. C. Ashley et al., Surf. Science **41**, 615 (1974)

MI 10.6 Thu 11:00 H5

Confocal Raman Microscopy: True Surface and 3D Raman Imaging — Ute Schmidt, •Max Stadler, Thomas Dieing, and Olaf Hollricher — WITec GmbH, 89081 Ulm, Germany

Confocal microscopy has been used to reconstruct three-dimensional images of micro-objects by using a spatial pinhole to eliminate out-of focus light in specimens thicker than the focal plane. Raman spectroscopy on the other hand is used to unequivocally determine the

chemical composition of a material. Confocal Raman microscopy combines the chemically sensitive Raman spectroscopy with high resolution confocal microscopy leading to chemical images with diffraction limited resolution. The discrimination of out of focus information used in confocal microscopy is particularly beneficial for confocal Raman imaging since it reduces the volume from which the Raman spectrum is collected. This leads to a diffraction limited resolution in chemical imaging of samples. However, the high confocality always results in high focus sensitivity. Therefore, Confocal Raman imaging of rough opaque samples was so far very challenging due to the inability to keep the samples in focus. The true surface confocal Raman imaging method combines confocal Raman imaging and optical profilometry. An integrated profilometer is used to acquire topographic scans of several square millimeters, similar to very large AFM topographic images. The coordinates of this large topographic image are used to trace the surface contours while acquiring the confocal Raman image. Therefore, topographic and diffraction limited Raman images of heavily inclined and rough samples can be obtained in one instrument.