

**38th IUVSTA Workshop and ISF Workshop:
“Electronic Processes and Sensing on the Nanoscale”**

This workshop was initiated with the intent of addressing the following issues and questions:

Unique electronic effects at the nano-scale (Coulomb effects, resonant tunneling, quantum size effects); Nano-devices (both "top-down" and "bottom up"); Materials aspects of Nanoelectronics (synthesis, assembly); Electrostatics on the nanoscale: unique polarization and magnetic effects; Nano scale limits to the space charge-controlled electronics; Interplay between theory and experiment; self-assembled molecular systems in molecular electronics.

The international organizing committee consisting of Sidney Cohen (Chairman, Weizmann Institute Israel), Antoine Kahn (Princeton, USA), Herbert Pfnuer (Hannover Univ. Germany), Angus Rockett (Univ. of Illinois, USA), Lars Samuelson (Lund Univ., Sweden), Yossi Shacham (Tel Aviv Univ., Israel), and Shlomo Yitzhaik (Hebrew Univ., Israel), recognized at the outset the delicacy of the political situation in the Middle East. The situation was closely monitored and as the war in Iraq unfolded precisely on the scheduled date of the workshop, the decision was made to postpone the workshop by 3 months (from start of March to end of May) which found a much improved political situation. Indeed the attendees all marveled at the warm atmosphere in the conference, which led to relaxed scientific discussions both in and out of the conference hall. Over 60 delegates representing 7 different countries (Austria, France, Germany, Israel, Russia, Spain, USA) were in attendance.

The conference opened on Sunday afternoon with a lecture by Uzi Landman of Georgia Tech entitled “SMALL IS DIFFERENT – Physics and Chemistry in the Nano-Scalable Regime” which helped to set the overall emphasis of the conference in examining the peculiarities of nano-systems with respect to their electronic behavior. Here, the concept of the “non-scalable regime” of only a few nm size where scaling laws break down was emphasized. The ensuing talks dealt with experimental and theoretical concepts in quantum conductance, considering both elastic and inelastic scattering effects. The oral session was concluded by selected brief (5 minute) oral

preludes to posters, which were presented in a lively evening poster session (comprising 20 posters) together with dinner.

Monday morning, the group boarded a charter bus and traveled to Eilat, learning about the fascinating geology of the Negev craters on the way by a seasoned geology professor. The scientific sessions continued that afternoon with two presentations on quantum dots and structures - theoretical and experimental, and concluding with a perspective on the detection of single spins on a surface using STM.

Tuesday was a full day, with morning, afternoon, and evening sessions. The day started with a consideration of organic systems – synthetic issues, tailoring of electrical properties (such as for dye-sensitized solar cells) by unique synthesis and modification schemes, and integration of neurons into small electronic devices. The morning continued with talks on photoelectronic properties of porous silicon, small domain creation in ferroelectrics activated by application of an inhomogeneous field, and unique properties of quantum rods. After an afternoon trip to the underwater observatory and aquarium of exotic fish, the afternoon session was held. Specific electronic-related properties such as those of color centers in insulating surfaces and current spectroscopy of high T_c superconductors were discussed. The evening discussion session, held after dinner, was quite lively and continued in smaller groups into the small hours of the morning.

Wednesday and Thursday morning sessions included several SPM-related measurement techniques and practices. New modes for nano-scale characterization such as nano-potentiometry, Kelvin Probe Force Gradient Microscopy, and unique applications of established techniques such as scanning capacitance microscopy for ferroelectric investigations, and use of distance-dependent electric force to distinguish topographic and electrical effects were introduced. Scattered amongst these talks were lectures on modification of metallic and semiconducting surfaces by thin organic films, the characterization of such surfaces and how they affect such properties as spin-selective transport of electrons, surface work function. More physically-related talks included theoretical issues of potential drop across a molecule bridging two electrodes, fundamentals of quantum computing, and 1D electron flow. The conference was closed with a talk on the use of base-specific recognition for using DNA as a template for molecular lithography.

Although no brief summary can do justice to the wealth of topics and interplay between chemists and physicists, experimentalists and theoreticians at the meeting, a few issues which arose during the general discussion sessions and in question and answer periods are worthy of mention:

1) Electron transport through molecules, ranging from DNA down to relatively short organic molecules, is not a 1-D problem. We need to also break away from thinking of these systems as molecular wires for electron flow. Charge transport in DNA, for instance, is by ions which places strict requirements on the chemical environment.

2) The influence of the molecule-electrode contact is poorly understood, and likely leads to many of the inconsistencies found in the literature. Further, gold is a very poor choice of electrode since it is not stable at room temperature. Since many such hybrid metal-organic systems rely on a thiol-linkage between molecule and electrode, other solutions should be sought.

3) Comparisons continue to be made between “chemical” nanostructures (e.g., colloidal quantum dots, self-assembled molecular films) to “physical” nanostructures, those grown by MBE. It seems that both have their place. Whereas physical dots enjoy certain advantages such as low barrier for dot-dot transport, no surface passivation required (that is, the ligand which itself has unique chemical and physical properties), the chemical dots enjoy easy and low cost preparation, possibility to vary the properties continuously by control of nanoparticles dimensions, and good flexibility in type and shape.

4) Great strides in chemical synthesis allow fine-tuning of surfaces as evidenced by large differences in transport and other properties seen between aliphatic and conjugated systems.

The closing dinner, held in a Bedouin tent in the Timna valley and ancient copper mines just north of Eilat, allowed us to marvel at nature and man’s continuing adaptation to it in order to further his technological needs – 3000 years ago as well as today.