Scanning Probe Microscopy Focus Topic
Room: 10 - Session SP+SS+TF-WeM

Probing and Manipulating Nanoscale Structure

Moderators: Zheng Gai, Oak Ridge National Laboratory, Qiang Zou, Oak Ridge National Laboratory

8:00am **SP+SS+TF-WeM1 STM-Based Nanofabrication and Integrating Nanostructures with Clean Semiconductor Surfaces**, ***Joseph Lyding***, University of Illinois at Urbana-Champaign **INVITED**

Integrating 1D and 2D nanostructures with clean silicon and III-V semiconductor surfaces represents an interesting route towards future hybrid electronic systems. In this effort, we are exploring the integration of carbon nanotubes, graphene and graphene nanoribbons (GNRs) with clean semiconductor surfaces. A key challenge is the fabrication of 'clean' nanostructure-substrate systems. We have addressed this by developing a simple dry contact transfer (DCT) process that enables the deposition of nanostructures onto atomically clean surfaces in ultrahigh vacuum. STM imaging and spectroscopy, coupled with our atomic resolution STM-based hydrogen resist process have been used to study the interactions of carbon nanotubes, graphene and atomically precise graphene nanoribbons with silicon, GaAs and InAs substrates. In these experiments, we have observed the metallic zigzag edge state in graphene[1], carbon nanotube-substrate lattice alignment effects[2], and the electronic structure of GNRs[3]. This talk will also show a method for creating sub-5nm metal wires for contacting nanostructures[4], a SPM probe sharpening technique for producing 1 nm radii probes[5], and a technique for improving the electronic performance of carbon nanotube array transistors as well as the structural and thermal performance of CNT-based composite materials[6].

References:

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8:40am **SP+SS+TF-WeM3 Calcium Mediates Adhesion in Reservoir Fluids**, *S.L. Eichmann*, Aramco Research Center - Boston, ***Nancy Burnham***, Worcester Polytechnic Institute

Oil powers modern economies [1]. Yet only 30% of oil is recovered from a typical reservoir [2]. The reservoirs of Saudi Arabia, which provide over 10% of the world's oil [3], are unusual . T hey are highly saline, with concentrations of up to 120,000 ppm total dissolved solids (TDS), the temperatures can exceed 100º C, and the emulsion of oil and brine is dispersed within small fissures in carbonate rock. These conditions are challenging for the unhindered diffusion of the nanoparticle tracers that are used to map an oil field from one well to the next [4]. In this study, bare and carboxyl-terminated atomic-force microscope tips and calcite surfaces acted as surrogates for nanoparticle tracers and carbonate rocks, respectively. They were immersed in three fluids: brine (120K ppm TDS), seawater (60K ppm TDS), and calcium-doped seawater (~60K ppm TDS). Surprisingly, the amount of total dissolved solids was not a good predictor of the tip-sample adhesion. Rather, specific ion effects were important; adding calcium to seawater brought the adhesion down to the ~100 pN levels of brine as compared to the ~400 pN levels of seawater . The adhesion for the carboxyl-terminated tips was greater (reaching into the nN-range) than for the bare tips, but the same trends were observed. These results can be used where fresh water for oil recovery is in short supply. The addition of calcium to seawater should mitigate nanoparticle-rock adhesion and allow more efficient diffusion of nanoparticle tracers through a reservoir, which could in turn lead to better oil recovery and help ensure a stable supply of an essential global resource.

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9:00am **SP+SS+TF-WeM4 Nanoscopy of Muscovite Mica**, ***Sampath Gamage***, *M. Howard, A. Fali*, Georgia State University, *K. Bolotin*, Free University of Berlin, Germany, *Y. Abate*, Georgia State University

Muscovite type mica is an inorganic material most commonly used as in various electronic devices. Mica also satisfies many characteristics such as excellent thermal stability, high dielectric strength, larger dielectric constant, high Q factor, and high electrical resistivity needed for organic field effect transistors (OFETs) 1-2. We use the near-field imaging and nano-FTIR techniques to investigate nanoscale absorption properties of mica exfoliated on SiO2 substrate in the frequency range of 4 – 15 μm.

References

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11:00am **SP+SS+TF-WeM10 Investigation of Energy Transfer and Conversion at a Single Molecule with an STM**, ***Yousoo Kim***, RIKEN, Japan **INVITED**

Excitation of molecules by light irradiation triggers various important processes including luminescence, photovoltaic effect and photochemical reactions, and detailed understanding of the molecular excited states is crucial to improve organic opto-electronic devices. Absorption spectroscopy is a powerful tool to describe the molecular excitations and the combination with emission (luminescence) spectroscopy which deals with deexcitation processes is effective to investigate the excited states. Single-molecule luminescence detection has progressed rapidly and become indispensable in quantum physics, physical chemistry, and biophysics. However, despite considerable effort and progress, absorption spectroscopy is far behind; number of molecules are still necessary to obtain an absorption spectrum. A difficulty lies in the difference between the diffraction limit of excitation light and absorption cross section of a single molecule.

Here I introduce our recent progresses in measurement of luminescence and absorption spectra and in plasmon-induced reaction at a single-molecule level using a scanning tunnelling microscope equipped with optical detection/excitation facilities.

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