IVS-IPSTA 2019

The 37th Annual Conference of the Israel Vacuum Society

September 3rd ● Sammy Ofer Stadium, Haifa

Book of Abstracts

IVS Israel Vacuum Society

AVS

TECHNION Israel Institute of Technology | Department of Materials Science and Engineering

ISI Science for Life

MEDIFISCHER Engineering & Science

ODEMOTIX

AVBA Matching your needs precisely

Mark Technologies

intel

Impedans Plasma Measurement

TRIGON www.trigonmicro.com

VIS Vacuum and Instrument Services

Dashro Trade | דשרו סחר Wafer ★ Materials ★ FAB Process ★ Analytics ★ Metrology

BUSCH

el-tan technologies Vacuum / Gas

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GTEP Grand Technion Energy Program | Securing Israel today. Transforming Israel's tomorrow.

האוניברסיטה הפתוחה The Open University of Israel الجامعة المفتوحة

BINA Bar-Ilan Institute of Nanotechnology & Advanced Materials

IKI Ilse Katz Institute for Nanoscale Science and Technology Ben-Gurion University of the Negev

Bar-Ilan University Department of Chemistry

ARIEL UNIVERSITY

OK Dr Ofra Kalisky Award

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Plasma Science session,
Chair :Zohar Henis

Michael Mond (BGU) - Quasi Incompressible Growth of Magnetic Fields in Supersonic Turbulence

The growth of small fluctuations of magnetic field in supersonic turbulence, namely small- scale dynamo is studied. The growth is due to the fastest turbulent eddies above the resistive scale. It is observed that for supersonic turbulence these eddies are effectively incompressible which creates a robust structure of the growth. The eddies are localised below the sonic scale defined as the scale where the typical velocity of the turbulent eddies equals the speed of sound. Thus the flow below

Ion velocities measurements in Z-pinch with pre-embedded axial magnetic field

Marko Cvejić[1], Dimitry Mikitchuk[1], Eyal Kroupp[1], Ramy Doron[1], Yitzhak Maron[1], Uri Shumlak[2]

[1]*Weizmann Institute of Science, Rehovot, Israel*

[2]*University of Washington, Seattle, Seattle, United States*

We present new experimental results of plasma rotation phenomena in Z-pinch with pre-embedded axial magnetic field. These results are relevant to basic physics of magnetized plasma compression and the effect of the electrodes on the plasma dynamics.

The experimental configuration is a gas-puff Z-pinch with pre-embedded, quasi-static axial magnetic field (B_{z0}) that implodes under the J×B force resulting from a 1-μs long, 300-kA axial current pulse. In contrast to the classical Z-pinch implosion (without B_{z0}), where the electrode effect on the plasma dynamics is usually negligible, in this configuration the electrodes may have significant effects due to the Bz-field line-tying to the metal.

High-resolution imaging spectroscopy is used for the simultaneous determination of the electron density and temperature, azimuthal and axial magnetic fields, and ion velocities during the implosion and at stagnation. The measurements show significant slow-down of the plasma implosion near the electrodes that results in a formation of bell-shaped plasma surface with the largest radius near the electrode. Measurements of B_z distribution along the z-axis show increase of B_z magnitude from the anode (z=0) to the middle of the plasma (z=5 mm) that is consistent with the B_z-field line-tying to the electrodes and the plasma radius dependence on z. These results demonstrate the existence of a transition region near the electrode where the uncompressed B_z-field lines inside the electrode converge towards the axis further from the electrode surface. Another important observation reveals the existence of a sheared plasma rotation at the outer radius of the plasma shell at times close to the stagnation. Moreover, it is found that the rotation velocity is nearly uniform along the plasma column. We believe that the rotation is connected to the transition region near the electrodes that result in a formation of a radial magnetic field component.

These new observations may shed light on stabilization mechanisms in plasma implosion in the presence of pre-embedded axial magnetic field, since both phenomena, B-field line tension near the electrode and the sheared rotation mitigate the development of the instabilities. In addition, the new measurements provide information on the energy conversion mechanism at stagnation.

This work was supported by the Israel Scientific Foundation.

Generation of Space Charge Self-Oscillations in a diode by Over-Injection

Meytal Siman Tov, John G. Leopold and Yakov E. Krasik

Physics Department, Technion, Israel Institute of Technology, Haifa 32000, Israel

A practical method to inject current higher than the space-charge limiting current into a vacuum diode was proposed [1]. The current is produced in an arrangement of three electrodes (a triode) consisting of an accelerating voltage gap followed by a decelerating gap. The cathode emits a current lower than the space charge limit of the accelerating gap so that when the beam is not fully decelerated in the decelerating gap, it does not oscillate as it would in a reflex triode. This triode generated beam is then injected into a further gap which we consider to be an injected diode. When the injected current exceeds the space charge limited current of this gap a virtual cathode forms and the current self-oscillates by initiating triode oscillations. Electron bunches are formed at a frequency determined by the distance travelled in the triode.

We have set up an experiment based on a dispenser cathode heated to a temperature of ~1200^{0}C, three high temperatures resistant, 94% transparent Molybdenum grids placed at a distance of 1 cm between each two and a 50 Ω Faraday cup to measure the output current. The experimental chamber is kept at a vacuum of ~3×10^{-7} Torr by scroll and turbo-molecular pumps. Three N35 Neodymium magnet rings which generate a uniform axial magnetic field of 0.054T, are located inside the chamber, enclose the entire path of the electron beam. The emitted current is 1 A and the accelerating voltage in the first gap is 10 kV, that is, the emitter is operated in the current limited mode. In the second gap, the voltage is varied to examine the effect of the initial energy of the electrons injected into the third gap. In the third gap a low accelerating voltage is applied. Its value was increased until we stop seeing current oscillations below the space charge limit of this diode. The frequency of the collected current was different from the frequency obtained in PIC simulations. The reason for this discrepancy is due to non-uniform emission of the dispenser cathode [2].

We have recently acquired a new type of dispenser cathode which emits a uniform beam and we obtain results closer to those predicted.

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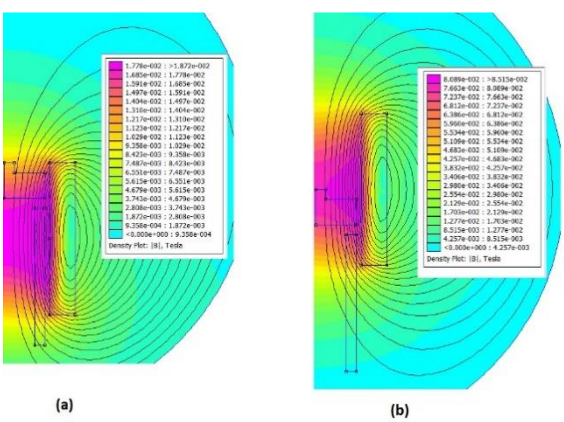
Effects of magnetic field on the performance of the Inline Screw Feeding Vacuum Arc Thruster (ISF-VAT)

Satyajit Chowdhury*, Matteo Laterza, and Igal Kronhaus
Aerospace Plasma laboratory, Faculty of Aerospace Engineering, Technion-Israel Institute of Technology, Haifa 3200003, Israel
**satyajit@campus.technion.ac.il*

The Inline Screw Feeding Vacuum Arc Thruster (ISF-VAT) [1,2] is the first vacuum arc thruster to be operated with an active feeding system. Previous studies has shown that the ISF-VAT is capable of a highly regular long-duration operation at low input power (< 5W), which is critical to its application as a miniature thruster [3]. The measured average thrust is T~*6μN* and Thrust-to-power ratio T/P~*1.33μN/W*, including the power processing unit (PPU) efficiency. In this work the effect of external magnetic field on thruster performance is investigated. For this, we have combined measurements of input power using a Hall current monitor and direct thrust measurements using a micro-Newton Thrust-balance. By operating an electromagnet with a separate power supply, several magnetic field topologies were studied by changing the coil current and its axial position relative to the thruster anode (Fig.1). The magnetic field is shown to focus the plasma plume providing a substantial increase in thrust *T ~ 14μN* and T/P ~ *1.8μN/W*.



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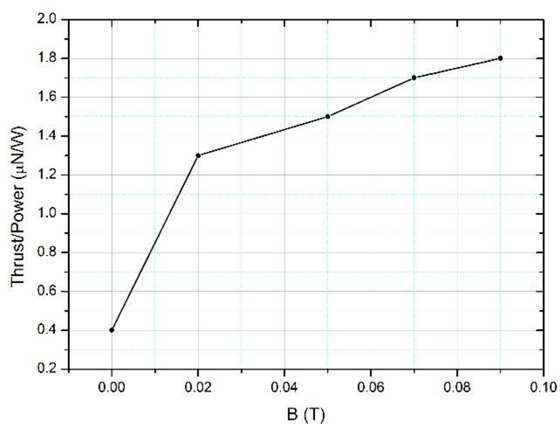

Fig. ni dleif citengam revo noitairav P/T retsurhT :2 noitarugifnoc dekcolb

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Plasma reforming of n-heptane for ignition control of a homogeneous charge compression ignition engine

Galia Faingold1, Joseph K. Lefkowitz2
1PhD student, Faculty of Aerospace Engineering, Technion I.I.T, Israel.
2Associate Professor, Faculty of Aerospace Engineering, Technion I.I.T, Israel.

Combustion processes can be greatly improved using reactive species created in non-equilibrium plasma for the initiation of fuel oxidation and pyrolysis. One such process is volumetric ignition, inherent to homogeneous charge compression ignition (HCCI) engines. The HCCI engine has high efficiency and low emissions of both nitrous oxide (NO) and carbon monoxide (CO), and does not produce soot particles. However, HCCI technology is currently limited by control difficulties and has a narrow operating range when compared to the traditional compression ignition or spark ignition engines.

The present study seeks to control ignition timing by reforming a fuel-air mixture in a plasma discharge. A small charge of n-heptane/air mixture is subjected to a plasma discharge and then mixed with a main charge in order to modify ignition characteristics. The effects of the reformed charge on ignition timing are investigated using zero-dimensional time dependent models. Plasma reaction calculations employ an open-source zero-dimensional discharge solver ZDPlaskin1, incorporating BOLSIG+ to obtain electron transport coefficient and for pre-processing the plasma chemistry mechanism, including rates of electron collision reactions. Ignition delay of fuel-air mixture with species created in the discharge is calculated using Cantera2.

The electron collision rates of n-heptane are unknown, and so the mechanism is constructed using cross sections and reaction branching ratios adapted based on trends from smaller hydrocarbons (i.e. ethane).

Figure 1 shows the effect of the reforming products on ignition timing at 1 atmosphere pressure. 10% or 20% of partially reformed gas, of which about 1% is reformed oxygen and n-heptane, is mixed with main intake charge. Adding a small amount of reformed fuel, ignition delay was shortened by more than a factor of 2, especially at low temperatures of 600 to 800K. These relatively low temperatures are typical during the compression stroke in an HCCI engine. The effect of plasma-reformed species on ignition at elevated pressures will also be investigated.

The results show the potential of plasma reforming as a method to control ignition timing in advanced engine technologies. In addition, reforming can be used to generate H2 for fuel cells, or to lower the energy (and cost) required for production of petroleum-derived chemicals.

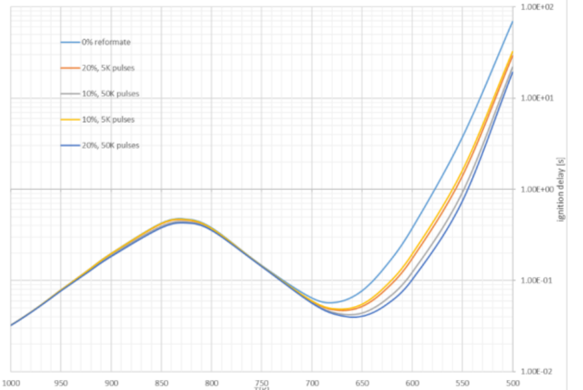

Figure 1Ignition delay for different temperatures at (1)xref=0.1and xref=0.2; (2) 5,000 and 50,000 pulses

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Laboratory Astrophysics - Cold Absorption

Itay Gissis, Ehud Behar, Amnon Fisher

Technion Inst. Of Technology, Israel

Abstract

The ability to create plasma sources similar in nature to astrophysical sources, but scaled to the laboratory, is extremely challenging. Specifically, photo-ionized plasmas that are common around black-hole accretion sources, nebulae and the cold interstellar medium, require powerful radiation sources that are not usually accessible in the laboratory. This leaves the photo-ionized plasma models and codes used by astrophysicists with severe uncertainties.

In the following study, we use a high-energy current generator combined with a gas-puff z-pinch load, to create a controlled X-ray source. The source is used to photo-excite and photo-ionize cold gas of astrophysical abundant elements such as oxygen and nitrogen in vacuum. We developed a spectroscopic apparatus dedicated to measure absorption spectra from which we calibrate atomic and molecular electronic transitions, coefficients, wavelengths, oscillator-strengths and cross-sections of the cold absorber. These measurements can be used to mitigate the lack of accurate atomic data in these elements, which is specifically important to better analyze many astrophysical spectra.

The experimental plasma source, the diagnostic system, and preliminary results of the X-ray source characterization will be presented.

Magnetized plasma compression: what can we learn from measurements of the compressed magnetic field?

R. Doron[1], D. Mikitchuk[1], M. Cvejic[1], E. Kroupp[1], C. Stollberg[1], Y. Maron[1], A.L. Velikovich[2], J. L. Giuliani[2]

[1]*Faculty of Physics, Weizmann Institute of Science, Rehovot 76100, Israel*

[2]*Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375, USA*

The physics of magnetized plasma implosion is studied using a gas-puff Z-pinch with quasi-static, pre-embedded axial magnetic field (B_z). Recent measurements showed that the pre-embedded axial magnetic field has an unexpected dramatic effect on the current distribution flowing in the plasma column. It was demonstrated that in the presence of even a relatively weak pre-embedded B_z, a large fraction of the current does not flow through the imploding plasma, rather, it flows at large radii through a low-density plasma that is practically not imploding. Here, we focus on the challenging measurement of the compressed B_z. In the experiment, a pulsed-power current (300 kA, rise time 1.6 µs) implodes a plasma column in an initial B_z of up to 0.5 T. Polarization spectroscopy in the visible-UV, combined with laser-ablation doping technique, are employed to determine the magnetic fields and plasma parameters. Knowledge of the evolution of the compressed B_z provides rich information. It gives the confinement efficiency of the magnetic field by the plasma, the plasma resistivity, and enables studying the pressure balance in the system. The axial distribution of B_z also reveals the effect of the conducting electrodes on the implosion, and the origin of fields in the radial direction that may explain plasma rotation, recently observed. Future measurements of B_z with improved sensitivity may shed light on the mechanism that prevents a significant portion of the current from taking part in the plasma compression in the presence of B_z.

Microscopy and Spectroscopy of Surfaces and Interfaces - session Chair: Yaron Kauffmann

Guido Schmitz (University of Stuttgart) - Atom probe tomography: Analysis of soft matter, liquids and interfaces at the top of the tip

Guido Schmitz and Patrick Stender

Atom probe tomography: Analysis of soft matter, liquids and interfaces at the top of the tip

Atom probe tomography is an exciting tool in the analysis of nano-structured materials, interfaces and surfaces. The method stands out by joining single-atom sensitivity with a volume reconstruction, that delivers three-dimensional maps of the atomic arrangement. Due to this direct 3D information, the method is especially suitable for the investigation of complex microstructures that comprise curved or rough interfaces. By extension with laser-assisted evaporation modes, the analysis of semiconductors and ceramics has become a substantial task. Nowadays, the method is about to break the barrier towards soft matter and liquids.

The talk provides an overview of the experimental technique. Modern concepts for improving the data processing and the tomographic volume reconstruction are described. Atom probe tomography is well established in the analysis of solid-state materials. The analysis performance is demonstrated with recent examples of nano-crystalline thin films and silicide formation.

Atom probe analysis of soft matter is still a widely unexplored landscape. Well-controlled field-desorption of macromolecular materials has been confirmed by studies of self-assembling monolayers and polyelectrolyte coatings. An accurate volume reconstruction, however, would become possible only after having derived a detailed understanding of the complex evaporation sequences. For the analysis of liquids, the method is combined with cryo-preparation. For this purpose, at the University of Stuttgart, a dedicated atom probe has been attached to a cryo dual beam scanning microscope. The unique instrument has the potential of analysing liquid/liquid and solid/liquid interfaces. Exemplary analyses of sugar solution demonstrate the cutting-edge possibilities of the innovative instrument.

Institute of Materials Science, Chair of Materials Physics
University of Stuttgart, Germany
Heisenbergstr. 3, 70569 Stuttgart
guido.schmitz@imw.uni-stuttgart.de

Ora Bitton (Weizmann) - Vacuum Rabi splitting in a plasmonic cavity at the single quantum emitter limit

Vacuum Rabi splitting in a plasmonic cavity at the single quantum emitter limit

Ora Bitton
Department of Chemical Research Support
Weizmann Institute of Science, Rehovot, Israel

The strong interaction of individual quantum emitters with resonant cavities is of fundamental interest for understanding light–matter interactions. Plasmonic cavities hold the promise of attaining the strong coupling regime even under ambient conditions and within subdiffraction volumes. In this study, we show that one can observe strong coupling in the limit of a single quantum emitter positioned within a plasmonic cavity[1]. We use a unique technique to fabricate silver bowtie plasmonic cavities and couple them to semiconductor quantum dots (QDs). Advanced-microscopy techniques enable us to characterize the samples at a very high spatial and spectral resolution. Scattering spectra, measured by dark-field spectroscopy, registered from individual plasmonic cavities containing one to a few QDs show vacuum Rabi splitting, indicating that the strong coupling regime is approached in these systems. Rabi splitting is also observed in photoluminescence (PL) and electron energy loss spectroscopy spectra, clearly indicating that the transparency dips in the scattering spectra are due to a genuine coupling of the plasmon and QD excitations. Second-order correlation functions of the PL from individual devices manifest non-classical emission through the photon antibunching effect. Interestingly, we find discrepancies between the scattering and PL spectra. A theoretical analysis based on an extended Jaynes-Cummings model attributes these differences to the involvement of dark excited states of the QDs in the dynamics.

Fig 1. Scanning transmission microscope image of a bowtie coupled with QDs.

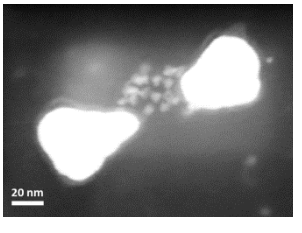
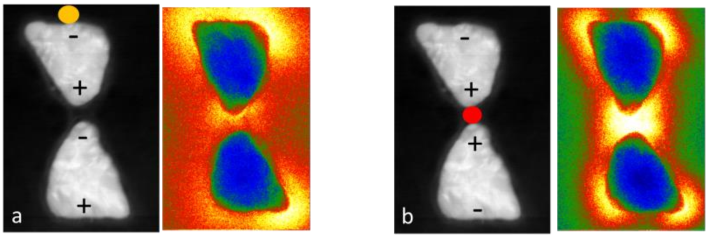


Fig 2. TEM images and EELS maps of: **a)** bright plasmonic mode, **b)** dark plasmonic mode of a silver bowtie.



1. Nature Communications **volume 7**, ncomms11823 (2016)

Microtube Fabrication by the Sacrificial Salt Whisker Technique

E. Almog[1], A. Sharma[1], N. Gazit[1] and E.Rabkin[1]

[1]Department of Materials Science and Engineering, Technion – Israel Institute of Technology, 3200003 Haifa, Israel

We developed a novel technique to fabricate metallic micro-tubes with high aspect ratio and sub-micrometer wall thickness. The micro-tubes are formed by depositing thin metal films on KCl whiskers, followed by the dissolution of the whiskers. The KCl whiskers are high aspect ratio, <100>-oriented single crystals with perfect rectangular cross-section. The obtained hierarchical architecture exhibits the overall dimensions in the micrometer range, but draws its strength and stability from the nanometer-size features, such as the wall thickness and grain size. To investigate the thermal stability of the micro-tubes, they were annealed at different temperatures and for different annealing times. The obtained tube morphology and microstructure are the result of an interplay between the grain growth, curvature-driven surface self-diffusion, and defects annihilation.

Nina Armon (Bar Ilan) - Simultaneous synthesis and micro patterning of a metal organic framework by the laser induced microbubble technique

Simultaneous synthesis and micro patterning of a metal organic framework by the laser induced microbubble technique

Nina Armon,[1,2] Ehud Greenberg,[1,2] Avi Keninsberg,[1,2] Eitan Edri,[1,2] Silvia Piperno,[1,2] Omree Kapon,[1,2] Ohad Fleker,[1] Gili Cohen-Taguri,[2] Idan Hod[3] and Hagay Shpaisman[1,2]

[1] Department of Chemistry, Bar-Ilan University, Ramat Gan 5290002, Israel

[2] Institute for Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat Gan, 5290002, Israel

[3] Department of Chemistry and Ilse Katz Institute for Nanoscale Science and Technology, Ben-Gurion University of the Negev, Beer-Sheva 8410501, Israel

Metal organic frameworks (MOFs) are compounds comprising of metal ions coordinated to organic ligands that have attracted substantial attention during the last two decades due to their controlled porosity, high surface area and electrochemical properties. Patterning of MOFs is required for many applications in the fields of sensing, microelectronics, and controlled drug release. Here, we present micro-patterning of MIL-100(Fe) from a solution of precursors achieved by local laser heating. Nano-MOFs are formed followed by their rapid assembly due to convective flows around a heat induced micro-bubble.[1] This laser induced bottom-up technique is the first to suggest simultaneous synthesis and micro-patterning of MOFs, thus pre-preparation and stabilization of MOFs is not required.

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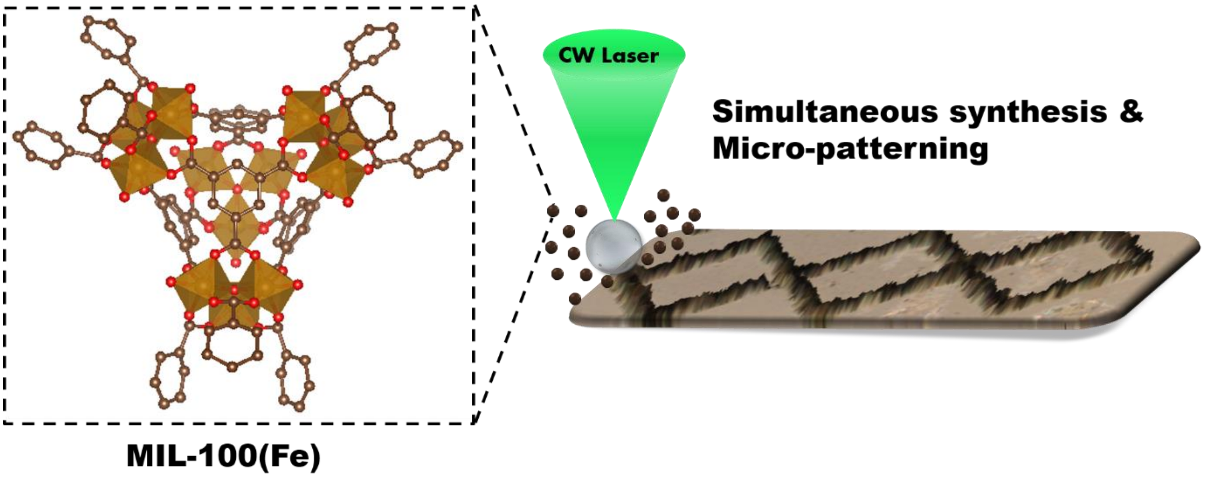

Figure 1: Illustration of the simultaneous synthesis and micro-patterning of MIL-100(Fe) by a laser induced microbubble technique.

2D-MATERIAL BASED FOAMS FOR SPACE APPLICATIONS

Asaf Bolker,[1] Ranjan Shivakumar,[2] Nurit Atar,[1] Siu Hon Tsang,[2] Cecile Uzan-Saguy,[3] Ronen Verker,[1] Irina Gouzman,[1] Eitan Grossman,[1] Timothy Minton,[4] and Edwin Hang Tong Teo[2]

[1] Soreq NRC, Space Environment Department, Yavne 8100, Israel,
[2] Nanyang Technological University, School of Electrical and Electronic Engineering, 639798, Singapore
[3] Technion IIT, Solid State Institute, Haifa 3200, Israel
[4]) Montana State University, Department of Chemistry and Biochemistry, Bozeman, MT 59717, USA

Synthesized three-dimensional (3D) foam-like materials are a way of building up normally 2D flat materials into 3D space, the so called “3D interconnected 2D material networks”. These 3D porous materials retain many of the unique properties of their 2D precursors, creating a low density, flexible, and ultralight version of their “bulk” form. These highly porous and interconnected materials can serve as effective fillers for creating improved composite materials in combination with a variety of polymer matrices.

In this talk we demonstrate the use of these unique materials in two of space related applications, and also address their interaction with the space environment. Examples include: 3D Graphene (3D-C)/polyimide (PI) composite for electrostatic discharge protection, and 3D-Boron nitride/Graphene (3D-BNC) incorporated into shape memory polymers (SMP) in order to enhance their thermal properties and control their electrical conductivity.

In the first example, 3D-C is incorporated into PIs. PIs are extensively used for space applications, since they can withstand high temperature and exhibit high UV stability and toughness. However, their poor thermal conductivity and electrically insulating characteristics are the cause of limitations such as electrostatic charging. In order to target these issues, a hybrid of PI with 3D-C, 3D-C/PI, was developed.

In the second example 3D-BNC is combined with epoxy to serve as a composite SMP. SMP is a polymer that can alter its shape from a deformed temporary shape back to its original permanent shape induced by an external stimulus such as heating. Similar to other polymers, SMPs are poor conductors for heat. In order to overcome this limitation, an SMP infused with 3D-C, 3D-BN and 3D-BNC was developed.

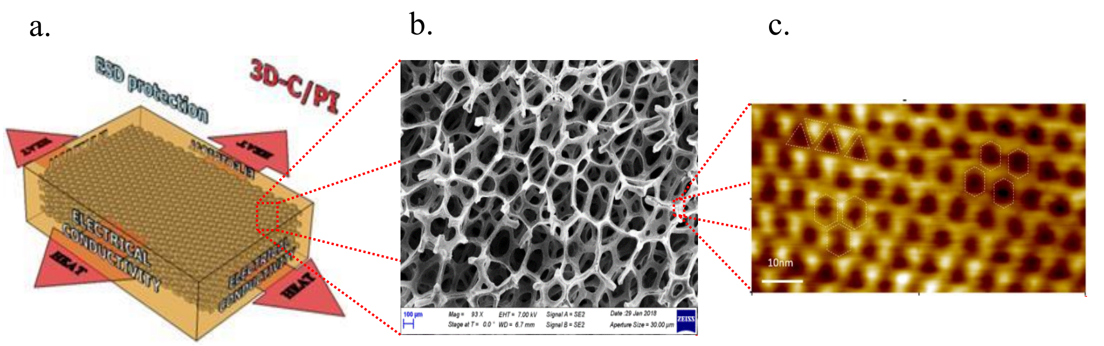

Figure 1: (a) Schematic representation of the 3D-C/PI composite material. (b) SEM image of the 3D-C material. (c) Atomic resolution STM image of the 3D-C.

Controlling the handedness of chiral nanocrystals by chiral molecules

Gil Markovich
School of Chemistry, Tel Aviv University, Tel Aviv 6997801

In recent years we have been studying the handedness controlled synthesis of inorganic nanocrystals made of materials which crystallize in chiral space-groups. In the talk I will discuss the demonstration of strong chiral amplification in the colloidal synthesis of intrinsically chiral lanthanide phosphate nanocrystals, quantitatively measured via the circularly polarized luminescence of the lanthanide ions within the nanocrystals. Together with the group of Ori Cheshnovsky, we were able to measure single particle handedness though circularly polarized emission microscopy. We obtained 100% enantiomeric purity of the nanocrystals by using chiral tartaric acid molecules in the synthesis which act as an external “chiral field”, sensitively directing the amplified nanocrystal handedness through a discontinuous transition between left- and right-handed excess. The amplification involves also spontaneous symmetry breaking into either left- or right-handed nanocrystals below a critical temperature, in the absence of the tartaric acid molecules. These characteristics suggest a conceptual framework for chiral amplification, based on the statistical thermodynamics of critical phenomena, which we use (with Haim Diamant) to qualitatively account for the observations.

Nanomechanics of Materials – session Chair: Eugen Rabkin

Dan Mordehai (Technion)- Probabilistic strength of metallic objects at the nanoscale

The Structure and Mechanical Properties of the Scorpions' Pincers

Israel Kellersztein[a], Israel Greenfeld[a], Sidney R. Cohen[b], Benny Bar-On[c], H. Daniel Wagner[a]

[a]Department of Materials and Interfaces, Weizmann Institute of Science, Rehovot 76100, Israel.
[b]Department of Chemical Research Support, Weizmann Institute of Science, Rehovot 76100, Israel.
[c]Department of Mechanical Engineering, Ben-Gurion University of the Negev, Israel.

Since scorpions exist almost all over the world, some expected body differences exist among the species: undoubtedly, the most evident is the shape and size of their pincers or chelae. The scorpion chela is a multifunctional body component (e.g. attack/defense, mating and protection from the environment) that leads to the development of different stresses in the cuticle. How such stresses in the cuticle are accommodated by different chelae shape and size is largely unknown. In this talk, we provide new comparative data on the hierarchical structure and mechanical properties of the chela cuticle in two scorpion species: Scorpio Maurus Palmatus (SP) that has a large chela and Buthus Occitanus Israelis (BO), with a slender chela. Nanoindentation measurements were performed under dry conditions on transversal and longitudinal planes to evaluate the stiffness and hardness of the different chela cuticle layers in both scorpions. In addition, we offer a geometric model, where the mechanical stiffness is calculated using classical laminate theory adapted to the helicoidal (Bouligand) structure present in the scorpion chela cuticle. The chela cuticle structure is a key factor towards the decision of the scorpion whether to choose to sting or use the chela for other mechanical functions.

The Surface and Stress Behavior of Manganese-Oxide Electro-Catalyst during Oxygen Reduction Reaction

Or Keisar[a,b], Yair Ein-Eli[a.c], Yair Cohen[d]

a) The Nancy and Stephen Grand Technion Energy Program, Technion
b) Israel Atomic Energy Comission, IAEC
c) Department of Material Science and Engineering, Technion
d) Department of Chemistry, Nuclear Research Center- Negev

P.O.B. 9001, Beer-Sheva, 84190, Israel
Yair Cohen- yairc@nrcn.org.il

The electro-catalysts for oxygen reduction reaction (ORR) on air-cathode have a decisive impact on metal-air batteries and fuel cells. Much effort has been invested in finding a cost effective electro-catalyst, enabling a decrease in the ORR over-potential and enhancing the power source device discharge performance.[1-2]
Manganese-oxides (MnOx) are particularly interesting as non-precious ORR electro-catalysts candidates due to their rich oxidation states, chemical compositions and their variety of crystal structures[1-3]. In order to broaden our understanding on the catalytic mechanism of Manganese-Oxide and its surface chemistry during ORR, we performed unique *in-situ* electrochemical surface stress (ESS) measurements[4].
The *in-situ* ESS response was measured on an Au/MnOx electrode in both Ar and O2 saturated electrolytes. A complex stress response was measured during the electrochemical scan caused by various crystal structure transitions[5]. The presence of oxygen resulted in a less compressive stress response during the ORR; suggesting that part of the activated sites on the surface are reduced and re-oxidized ($Mn^{4+} \leftrightarrow Mn^{3+}$) during the ORR. These observations evidently support the proposed ORR catalytic mechanism[3,5]. The amount of catalytically active sites on the surface can be estimated based on these results.
In addition, an overall tensile trend was recorded during multiple cycling, pouring some light on the poor mechanical stability of the MnOx film. This insight has major implications on the applicability of MnOx as a catalyst on practical carbon-based electrodes.

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Elastic Carbon Dot/Polymer Films for Fluorescent Tensile Sensing and Mechano-Optical Tuning

*Nitzan Shauloff, Sagarika Bhattacharya and Raz Jelinek**

Development of simple, readily-applicable sensors for mechanical deformation of polymers is highly sought albeit a formidable task. Here we demonstrate that composite films comprising carbon dots (C-dots) embedded in an elastic polymer host allow fluorescence-based quantitative determination of tensile modulation. Film stretching induced both blue shift in the C-dots' fluorescence peak positions and dramatic increase in fluorescence intensities. The phenomenon was demonstrated for different C-dots exhibiting distinct fluorescence emissions (e.g. colors). Importantly, the C-dot/polymer fluorescence intensity could be quantitatively correlated to tensile parameters, specifically film stress and strain. The direct correlation is ascribed to stretch-induced modulation of the average distances among the polymer-embedded C-dots and concomitant modification of aggregation-induced self-quenching. We further exploited the tensile-dependent fluorescence modulation of the C-dot/polymer system to construct a tunable-intensity white light emitter, opening the way to innovative mechanically-tuned optical device.

Design and operation of a room temperature electro-chemo-mechanical actuator

Evgeniy Makagon[1]*, E. Mishuk[1], E. Wachtel[1], S. R. Cohen[2], I. Lubomirsky[1]
[1]Weizmann Institute of Science, Department of Materials and Interfaces, Rehovot, Israel
[2]Weizmann Institute of Science, Department of Chemical Research Support, Rehovot, Israel
*e-mail: evgeniy.makagon@weizmann.ac.il

The chemo-mechanical effect in a solid refers to a dimensional change due to change in stoichiometry [1]. Dimensional change caused by a compositional change, which in turn is induced by an electric field has been termed the electro-chemo-mechanical (ECM) effect. Such instability is clearly deleterious for batteries or fuel cells, but, as recently suggested, has potential for use in actuation [2]. The structure of a typical actuator device that operates on the ECM principle is a micrometer thick solid electrolyte (SE) sandwiched between two ECM-active layers. An electrochemical reaction must occur in these layers, causing them to expand or contract. In order to facilitate the ECM response, these layers must display mixed ionic and electronic conductivity (MIEC) and a large chemical expansion coefficient.

ECM actuation has two main advantages: (i) large strain can be simultaneously delivered with large stress, which is difficult to achieve with any other actuation mechanism. (ii) The displacement generated by an ECM actuator is defined by the amount of charge transferred, which is easier to control than electric field-driven devices.

To demonstrate the concept, we have constructed a 2mm diameter, self-supported, thin film ECM room temperature actuator, with Gd-doped ceria (GDC) as the SE. We have tested several alternatives for the ECM-active layers: (a) Single phase Ti metal/Ti oxide [3]; (b) GDC/Ti composite; and (c) an all oxide GDC/TiO_2 composite. Electrical and electromechanical measurements demonstrated that the metal/metal oxide actuator response is limited by the rate of oxygen diffusion from the SE to the metal surface. Actuators with composite active layers (b or c) provide shorter response time and larger vertical displacement (>1.5μm). Our findings suggest that ECM may represent a viable actuation mechanism, in particular for microelectromechanical systems.

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EXTREME SCALE-DEPENDENT TENSILE PROPERTIES OF AN EPOXY RESIN

X. Sui[1], M. Tiwari[1,2], I. Greenfeld[1], R. L. Khalfin[3], H. Meeuw[4], B. Fiedler[4], H. D. Wagner[1]

[1] Weizmann Institute of Science, Rehovot 7610001, Israel
[2] Indian Institute of Technology Ropar, Rupnagar 140001, India
[3] Technion, Israel Institute of Technology, Haifa 32000, Israel
[4] Hamburg University of Technology, Hamburg D-21073, Germany

Materials with reduced size and dimensionality such as thin fibers and films, nanotubes and nanowires, or metallic clusters often exhibit exceptionally high mechanical properties compared to those of corresponding macroscopic specimens. Epoxy is an archetypal brittle amorphous isotropic polymer, which means that when stressed under a tensile force, its deformation is linear and elastic up to failure. However, thin epoxy fibers prepared in our laboratory (with a diameter in the 20-150 µm range) exhibit a striking plastic (non-elastic) behavior. This plastic deformation is accompanied by necking, a sudden prominent decrease in local cross-sectional area, a phenomenon which is almost never-observed in highly cross-linked glassy polymers. Enormous increases in all mechanical properties (Young's modulus, strength, strain, toughness) are observed in the fibers and the necked fiber segments, compared with bulk epoxy specimens. This is especially true at the smallest fiber diameters. Size effects for the strength of epoxy can be elucidated in principle either by means of a classical fracture mechanics argument (strength ~ 1/d1/2), or via a stochastic model argument (strength ~ 1/d1/β, where β is a function of the material and is generally larger than 2). In both models the presence and size of critical defects plays a key role. However, defects cannot explain the colossal ductility (plastic deformation) seen in our experiments, nor can the presence of defects justify a size effect in an elastic property, namely Young's modulus. Scarce evidence exists in the literature for similar (milder) size effects in epoxy fibers but without any structural justification. We find here that highly cross-linked necked epoxy fibers exhibit macromolecular anisotropy which likely explains the observed high mechanical characteristics. Could the ductility, necking behavior, and size effect in highly cross-linked epoxy fibers be attributed to macromolecular re-alignment? This is a highly counterintuitive conjecture because unlike semi-crystalline polymers, or even lightly cross-linked polymers, epoxy is an amorphous polymer which forms 3D rigid interconnects when cured, thus a macromolecular network with very little propensity to flow. Despite this apparent conceptual obstacle, first evidence of molecular (re)orientation in an epoxy fiber was obtained by Wide Angle X-ray Scattering (WAXS). If molecular (re)orientation is indeed confirmed, an explanation/mechanism will have to be proposed for such unexpected observation. This might involve reordering of polymer segments, distortion of crosslinks, or other molecular-scale structural changes, which would favor mechanisms leading to high strength, stiffness and plasticity.

X. Sui, M. Tiwari, I. Greenfeld, H. Meeuw, B. Fiedler, H.D. Wagner, "Extreme scale-dependent tensile properties of an epoxy resin". *Express Polymer Letters*, In Press (2019).

Epitaxial Films: Science & Technology- session Chair: Lior Kornblum

Towards Room Temperature Operation of Terahertz Quantum Cascade Lasers: Carrier Leakage Engineering as a Novel Design Concept

Asaf Albo[1,*]

[1] *Faculty of Engineering and Institute of Nanotechnology, Bar-Ilan University, Ramat Gan 5290002, Israel.*

**Contact Email: asafalbo@gmail.com*

Abstract

The terahertz spectral region is subject to intensive research in view of its potential in a number of application domains such as medical diagnostics, trace molecule sensing, astronomical detection, non-invasive quality control and more. However, maximum operating temperature achieved with terahertz quantum cascade lasers (~200 K) imposes cryogenic techniques.

In general, the ideal operation mode of a terahertz quantum cascade laser assumes that an electron injected externally into the device will generate multiple photons – one in each "energy cascade"– while transporting through the heterostructure. However, alternative scattering leakage paths deviate electron transport from the ideal picture and present a considerable effect on devices' performance. In that context, temperature-driven leakage of charge carriers out of the laser's active region states is considered as an unwanted effect that limit its temperature performance. However, as we showed in our latest works, contrary to common sense expectations, carrier leakage under some conditions can be beneficial for the device and enhance lasing.

Our results highlight the importance of the carrier leakage out of the lower laser level to the laser's performance. This understanding clearly point out to a potential improvement direction in the design of highly temperature-insensitive terahertz quantum cascade lasers, namely to minimize thermally activated leakage from the upper laser level and maximize thermally activated leakage from the lower laser level. In other word, to address a carrier leakage engineering procedure as a new design concept for high performance terahertz quantum cascade lasers.

BIO

Asaf Albo received the B.Sc. degrees (Hons.) in physics and materials engineering from the Technion, in 2002, the M.Sc. degree from the Department of Materials Engineering, Technion, in 2005, and the Ph.D. degree from the Department of Electrical Engineering, Technion, in 2011. He was a Research and Development Senior Physicist in the semiconductor industry for four years (2010-2013). He was also a Research Fellow/Associate with the Research Laboratory of Electronics (RLE), Massachusetts Institute of Technology (MIT) for another four years (2013-2017). Dr. Albo has joined the Faculty of Engineering at Bar-Ilan University on June 2017, Israel.

Comparison of GaN on GaN and GaN on sapphire p-i-n diodes

Noam Sicron[1,2], Sergei Shusterman[1,2], Shoval Zoran[1], Ofer Sinai[2,3], Linoy Amar[1] and Adi Levy[1]

[1] Soreq Nuclear Research Center, Yavne, Israel

[2] Israel Center for Advanced Photonics, Yavne, Israel

[3] Ben-Gurion University of the Negev, Beer-Sheva, Israel

Gallium Nitride (GaN) p-n diodes have been studied intensively for more than 2 decades, since the breakthrough of Shuji Nakamura who developed an efficient method for GaN p-doping and thus was able to demonstrate blue light emitting diodes (LEDs). In the past, the lack of GaN substrates forced crystal growers to use hetero-epitaxy on foreign substrates such as sapphire, silicon carbide or silicon. The large lattice mismatch between the GaN layer and the substrate results with a high threading dislocations density (TDD), typically 10^{8}-$10^{10}cm^{-2}$, depending on the substrate material. Despite the very high defect density, devices made of GaN hetero-epitaxial grown layers are being used commercially for various applications such as LEDs or high mobility electron transistors (HEMTs). In more recent years GaN substrates are becoming more available, but even nowadays these wafers are expensive and high quality GaN wafers are difficult to obtain.

Vertical devices operated under reverse bias are expected to be especially sensitive to growth defects. In this work we compare the electrical performance of GaN diodes that were grown on two different substrates: bulk GaN with a nominal $TDD<10^{5}cm^{-2}$ and sapphire ($TDD \sim 5x10^{8}cm^{-2}$). The layers, with a p-i-n structure, were grown using MOCVD by a commercial vendor. Square mesas with different sizes were defined using standard lithography and etched by reactive ion etching. The diodes were characterized by current voltage (IV) measurements in a dark environment. At a reverse bias of several volts the dark current density in GaN/GaN diodes is a few times smaller than in GaN/sapphire diodes. As the negative bias increases beyond a few volts the leakage current in GaN/GaN diodes increases much slower than in GaN/sapphire diodes so that at -40 volt it is 2-3 orders of magnitude smaller. In this high voltage region the leakage currents are related to the voltage roughly by a power law. The significant reduction of leakage currents in GaN/GaN diodes suggests that threading dislocations in GaN layers play an important role in the formation of leakage currents. These results demonstrate the advantages of GaN/GaN homo-epitaxial layers for vertical devices.

Naor Vardi (Bar-Ilan) - Glass-like relaxation dynamics following the metal to insulator transition of VO2

Glass-like relaxation dynamics following the metal to insulator transition of VO_2

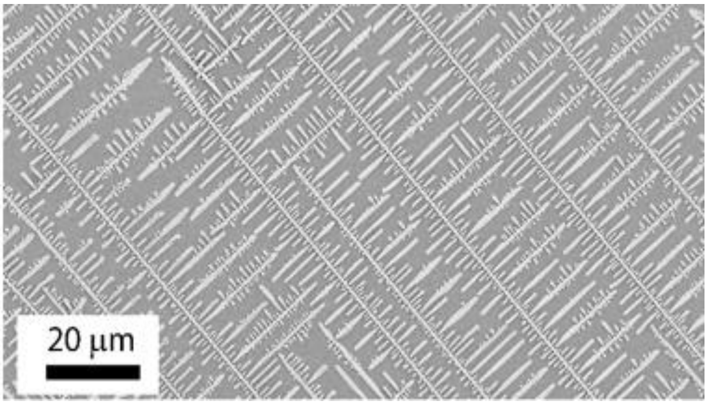
Naor Vardi
Bar Ilan University, Ramat-Gan, Israel

Glassy behavior has been observed in countless systems, puzzling researchers for over 150 years. We present another piece to this puzzle for the correlated oxide VO_2. VO_2 has a temperature driven metal-insulator transition with Tc ~342K. We find that after cooling a thin film from metallic phase to some temperature T_{dwell} in the insulating state, the resistivity slowly increases over time with stretched exponent relaxation behavior. We will discuss the properties of the glassy behavior, its relation to other correlated oxides and possible microscopic origins.

Orthogonal fractal growth of CsI domains forming a ladder-like structure

Omry Dinner, Gideon S. Grader and Yaron Paz
The Wolfson Department of Chemical Engineering, Technion, Haifa 3200003, Israel
E-mail address: paz@technion.ac.il

A unique structure of a thin layer consisting of cesium iodine, manifested by a "ladder-like" fractal structure formed by spin-coating is reported herein. The ladder-like structure is made of mm-size domains, each comprising of a highly correlated, perpendicularly interconnected, network of CsI lines. Each line served as the growth origin of 2-3 levels of short, perpendicularly-oriented CsI crystals, yielding a fractal dimension of 1.53. The observed structure differs from common Diffusion Limited Aggregation (DLA) shapes by the absence of any morphological indicators that may point on the origin of growth. Furthermore, the perfect orthogonal alignment of all junctions in the CsI structure is very rare in DLA type of growth. A formation mechanism is presented, based on studying the evolution of this structure at different spinning rates and on a variety of substrates. It is proposed that this unique structure originates from a rare combination of conditions: strong anisotropy in surface energy between different facets arising from the primitive ionic crystal of CsI, the strong water-breaking property of cesium ions and an unusual effect of mesoporous substrates in preventing premature nucleation.



Yossi Cohen (SCD)- Investigation of gallium-related defects in III/V epitaxial layers

Investigation of gallium-related defects in III/V epitaxial layers

Y. Cohen, O. Klin, I. Grimberg, N. Yaron and E Weiss.

SemiConductor Devices P.O. Box 2250, Haifa31021, Israel

III/V materials are among the most common materials for the production of IR detectors. Gallium and indium droplets in MBE grown material are long-time known to be a major cause for decrease in detector operability (percentage of good pixels). In this work we present the investigation of gallium-related defects formed in an InAs/GaSb strained layer superlattice (SLS) structure. The SLS structure allows us to understand, in details, the mechanism in which the defect is formed and evolves.

Based on TEM analysis shown in figure 1 and other results (AFM, SEM, cross-section EDS mapping), we conclude that after a gallium droplet reaches the epilayer, it etches and dissolves several hundreds of nanometers below its landing point. Gallium from the droplet migrates sideways on the surface (at different rates along the [01-1] and [011] directions) for few microns, increasing temporarily the growth rate of the epilayer around the droplet and changing its composition (figure 1c). The incoming fluxes together with the dissolved material enrich the Ga droplet with Sb, As and In. In our growth conditions, the Ga droplet top surface solidifies, forming a GaAs shell [1]. High threading dislocation density is formed in the InAs-GaSb SLS grown on such surface due to the large mismatch between the SLS and the GaAs shell. The InGaAsSb solution inside the droplet separates, at some point, to the thermodynamically stable InSb and GaAs phases. In some parts of the core we see pure gallium that probably solidifies only when the sample is cooled down.

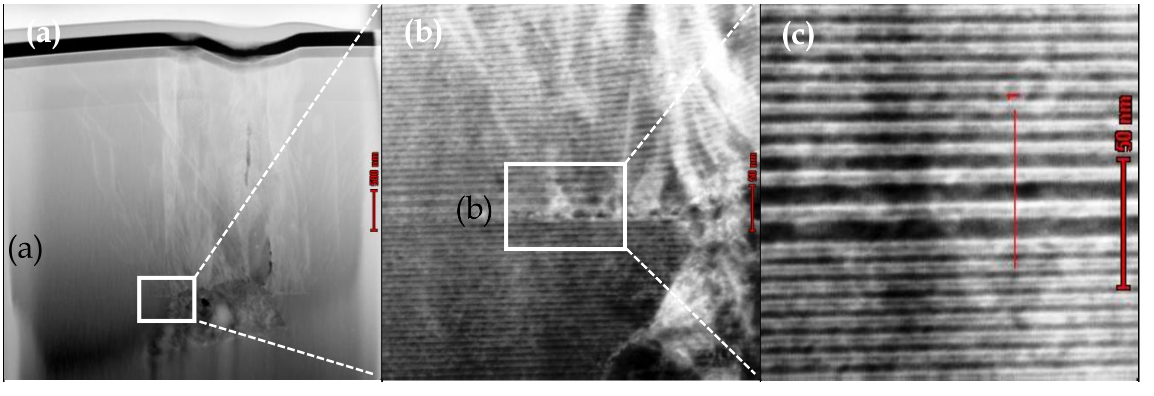


Figure 1. TEM cross section images of the Ga-related defect. (a) Cross section of the entire structure from the bottom of the defect to the epi-layer surface. (b) Higher magnification of the highlighted area in figure 1a showing the details of the growth disruption due to the defect. (c) Higher magnification of the highlighted area in figure 1b showing the abrupt change in the growth rate for several SLS loops.

[1] K. Reyes, Phys. Rev. B **87**, 165406 (2013).

+ Author for correspondence: yossic@scd.co.il

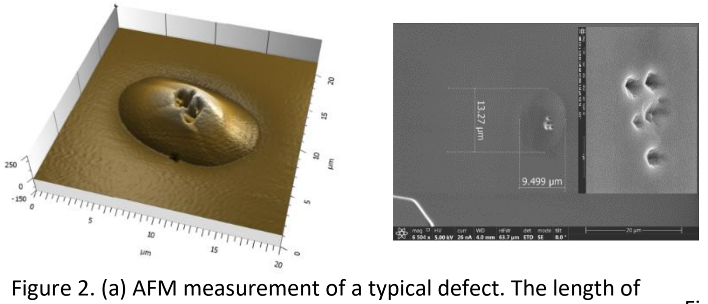


Figure 2. (a) AFM measurement of a typical defect. The length of the defect in the [0-1-1] direction is in the order of 10-15 µm while the length in the perpendicular direction [01-1] is always shorter (probably due to lower ad-atom mobility at this direction in this material) (b) SEM images of the defect shown in figure 1. The pits in the center of the defect are seen also in the TEM cross section.

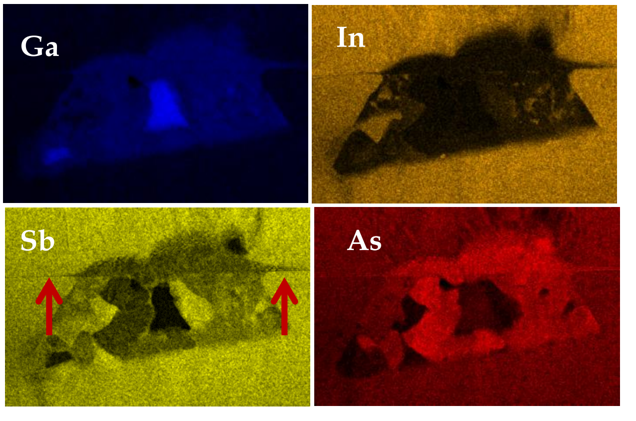


Figure 3. TEM EDS mapping images of the sample shown in figure 1. Note that in the center of the defect there is practically pure Ga and around it we can see mainly GaAs and some InSb although our structure is InAs/GaSb. The two red arrows indicate the growth front at the moment of the Ga droplet landings. The highlighted layer there is Ga rich due to gallium migration from the droplet.

GaN HEMT Epitaxy Structures and Device Architecture for RF High Power Amplifiers

Wide bandgap semiconductor is a promising technology for high power microwave devices. High electron mobility transistors (HEMT) on GaN based epitaxy are using for RF high power amplifier. The common material system is AlGaN/GaN which were demonstrated 30W/mm RF power, due to cooling difficulty and crystal quality in practice 3-8 W/mm are being used. The AlGaN/GaN structure mainly used for L-Ka band. In the last decade other GaN based epitaxy was under research and development mainly for higher frequency operation such as InAlN/GaN, InAlGaN/GaN, AlN/GaN, ScAlN/GaN etc. by using those material systems transistors operating in the W-band and higher were demonstrated. In this paper we will review the GaN based HEMTs epitaxy structures, performances and challenges.

Scanning Probe Microscopy – session
Chair: Ruti Kapon

Unraveling the mechanism of HIV genome release from the capsid using mechanical and morphological analysis

Itay Rousso

Dept. of Physiology and Cell Biology, Ben-Gurion University of the Negev

For successful infection, the human immunodeficiency virus type 1 (HIV-1) genome, which is in the form of a single-stranded RNA enclosed inside a capsid shell, must be reverse transcribed into double-stranded DNA and released from the capsid (in a process known as uncoating) before it can be integrated into the target cell genome. The mechanism that triggers uncoating is a pivotal question of long standing. By using atomic force microscopy, we analyzed the mechanical properties of isolated WT and hyperstable mutants of HIV capsids. In addition, we analyzed capsid morphology and mechanical properties during reverse transcription. We found that during reverse transcription the pressure inside the capsid increases until the internal stress exceeds the strength of the capsid structure and the capsid breaks open. The application of AFM technologies to study purified HIV-1 cores represents a new experimental platform for elucidating additional aspects of capsid structure, disassembly and HIV-1 uncoating.

Rakefet Ofek Almog (Azrieli College, TAU) - Metrology of Self-Assembled Monolayer Barrier for Cu Metallization

Coverage of Self-Assembled Monolayer Barrier for Cu Metallization

Rakefet Ofek Almog [a,b] , Kian Kadan[b], Tali Dotan, Yelena Sverdlov[b], Ronen Dagan[b] , Slomit Tsurel and Yosi Shacham-Diamand [b]

[a] Department of Advanced Materials Engineering, Azrieli College of Engineering, Jerusalem, Israel

[b] Department of Physical Electronics, School of Electrical Engineering, Faculty of Engineering, Tel- Aviv University, Ramat Aviv, 69978, Israel

Email: rakefetof@jce.ac.il

Abstract

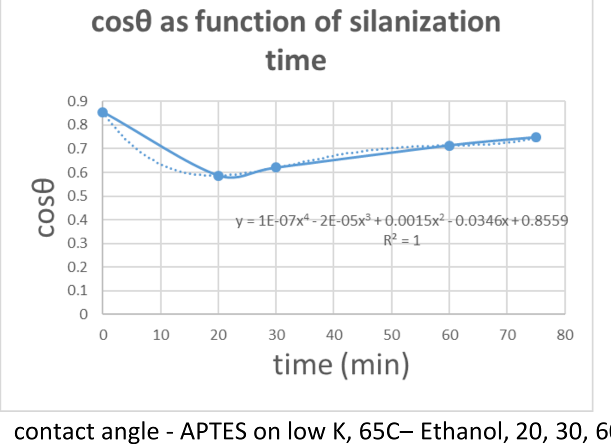
Silane based Self assembled monolayer (SAM) has been demonstrated as a diffusion barrier layer on lowK dielectrics for sub 10 nm Cu interconnects for Integrated Circuit (IC) applications.

The aim of this work is to develop surface analysis methods for characterizing those variables providing in line monitoring techniques that can predict barrier quality and reliability. The approach presented in this paper was to examine the defect density and coverage properties of the SAM on LowK dielectric using physical methods for the characterization of monolayer thick films.

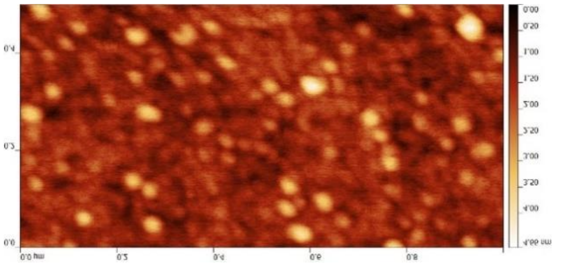
Kelvin Probe Scanning Force Microscopy (KPFM) and contact angle measurements are used in order to study the nucleation and growth of the SAM on low K dielectric, and also to examine the defect density and coverage properties of the SAM. We show that KPFM gives a good image of SAM on low K material. Contact angle measurements, on the other hand, give a good idea of the hydrophility of the surface, thus giving us a picture of the surface coverage. By combing those two methods, we can learn a lot about the homogeneity and coverage properties, and a thorough understanding of the self-assembly process can be achieved.

A study of the nucleation and growth of the SAM on low K, dependent on temperature and time was conducted.

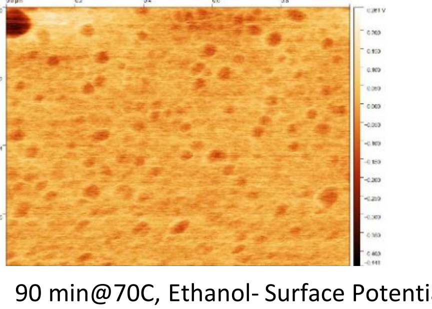
After mastering the use of the different methods for SAM surface analysis and characterizing, the results will be compared in order to find the most suitable method for SAM metrology and monitoring that can be employed by the Semiconductor industry.



contact angle - APTES on low K, 65C– Ethanol, 20, 30, 60 and 75 minutes



90 min@70C, Ethanol- Topography



90 min@70C, Ethanol- Surface Potential

Kelvin probe force microscopy - APTES on low K, 70C - Ethanol, long silanization times, Topography and CPD (contact potential difference)

STM Imaging of deposited graphene oxide on Au substrate

O. Livni[a], F. Horani[a], C. Saguy[a], Y. Kaufman[a], E. Lifshitz[a]*, D. Cheskis[b]*

a. Sold State Institute, Technion
b. Physics Department, Ariel University

Graphene oxide (GO) is used for the mass production of many graphene-type materials [1]. Moreover, large-scale GO membranes, owing to their unique properties, are used as filters, biomarkers and more [2]. For all these applications, the distribution of the functional groups over the film surface is required.

We demonstrate the clear picture with atomic resolution of single-layer graphene oxide films on Au/Mica substrate at room temperature. We measure the hexagonal lattice structure of unreduced graphene oxide using scanning tunneling microscopy and high-resolution transmission electron microscopy. We find that oxygen functional groups are concentrated in islands, while the rest of the material has the structure of pristine graphene.

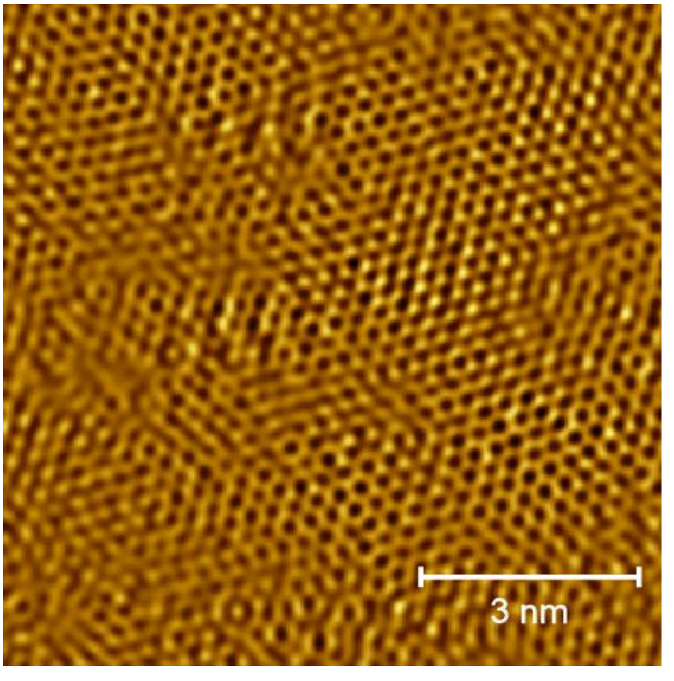


Figure 1 GO STM image with ideal hexagonal and distorted regions

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Irit Rosenhek-Goldian (WIS)- Photo-Induced Charge Transfer in Organic Nano-Crystalline Donor-Acceptor Heterojunctions Studied by Scanning Kelvin-Probe Microscopy

Photo-Induced Charge Transfer in Organic Nano-Crystalline Donor-Acceptor Heterojunctions Studied by Scanning Kelvin-Probe Microscopy

Qian Zhang[±], Sidney R. Cohen[‡], **Irit Rosenhek-Goldian**[‡], Daniel Amgar[‡], Omri Bar-Elli[‡], Yael Tsarfati[±], Tatyana Bendikov[‡], Linda J. W. Shimon[‡], Yishay Feldman[‡], Mark Iron[‡], Haim Weissman[±], Igal Levine[§], Dan Oron[‡], and Boris Rybtchinski[±]

[±]Departments of [±]Organic Chemistry, [‡]Chemical Research Support, [‡]Physics of Complex Systems, and [§]Materials and Interfaces, Weizmann Institute of Science, Rehovot 7610001, Israel.

In this study photo-induced charge transfer processes between electron donor and acceptor organic nanocrystals are investigated as a step towards developing robust and efficient organic nanocrystalline materials for photovoltaic applications. The Copper Phthalocyanine CuPc(donor)/ Perylenediimide PDI(acceptor) system was chosen due to its stability, robustness and favorable spectral characteristics. We studied and compared the charge generation, transport, and recombination in these donor–acceptor pairs using scanning Kelvin probe microscopy (SKPM). Three different PDI derivatives were tested in three different donor–acceptor heterojunction configurations. The charge distributions were measured in the dark, under red laser illumination to excite only the CuPc, or under LED illumination to excite both CuPc and PDI. The microscopic results, supported by theoretical calculations and spectroscopic and time-resolved fluorescence studies, afford direct insight into how crystallinity, solid-state energetics and exciton dynamics control the photovoltage. Our work demonstrates that nanocrystalline heterojunctions can be tuned to provide significant control over excitonic properties as a function of crystal and interface structure, resulting in minimal photovoltage losses.

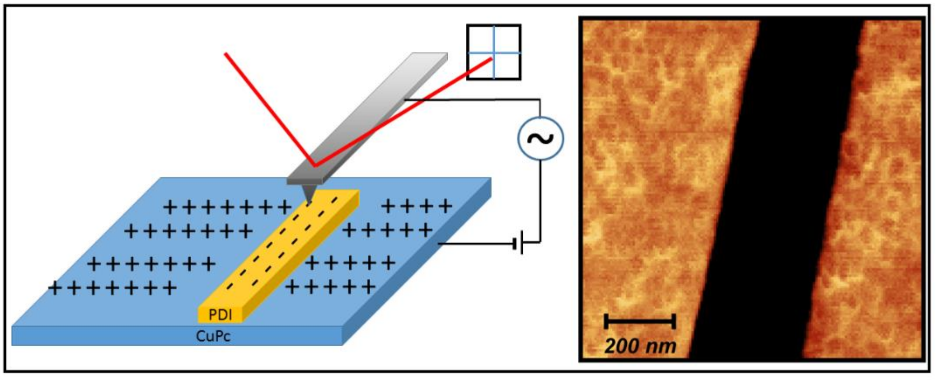

Figure 1: KPFM measurements of a PDI nanocrystal on CuPc PVD film.

Title: Resolving Topological Classification Using Topological Defects

Authors: Abhay Kumar Nayak[1], Jonathan Reiner[1], Raquel Queiroz[1], Huixia Fu[1], Chandra Shekhar[2], Binghai Yan[1], Claudia Felser[2], Nurit Avraham[1], Haim Beidenkopf[1]

Affiliation: [1] Weizmann Institute of Science, Rehovot, Israel.

[2] Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Bulk boundary correspondence has allowed the study of electronic bulk properties through the investigation of their topological boundary modes. However, for some materials the growing diversity of topological classes leads to ambiguity between classes sharing similar boundary phenomenology. Such is the current status of bismuth, for which recent studies have suggested several non-trivial classification, such as a strong or higher order TI, both of which hosts helical 1D modes on their boundaries. We use a novel approach to resolve the topological classification of bismuth by spectroscopically mapping the response of its boundary modes to a topological defect in the form of a screw dislocation using Scanning Tunneling Microscopy. We find a 1D mode bound to the step edges of bismuth, spanning over a wide energy range than previously identified and extends along the step edge up to the core of the screw dislocation without gapping out. This signifies that the edge mode also binds to the topological defect, characteristic of a material with non-zero weak indices. We argue that the small scale of bulk energy gap at the TRIM L point, positions bismuth within the critical region of a topological phase transition between a higher order TI and a strong TI with weak indices.

Probing the robustness of Weyl semimetals Fermi arcs to surface perturbations

Nurit Avraham[1]

[1]Department of Condensed Matter Physics, Weizmann Institute of Science, Rehovot 7610001, Israel.

Topological materials host unique boundary states that cannot be realized as stand-alone systems, but only at the boundaries of a topological bulk. One of the hallmarks of topological surface states is their robustness to perturbations. Weyl semimetals exhibit unusual topological surface states known as ‘Fermi arcs’. These states form open contours in momentum space that emanate and end at the surface projection of bulk Weyl nodes with opposite chirality. While the formation of Fermi arc states is guaranteed by the bulk topology, their actual configuration and connectivity with the Weyl nodes, as well as their level of protection to perturbations, can be affected by the details of the material system. We examine these properties in two types of Weyl semimetals: the non-centrosymmetric Weyl semimetal TaAs [1] and the time reversal symmetry broken $Co_3Sn_2S_2$ [2]. In both systems we have confirmed the Weyl topological classification by spectroscopic visualization of their Fermi arcs states through the interference pattern they embed in the local density of states. I will show how we extract information, from these interference patterns, on the structure of the surface states wavefunction within the unit cell. In TaAs we find that in contrast to non-topological surface states, that coexist on the material surface, the Fermi-arc wavefunction is weakly affected by the surface potential: It spreads rather uniformly within the unit cell, and penetrates deeper into the bulk. In contrast, in $Co_3Sn_2S_2$ the dispersion of the topological Fermi arcs states and their Weyl node connectivity, are found to vary with surface termination. This suggests that long Fermi arcs that connect far apart Weyl nodes, like those in $Co_3Sn_2S_2$, are more susceptible to surface perturbations, while short extent ones, as those in TaAs, are harder to detect but are more robust to surface perturbations.

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Plasma Science session
Chair: Asher Yahalom

Superradiant and Stimulated-Superradiant Emission of Bunched Electron Beams

We outline the fundamental processes of coherent radiation emission from a bunched charged particles beam[1]. In contrast to spontaneous emission of radiation from a random electron beam that is proportional to the number of particles N, a pre-bunched electron beam emits spontaneously coherent radiation proportional to N^2 through the process of (spontaneous) superradiance (SP-SR) (in the sense of Dicke's[2]). The SP-SR emission of a bunched electron beam can be even further enhanced by a process of stimulated-superradiance (ST-SR) in the presence of a seed injected radiation field. These coherent radiation emission processes are presented in term of a radiation mode expansion model, applied to general free electron radiation schemes: Optical-Klystron, HGHG, EEHG, and coherent THz sources based on synchrotron radiation, undulator radiation or Smith-Purcell radiation. The general model of coherent spontaneous emission is also extended to the nonlinear regime - Tapering Enhanced Stimulated Superradiance (TESSA) [3], and related to the tapered wiggler section of seed-injected FELs.

The THz Superradiant FEL of TAU/ARIEL will be presented as an example for the realization of these concepts.

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Acknowledgement

We acknowledge support of the Israel Science Foundation and the German Israeli Projects Foundation (DIP).

Slava Smartsev (WIS)- Axiparabola: A long focal depth, high resolution mirror for broadband high intensity lasers

Title: Axiparabola: a long focal depth, high resolution mirror for broadband high intensity lasers

Slava Smartsev [1-2], Clement Caizergues [2], Kosta Oubrerie [2], Julien Gautier [2], Jean-Philippe Goddet [2], Amar Tafzi [2], Kim Ta Phuoc [2], Victor Malka [1-2], Cedric Thaury [2].

[1] Department of Physics of Complex Systems, Weizmann Institute of Science, Rehovot 7610001, Israel
[2] Laboratoire d'Optique Appliquée, Ecole Polytechnique, ENSTA, CNRS, Palaiseau, France

Abstract: Diffraction puts a fundamental limit to the distance over which a light beam can remain focused. For about 30 years, several techniques to overcome this limit have been demonstrated. Here, we propose a free-form reflective optics, namely the axiparabola, which allows to extend the production of ''diffraction-free'' beams to high peak power and broadband laser pulses. A 20 mm focal depth, off-axis axiparabola was manufactured. A focal line with a transverse size and an intensity which remained below 7 µm and beyond $4{\cdot}10^{17}$ Wcm^{-2} respectively was successfully produced using a 0.85 J, 30 fs laser pulse (Fig. 1). Achieved peak intensity (limited here by damage threshold of the mirror) can easily reached intensities above $1{\cdot}10^{18}$ Wcm^{-2} when using 2.5 J laser pulse, opening a route for exploring relativistic regime over a long distance. As a first example of application, the axiparabola was able to generate a 10 mm plasma channel in a low density hydrogen gas and to guide a 20 TW laser over nearly its 10 Rayleigh lengths with 47% efficiency. We believe this novel optic will have a strong impact and will boost fields of research related to high laser power and plasma sciences.

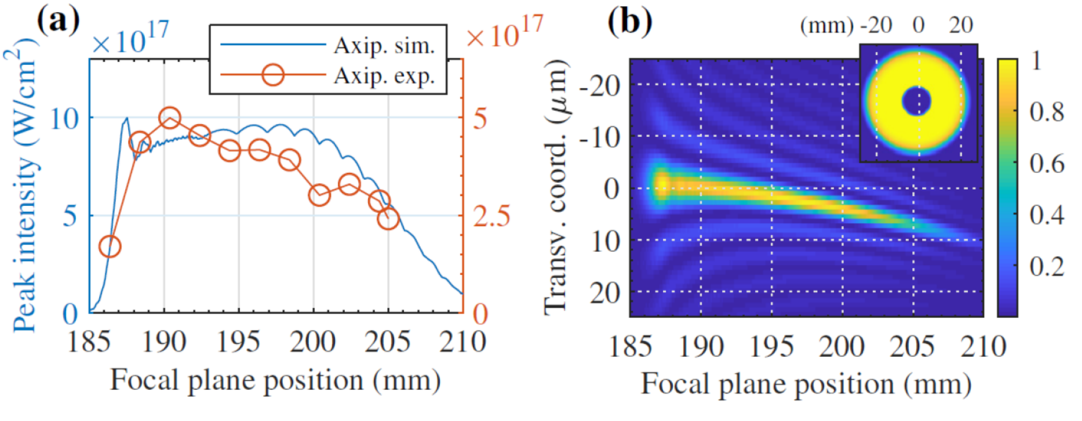

Figure 1. (a) Axiparabola peak intensity as a function of the focal distance: red circles are the experimental data and the blue line comes from a polychromatic PSF simulation for a 0.85 J, 30 fs pulse. (b) Simulated time integrated axiparabola beam profile (focal line) cross section as function of the focal distance. (Inset) Illumination profile used in simulation.

References:

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Self-Consistent Solution for Fowler-Nordheim Current in Superimposed DC and RF Fields

Miron Voin and Levi Schächter

Department of Electrical Engineering, Technion – Israel Institute of Technology
Haifa 32000, Israel

Abstract

Possibility of deep modulation of a field-emitted current in a superposition of DC and RF electric fields due to strong nonlinearity of the Fowler-Nordheim (FN) field emission law was initially studied in Ref [1]. It was shown recently that the paradigm may be employed for generation of e-bunches even at optical frequencies [2]. Simplified analysis in Ref [3] demonstrates dynamics of the FN current pulses of Gaussian temporal and spatial profile in a Penning-Trap-like electrostatic field.

In this report we present a self-consistent solution for interaction of the FN e-beam with electromagnetic field in a cylindrically symmetric flat diode schematically depicted in the Figure 1.

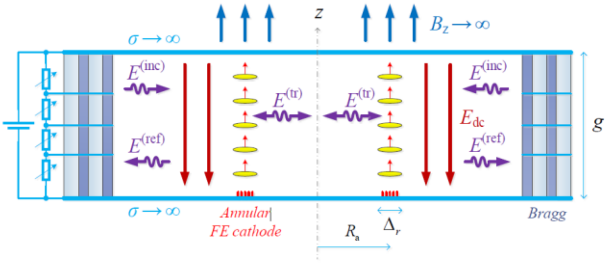

Figure 1. Schematic set-up; not to scale.

Axial confinement of the RF field is provided by two flat perfect conductor electrodes on the top and on the bottom. Radial confinement of the RF field – is facilitated by a concentric dielectric Bragg structure. Static axial electric and magnetic fields are applied between the electrodes. A field-emitted annular electron beam interacts with a time-varying electromagnetic field. FN law facilitates bunched electron beam emission at the frequency of the RF field. Interaction of the bunches, accelerated by the electrostatic field, with cylindrical EM wave facilitates energy transfer from the e-beam to the RF field.

We employ the slowly varying amplitude approximation for estimation of field components and particle dynamics, and establish set of equations describing the interaction process self-consistently. The equations are solved numerically with initial condition for the particles' dynamics being provided by FN emission law.

Numeric simulations confirm the possibility of generation of Gaussian-profile e-bunches by a harmonic EM field. During a transitions stage, due to space charge dynamics in the gap, initial bunches are distorted by evolving quasistatic electric field. In steady state, however, deeply modulated FN current is observed. This current may facilitate energy transfer from the e-beam to the RF field and thus amplification of the latter.

This study was supported by the Israel Science Foundation.

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MMW coherence detection for 5th generation of cellular communication

Moti Ben-Laish[1], Daniel Rozban[2], Avihai Aharon[2,3], Amir Abramovich[2], Yitzhak Yitzhaky[1] and Natan S. Kopeika[1,4]

[1]Department of Electro-Optical Engineering, Ben Gurion University of the Negev, Beer-Sheva, Israel

[2]Department of Electrical and Electronic Engineering, Ariel University, Ariel, Israel

[3]Faculty of Engineering, Holon Institute of Technology (HIT), Holon, Israel

[4]Department of Electrical and Computer Engineering, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Abstract **The demand for millimeter wave (MMW) wireless communication systems has increased in recent years due to new technologies especially the New Radio standard (5G). In the last years, new MMW detectors found in research. In this paper, we examine a new detection method was based on up-conversion of the MMW to visible light. A miniature neon indicator plasma lamp as a glow discharge detector (GDD) and commercial photodiode were used in this detector scheme. This work focuses on the design of a new coherence detector setup and measuring its parameters like noise equivalent power and bandwidth. The detector measurements were performed in the 100 GHz region.**

I. Gdd and upconversion method

When MMW radiation incident on GDD surface, the energy absorbed and increases the velocity of free electrons [1][2]. Thus the current increases and intensity of light from GDD also increases due to recombination process. In upconversion method we use photodiode to measure GDD emitted light. Using this method, we converting the signal from MMW to visible light. By this conversion we get low noise level due to usage very low noise photodiode.

II. Experiment setup

Two tunable MMW sources in range of 0.1 THz (one donate as local oscillator – LO and one as a signal) were controlled by two signal generators (so that the output frequency of the MMW source chosen using the output frequency of the signal generator) radiates to a free space horn antenna, signal radiation to free space using horn antenna, the radiation of each source was in the same polarization that was perpendicular to propagation axis in the plane of propagation axis, the radiation focused on the GDD a using off-axis parabolic mirror (OPM) and polyethylene lens, the GDD emitted light power was measured using an avalanche photodiode (APD, from Hamamatsu C12702-04) connected to a spectrum analyzer. Illustration of the experiment setup can be seen in figure 1. In the experiment we use IF frequency from 100kHz to 3GHz.

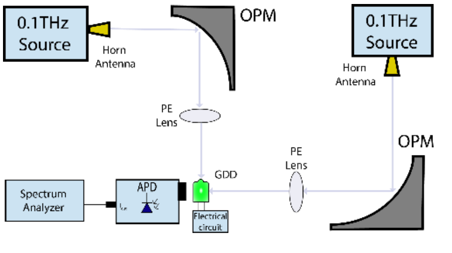

Fig. 1. Experimental setup for NEP estimation of GDD and up conversion as MMW detectors.

Acknowledgement

The authors are grateful to the KAMIN program of the Israeli Ministry of Commerce and Industry for the support of this research.

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Amit Beer (TAU)- Iris-assisted Terahertz field-induced second harmonic generation in air

Iris-assisted Terahertz Field-Induced Second Harmonic Generation in Air

Amit Beer[1,2], Dror Hershkovitz[1,2], Sharly Fleischer[1,2]

[1]Raymond and Beverly Sackler Faculty of Exact Sciences, School of Chemistry, Tel Aviv University 6997801, Israel.

[2]Tel-Aviv University center for Light-Matter-Interaction, Tel Aviv 6997801, Israel.

Terahertz field induced second harmonic generation (TFISH) is a technique used for optical detection of broad-band THz fields [1]. TFISH is a nonlinear four wave mixing of a THz field (E_{THz}) and two optical fields (E_ω, E_ω) via the 3rd order susceptibility, $\chi^{(3)}$, to yield a signal field at the frequency of $\omega_{TFISH} = \omega + \omega \pm \omega_{THz} \cong 2\omega$. We show that by simply placing an iris at the interaction volume of the fields, we obtain a **dramatic increase of few ten-fold in the generated TFISH signal** in atmospheric air. This effect is attributed to the inherent phase-mismatch of the nonlinear optical process ($\Delta k = k_{2\omega} - 2k_\omega$) that is partially compensated by the restriction of the interaction length using the iris. In fact, the iris acts as a selective beam block for the THz beam but does not affect the optical beam owing to the large difference in their wavelengths and correspondingly their beam diameters.

I will present our experimental characterization of the iris-assisted TFISH amplification by varying the air pressure and probe intensities. The measurements unveil the effect of laser-induced weak plasma that serves to improve the phase-matching conditions TFISH generation and directly observed in our experiments.

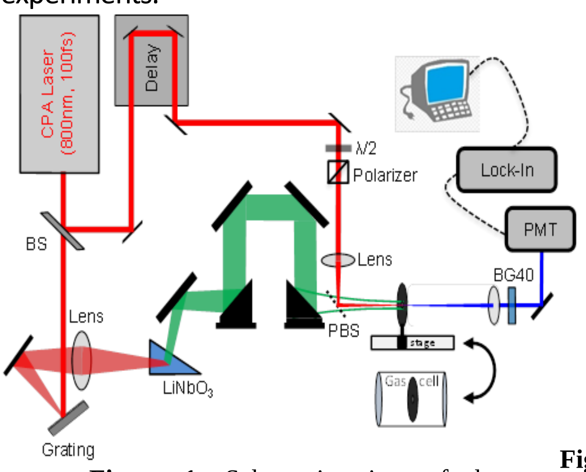

Figure 1: Schematic view of the experimental setup.

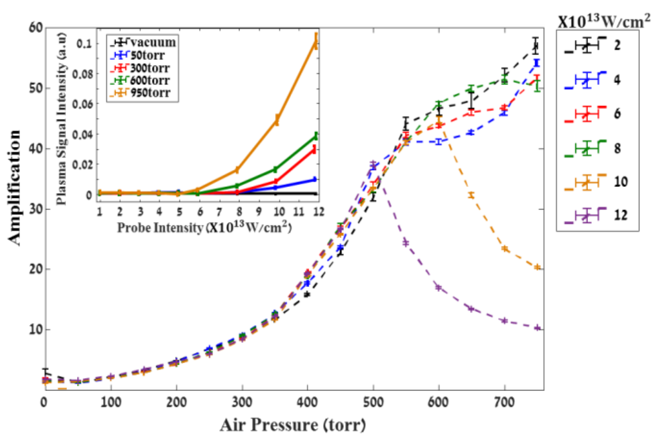

Figure 2: TFISH amplification factor measured obtained for different air pressures and probe intensities. The inset shows the corresponding plasma signal obtained.

The experimental system provides an elegant platform for studying nonlinear phase-matching in a fully controlled extended gas phase medium and is reminiscent of the semi-infinite gas cell [2]approach that is widely used in HHG experiments. In addition I will present recent results for characterization of the effective interaction volume for the TFISH process at varying probe beam diameters. If time permits I will also discuss our use of TFISH for monitoring rotational dynamics of oriented polar molecules.

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Microwave Pulse Compression based on Laser-induced breakdown

Yoav Hadas[1], Elhanan Maguid[1], Roy Alkabetz[1], Leonid Zorkin[1],

John G Leopold[2] and Yakov E. Krasik[2]

[1] Rafael Ltd. Haifa, Israel

[2] Plasma & Pulsed Power Lab. Technion, Haifa, Israel

Microwave Pulse Compressor (MPC) is an high power microwave device designed for generation of 100's of MW's thru amplification. The amplification is based upon time compression of an initial Microwave (RF) pulse characterized by a long (µsec) duration to a short (ns) output pulse, ideally increasing the RF power by the duration ratio of the pulses.

In order to accumulate RF power and radiate it outside a pressurized RF resonator we use a Q-switch method based on laser induced plasma channel. The RF pulse initiate a discharge in the gas, pre-ionization using microwave pulse, where a short (ns) laser pulse induce breakdown by a thin plasma channel which switch the resonator from a storage phase to a release phase, i.e. sufficient to reduce the *Q* factor of the resonator.

We demonstrate experimentally an efficient way to cause a discharge in the pressurized gas by focusing a short 2ns laser pulse inside the MPC volume. We have investigated the evolution of the plasma channel by means of gated MCP intensified CCD framing camera of ~1.5ns exposure time (4quikE camera). We found that as the accumulated energy inside the resonator increases, the time delay between lasing and switching decreases. Furthermore, stronger initiative RF pulse results in a stronger and spatially larger luminesce of the plasma channel. Using a spatial-temporal processing of the plasma luminesce imaging we were able to simulate this phenomenon by 2D-Lsp hybrid PIC modeling where we assume that the resonator is pressurized with gas, uniformly distributed background electron density of $10^3 cm^{-3}$ and seed electrons density occupying the laser focal region. Electron impact ionization develops self consistently with the oscillating RF field which eventually creates a plasma channel sufficient for the MPC switching. We fitted the seed electron density and the volume of the focal region to match the experimental results.

Study of radio frequency propagation in plasmas generated in rocket plumes

Yosef Golovachev[1], Gad A. Pinhasi[2] and Yosef Pinhasi[1]

[1]Dept. of Electrical and Electronic Engineering, [2]Dept. of Chemical Engineering

ARIEL UNIVERSITY, P.O. Box 3, Ariel 40700, ISRAEL

In rocket flights, ionized exhaust plumes may cause a severe interference to the telemetric communication [1-2]. The relative permittivity of the rocket exhaust plasma can be written as [3]:

$$\varepsilon_r(f) = 1 - \frac{f_p^2}{f^2 + f_e^2} - j\frac{f_p^2 f_e}{f^2 + f_e^2}$$

where f_p is the plasma frequency and f_e is the collision frequency of electrons. The propagation factor of electromagnetic wave $k(f) = 2\pi f\sqrt{\varepsilon_r(f)}/c$ is expressed in terms of the dielectric medium properties (c is the speed of light in vacuum), resulting in a complex, frequency dependent quantity. The imaginary part of the propagation factor is the attenuation coefficient $\alpha(f) = -\mathrm{Im}[k(f)]$ while the phase is determined by the real wavenumber $\beta(f) = \mathrm{Re}[k(f)]$. Using Equation (1), the attenuation and phase coefficients are derived to be expressed by:

$$\alpha(f) = \frac{2\pi f}{c}\sqrt{-\frac{1}{2}\left(1 - \frac{f_p^2}{f_e^2 + f}\right) + \frac{1}{2}\sqrt{\left(1 - \frac{f_p^2}{f_e^2 + f}\right)^2 + \left(1 - \frac{f_p^2 f_e}{f(f_e^2 + f)}\right)^2}}$$

$$\beta(f) = \frac{2\pi f}{c}\sqrt{\frac{1}{2}\left(1 - \frac{f_p^2}{f_e^2 + f}\right) + \frac{1}{2}\sqrt{\left(1 - \frac{f_p^2}{f_e^2 + f}\right)^2 + \left(1 - \frac{f_p^2 f_e}{f(f_e^2 + f)}\right)^2}}$$

In the current work, the effect of rocket plume's plasma on the propagation of electromagnetic radiation is studied considering broad frequency spectrum, including millimeter waves and Tera-Hertz regimes. It is shown that climbing up in frequencies, the attenuation may be decreased (see Figure 1). Link budget estimations are demonstrated.

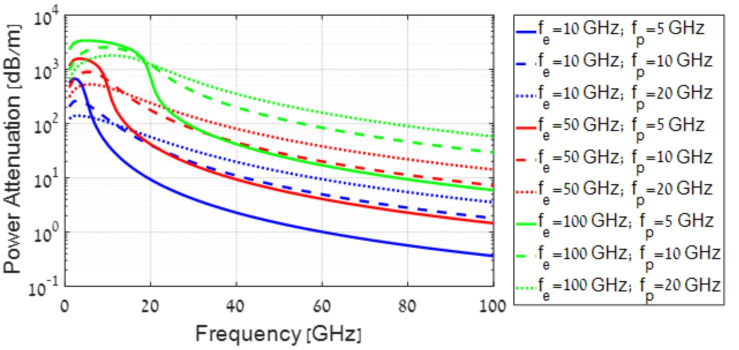

Figure 1: Power attenuation factor in different conditions of f_p - plasma frequency, and f_e – electron collision frequency

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Energy and Sustainability-session
Chair: Yaron Cohen

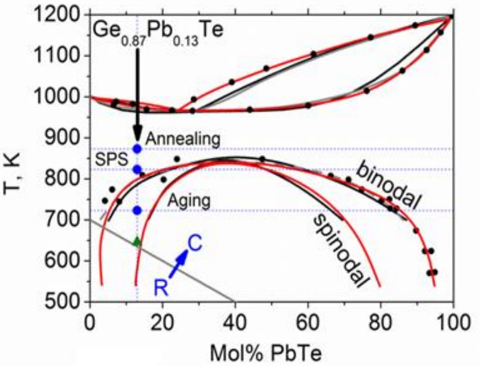
Advances in the development of thermoelectric materials for power generation

*Yaniv Gelbstein
Department of Materials Engineering, Ben-Gurion University of the Negev, Beer-Sheva, 8410501, Israel
*yanivge@bgu.ac.il
Thermoelectric, PbTe, GeTe, Phase separation

In the recent years, many efforts were made for generation of nano features in bulk thermoelectric materials for enhancement of the thermoelectric figure merit via the reduction of the lattice thermal conductivity. Taking into account that thermoelectric direct converters from heat to electricity, without involving of any moving parts, exhibit a major stability advantage for long-term operation, compared to many other competing conversion methods, the stability of nano-featured bulk thermoelectric materials is a major issue for consideration. Such converters usually operate under high temperatures and large temperature gradients conditions, which can affect the stability of the nano-features embedded in the bulk thermoelectric main phases. As an example, one popular production method of nano-featured bulk materials is based on rapid consolidation (e.g. Spark Plasma Sintering) of nano powders obtained by melt spinning or energetic ball milling. Yet, grain coarsening effects can result in gradual deterioration of the nano-structures and thermoelectric performance degradation upon long-term high temperatures operation.

In the current research, an alternative, thermodynamic nano-features generation approach in bulk IV-VI based thermoelectric materials, was considered, using controlled phase separation conditions according to the relevant phase diagrams. Specific systems showing a miscibility gap, including the PbTe-GeTe (Fig. 1) and PbTe-PbS systems, were heat treated under various required conditions for promoting spinodal decomposition and nucleation and growth reactions. High *ZT* values of up to 2.2 were obtained due to combined optimal doping and sub-micron phases' decomposition features. Such features were found as thermodynamically stable under long-term investigation at temperatures up to 400°C, resulting in almost unchanged figure of merit values after the various investigated heat treatment durations.

The mechanical properties of these systems, showing a significant high temperature plastic deformation, as required for long-term practical operation of thermoelectric devices will be described in details.



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Modeling performance and performance stability of anion exchange membrane fuel cells

Simon Brandon, Karam Yassin, Igal G. Rasin, Dario R. Dekel
Department of Chemical Engineering and Grand Technion Energy Program, Technion – IIT Haifa 3200003, Israel

Anion exchange membrane fuel cells (AEMFCs) are recently attracting attention as a potential alternative to their proton exchange membrane based counterparts. The possibility of using non platinum group (PGM) catalysts in AEMFCs, resulting in reduced cost devices, is one of their main advantages. Since their initial development, efforts to improve AEMFC performance have involved a significant focus on increasing the hydroxide conductivity of the anion exchange membranes (AEMs). However, although obtaining high cell performance is important, it is crucial to make sure that this performance remains stable throughout desired cell operation times. One of the main mechanisms responsible for loss of AEMFC performance involves the chemical degradation of the AEM and of the ionomer within the catalyst layers. We present a computational analysis of the sensitivity of AEMFC performance as well as performance stability to a number of key parameters, including membrane water diffusivity and membrane hydroxide conductivity. Our analysis involves the implementation of a recently developed 1D model [1,2], which specifically accounts for chemical degradation of the AEM and ionomer [2]. Our results demonstrate the obvious importance of AEM hydroxide conductivity for the achievement of high performance. At the same time, this parameter is shown to have minimal impact on performance stability. It is the diffusivity of water in the AEM which appears to be crucial to the achievement of *stable* high AEMFC performance. It is our conclusion that the development of the next generation of AEMs for AEMFCs, exhibiting both high performance and high performance stability, requires a focus on improving both hydroxide conductivity and water diffusivity.

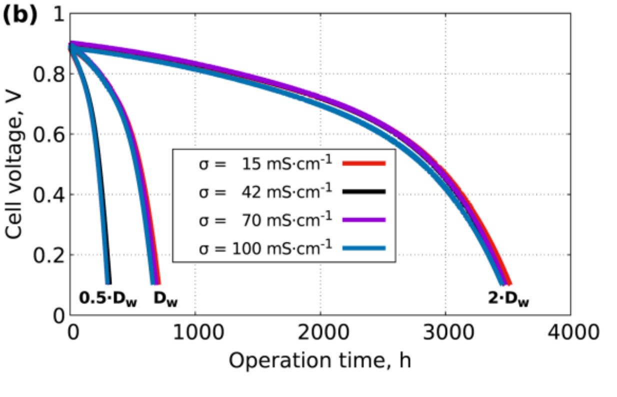

Figure 1. Simulated effects of AEM conductivity and water diffusivity on performance stability of an AEMFC operated at 0.1 A cm^{-2}. AEM thickness = 28 µm.

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Gideon Segev (Berkeley, TAU) - Electronic ratchet based ion pumps for high efficiency water desalination

Electronic ratchet based ion pumps for high efficiency water desalination

Gideon Segev[1,2,3], Shane Ardo[4,5], David Larson[1,2], Joel W. Ager III[1,2,6,7], Francesca M. Toma[1,2]

[1]Chemical Sciences Division, Lawrence Berkeley National Lab, Berkeley, CA 94720, USA

[2]Joint Center for Artificial Photosynthesis, Lawrence Berkeley National Lab, Berkeley, CA 94720, USA

[3]School of Electrical Engineering, Tel Aviv University, Tel Aviv 6997801, Israel

[4]Department of Chemistry, University of California, Irvine, CA 92697-2025, USA

[5]Department of Chemical Engineering and Materials Science, University of California, Irvine, CA 92697-2025, USA

[6]Materials Sciences Division, Lawrence Berkeley National Lab, Berkeley, CA 94720, USA

[7]Department of Materials Science and Engineering, University of California Berkeley, CA 94720, USA

Ion pumps are devices that use external power to introduce a net ionic flux. For example, in living cell membranes, nano scale channels pump different types of ions against a concentration gradient consuming energy from the hydrolysis of ATP. Although widely used in nature, there are very few technologies that can unleash the vast potential of ion pumps. Unlike electrons in electronic devices where contacts serve as nearly ideal sources and sinks for charge carriers, ions are sourced and removed by chemical reactions. However, since redox reactions have a threshold voltage that is defined by their Gibbs free energy and overpotentials, ion pumps that are based on such reactions are in most cases inefficient. In this contribution we report a first-of-its-kind “all electric”, ion pump based on an electronic ratchet mechanism. Electronic ratchets utilize modulation in a spatially varying electric field to drive steady state current. Similar to peristaltic pumps, where the pump mechanism is not in direct contact with the pumped fluid, electronic ratchets induce net current with no direct charge transport between the power source and the pumped charge carriers. Thus, electronic ratchets can be used to pump ions in steady state with no electrochemical reactions between the power source and the pumped ions resulting in an “all electric” ion pump. Porous capacitor based ion pumps were fabricated by coating the two surfaces of nano-porous alumina wafers with gold. The electric field within the nano-pores is modulated by oscillating the capacitors voltage. Thus, when immersed in solution, ions within the pores experience a modulated electric field resulting in ratchet based ion pumping. The device pumping performance was studied for various input signals, geometries and solutions. Devices are shown to operate with very low voltages making them a possible building block for high efficiency water desalination.

Amram Azulay (Technion) - Electronic transport mechanisms of La- and Y-doped calcium-manganite compounds for thermoelectric energy harvesting

Investigation of the Electronic Transport Mechanism of La- and Y-doped Ca_2MnO_4

Amram Azulay [1], Marwan Wahabi [1], Yuriy Natanzon [1], and Yaron Amouyal [1]

[1] *Department of Materials Science and Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel*

Abstract

Thermoelectric materials are used to cleanly convert waste heat to electrical energy. Their performance favors high electrical conductivity, large Seebeck coefficient, and low thermal conductivity. $CaO(CaMnO_3)_m$ compounds are promising due to their intrinsically low thermal conductivity, e.g. 0.75 $Wm^{-1}K^{-1}$ at 900 K [1], which is associated to internal rock-salt CaO layers residing between adjacent $CaMnO_3$ perovskite sub-cells. This study is aimed at increasing the electrical conductivity of $Ca_{2-x}R_xMnO_4$ bulk materials, where R = La or Y, and $0.01 \leq x \leq 0.20$. We prepare compounds with different doping levels of either Y or La applying standard solid state reaction routines [2]. The phase purity, chemical composition and microstructure are characterized, and electronic transport coefficients are measured in the range of 300-1000 K. It is found that Y-doping generally facilitates electronic transport compared to La-doping by up to two times. This trend is elucidated in terms of the small polaron hopping model, indicating that La-doping increases the conduction activation energy by 7-21 % in the range of 300-750 K, compared to Y-doping. Density functional theory (DFT) calculations corroborate this interpretation, showing that La-substitution for Ca in Ca_2MnO_4 increases the transverse sound velocity by up to 33 % compared to Y-substitution, implying that La-doping increases bond strength, thereby hindering lattice distortions. This is also manifested by higher shear moduli and Debye temperatures obtained for La-substituted compounds. Our results suggest that energy barriers for electronic transport in oxides may be tailored by point defect engineering.

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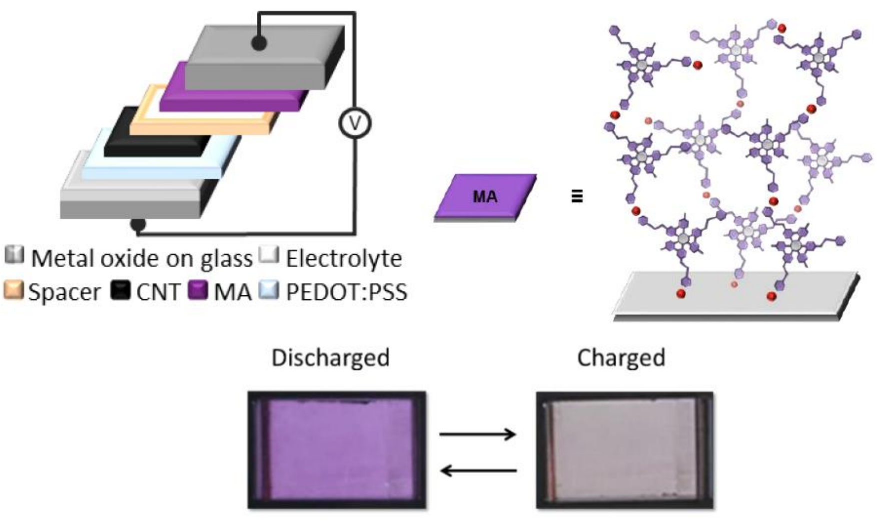
Metallo-Organic Assemblies for Dual-Function Electrochromic Supercapacitors

Ofir Eisenberg*, Yadid Algavi, Haim Weissmann, Michal Lahav and Milko E. van der Boom
Weizmann Institute of Science, Department of Organic Chemistry, 7610001, Rehovot. Email: ofir.eisenberg@weizmann.ac.il

The rapid and global increase in green energy demands has driven the research and development of alternative and efficient energy storage materials and devices.[1] Energy storage systems can be divided to two main categories: batteries and capacitors.[2] Batteries have a high energy density, whereas capacitors have a high power density. Hybrid supercapacitors combine battery-like and capacitive electrodes. This combination allows the best of both worlds: high power and high energy density. The replacement of conventional inorganic materials (eg. lithium, lead, antimony, cadmium) by molecular based materials is expected to result in flexible, readily available devices with enhanced functionalities.

We introduced a hybrid device which is composed of carbon nanotubes (CNTs) and PSS:PEDOT, as the counter electrode,[3] and metallo-organic assemblies (MA), as the working electrode. Our MA are robust, showed high stability in a non-inert environment at high temperatures. These assemblies can be deposited directly on conductive substrates. During the oxidation of the MA at the working electrode, the charge will be stored by the CNTs deposited on the counter electrode. We take advantage of the fact that our MA are electrochromic[4] (i.e. change their optical properties with respect to an applied potential) to generate dual-function devices. These devices indicate their charge state by their color.



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Spectroscopy and Solar Energy - A Review*

Yehoshua Kalisky, NRCN, P.O. Box 9001 Beer Sheva, 84190, Israel

Abstract

This short review summarizes briefly the novel research initiatives that led to significant discoveries as well as to the utilization of fundamental processes and photochemical dynamics into solar energy research. The various technologies and multidisciplinary fields such as optics, photoluminescence, photophysics, luminescence, spectroscopy, chemistry and physics of glasses, sol-gel technologies and polymer physics used for solar energy research will be presented.

The outstanding scientific achievements, that were obtained by using luminescent lanthanides-ions, transition metal-ions, polymers, organic dyes and nano-particles, to obtain efficient luminescent solar concentrators (LSC) will be reviewed .

*Dedicated to the memory of my late wife Dr. Ofra Kalisky, who passed away on August 6, 2016

Surface Science – session Chair: Shira Yochelis

Interaction of low-energy nitrogen species with the diamond surface studied by in situ electron spectroscopy

Alon Hoffman

Schulich Faculty of Chemistry, Technion - Israel Institute of Technology, Haifa 32000, Israel
**choffman@technion.ac.il*

Incorporation of nitrogen onto diamond surfaces may be achieved by plasma exposure or low energy ion implantation. However, the interaction of energetic nitrogen species with the diamond lattice may induce the formation of defects and incorporation of nitrogen in the sub-surface region. These in turn, may strongly influence the bonding configuration of the incorporated nitrogen and the electronic properties of the nitraded surfaces. These effects are poorly understood at the atomic Herein, we investigated the interaction of low-energy nitrogen species (generated by three different methods: radio frequency plasma, ion implantation, microwave plasma) onto diamond surfaces and their thermal stability. *In situ* X-ray photoelectron spectroscopy, high-resolution electron energy loss spectroscopy (HREELS) and ultraviolet photoelectron spectroscopy were used to investigate the bonding configuration and electronic properties. HREELS analysis suggests that nitrogen present in different bonding configurations: $C{-}NH_2$ and C=N and the thermal stability of N−H bond is below 700 °C. Further, structural recovery is possible with low-level of structurally damaged surfaces.

Microbubble Assisted Photo-Thermal Directed Assembly

Ehud Greenberg, Nina Armon & Hagay Shpaisman

Department of Chemistry & Institute for Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat-Gan 5290002, Israel

Micro-patterning of various materials was recently developed based on the laser-induced microbubble technique (LIMBT). LIMBT relies on the formation of a microbubble due to laser heating of a dispersion of nanoparticles (NPs) that absorb the laser light. Natural and Marangoni convection currents carry the NPs to the bubble/substrate interface where some of them are pinned. Moving the substrate relative to the laser beam results in deposition of NPs along a predetermined path. Unfortunately, for many materials this deposition is non-continuous.
We have found[1] that controlling the construction and destruction of the microbubble through modulation of the laser enables the formation of continuous patterns by preventing the microbubble from getting pinned to the deposited material. Furthermore, we show[2] that microstructure formation from an ion solution could be explained by a similar mechanism. Photo-thermal reduction of the metallic ions lead to formation of crystalline NPs. The NPs are then pinned to the bubble/substrate interface. These deposits absorb laser light, resulting in extensive local heating, which leads to fast thermal reduction of metal ions that are added as amorphous metal or metal oxides. The resulting deposition is therefore a combination of both crystalline and amorphous structures (illustrated below). This innovative approach could be applicable for producing thin conductive patterns and allow fabrication of microelectronic devices and sensors.

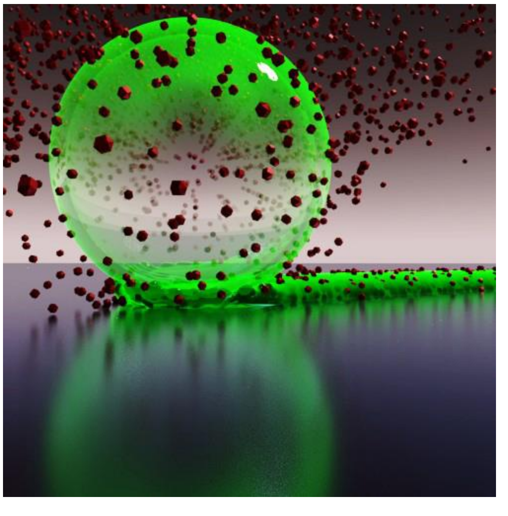

Illustration of the deposition mechanism from the metal ion solutions at the substrate/vapor/liquid interface.

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Direct evidence for in-gap states in Bromide Perovskites and their effects on devices

Arava Zohar, Igal Levine, Kohei Shimizu[#], Michael Kulbak, Hisao Ishii[#], Gary Hodes, David Cahen

Weizmann Institute of Science, Rehovot, Israel
[#]Chiba University, Chiba, Japan

The high optoelectronic quality of Halide Perovskite, HaP semiconductors is remarkable, given their low-temperature solution preparation. Up to now, there was little direct experimental evidence for significant trap densities within their band gap, from optical and/or electronic measurements. However, by using variable low-energy UV-photo emission spectroscopy (VE-UPS) we could detect in-gap states in (FA,MA,Cs)$PbBr_3$ perovskite film around the mid gap and estimate the defect densities. We find that the observed defects not only reduce the PL quantum efficiency, but also can dictate other electronic transport properties under illumination, such as the structure of the electronic junction and the charge carrier diffusion lengths. Customized Electron Beam-Induced Current (EBIC) measurements, with and without illumination, as function of bias, allow to map and track changes in the junction structure (space charge region) and diffusion lengths. We found changes in the EBIC profile shape that can be explained by a reduction of minority carrier diffusion length with increasing illumination intensity in this type of HaP. In addition, we find that, under reverse bias, the position of the junction remains the same, close to the ETL. This observation suggests that even if ions are mobile, they are not dictating the junction configuration and, hence, ion migration is not the main cause for the reduced device performance. By applying a two-level defect model, we can explain our experimental results and predict the cell`s performance as function of illumination in (FA,MA,Cs)$PbBr_3$ -based perovskite solar cells.

Ziv Golany (Technion) - Dewetting of polymer films in non-solvent - solvent environment, new approach for polymer particle patterning

Dewetting of polymer films in non-solvent - solvent environment
New approach for polymer particle patterning

Ziv Golany, Inbal Weisbord, Mohammad Abo Jabal, Neta Shomrat, Ofer Manor, Tamar Segal-Peretz

Dewetting of polymers is a central phenomenon in polymer thin films which can affect the film's stability and morphology. However, it can also be harnessed for patterning micro and nano features with controlled dimensions and order. Dewetting of polymer thin film occurs due to the film's instability and typically begins with the film's rupture and formation of holes; the holes continue to grow until they collapse and create small droplets.

In this research, we investigate the behavior of spontaneous dewetting of polymer thin films when immersed in a non-solvent and under exposure to solvent vapors (solvent annealing). In this solvent annealing process, the droplet's contact angle is extremely high compared to the contact angle obtained in common thermal and solvent dewetting processes, leading to the formation of spherical particles as observed with scanning electron microscopy (SEM) cross-sectional imaging (Figure 1). The particles' size and their spatial arrangement on the surface has a strong correlation to the polymer molecular weight, film thickness, and polymer chemistry, as revealed by SEM and light microscopy. *In-situ* imaging and arrested annealing experiments shed light on the kinetics and mechanism of the process and revealed the gradual transformation from holes to particles.

The dewetting process in solvent - non-solvent environment was further harnessed to fabricate ordered polymer particle arrays. A polymer solution was evaporated in a rectangular micro-chamber, forming a well-ordered striped pattern. Dewetting of the aforementioned pattern results in arrayed particles (Figure 2).

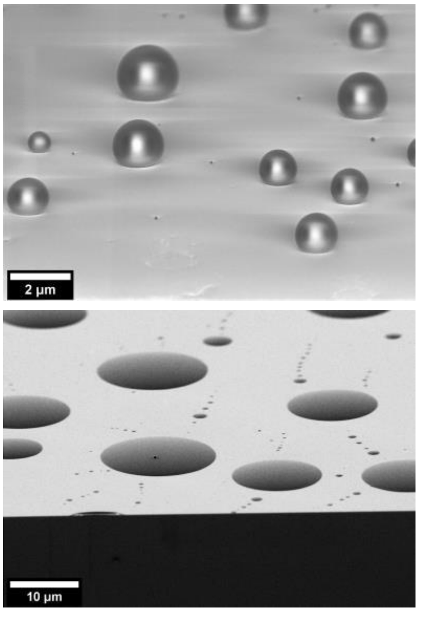

Figure 1: Cross sectional SEM images of polystyrene 100k particles after the dewetting process of a thin film in (a) solvent – non-solvent and (b) solvent environment.

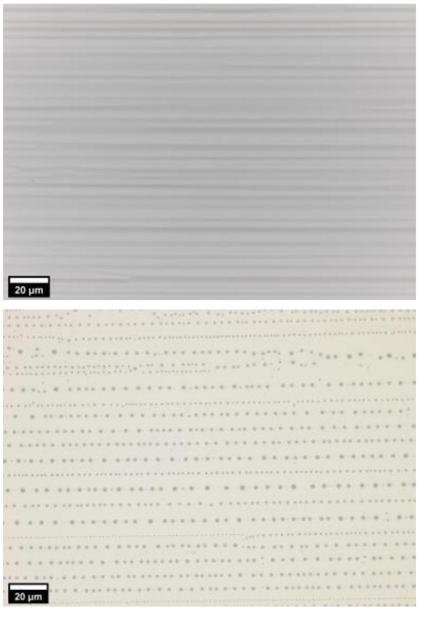

Figure 2: (a) Aligned PMMA stripes after evaporation in a rectangular micro-chamber. (b) PMMA particles located on Si wafer substrate after dewetting in solvent – non-solvent environment.

Elad Gross (HUJI) - Mapping Catalytic Reactions on Single Nanoparticles

TBA

Nanoelectronics and Spintronics – session Chair: Amos Sharoni

A route towards magnetic memory with 6 bits per cell

Lior Klein, Shubhankar Das, Ariel Zaig, and Moty Schultz
Department of Physics, Nano-magnetism Research Center, Institute of Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat-Gan 52900, Israel

One of the promising ways to address the rapidly rising demand for denser memory is to store more states in a single memory cell. We fabricate magnetic structures consisting of 3 (or 4) crossing ellipses which exhibit in the overlap area effective 3 (or 4) easy axes and demonstrate their switching with spin orbit torques between 8 (or 16) discrete remanent magnetic states. We show that if the two types of structures are to be used as the two ferromagnetic layers in a magnetic tunnel junction, up to 64 resistance states would be measured, paving the way for magnetic random access memory with 6 bits per cell.

Laser Induced Colloidal Writing of Pd-Ni for Formation of Hydrogen Sensors

Guy Rahamim[a], Ehud Greenberg[a], Khalil Rajouâ[b], Frederic Favier[b], Hagay Shpaisman[a,*] and David Zitoun[a,*]

Department of Chemistry, Institute for Nanotechnology and Advanced Materials (BINA), Bar Ilan University, Ramat Gan, 5290002, Israel

[b]Institut Charles Gerhardt Montpellier (ICGM), CNRS UMR 5253 – Université de Montpellier, Montpellier, France

The advent of hydrogen economy brings new challenges in terms of safety and sensing with a need for fast and low-cost monitoring of hydrogen concentration. Herein, we present a repeatable process for the fabrication of Pd based hydrogen sensor. First, a room-temperature reaction of organometallic precursors yields colloidal Pd/Ni alloyed nanoparticles. This organic solvent-based colloidal dispersion shows stability over months even with a relatively high metal content (≅1 wt%). Then, a laser induced micro-bubble deposits the nanoparticles in predetermined patterns from a micro-droplet dispersion that is placed on a glass slide. An optical microscope monitors the writing process while a multimeter measures the sensor's conductance, assessing the success of the fabrication process. The fabricated sensors demonstrate excellent hydrogen detection performance in terms of response time (31s and 61s for 0.5% and 0.01%, respectively), recovery time (75.5s and 156s for 0.5% and 0.01%, respectively), signal stability and detection limit down to 100 ppm of H_2 in air at room temperature.

Compression-enhanced thermal conductivity of polymer composites

Regev, O.

Department of Chemical Engineering, Ben-Gurion University of the Negev, Beer-Sheva 84105, Israel e-mail: oregev@bgu.ac.il

The miniaturization, integration and compatibilization of electronic devices dictate efficient thermal management to prevent heat accumulation, which may damage these devices in several ways. Addressing this challenge requires the development of novel polymer-based composite materials with enhanced thermal conductivity. Here, we report a compression-based (25-250 bars) approach for the preparation of polymer composites loaded with hybrid fillers, comprising graphene nanoplatelets and graphite flakes or boron nitride nanoparticles — the graphite flakes contributing significantly to the thermal conductivity of the composite and the boron nitride providing the desirable inhibition of electrical conductivity (to avoid short circuit). An optimal thermal conductivity of up to 27.5 W/mK may be obtained for epoxy polymer loaded with graphene nanoplatelets and graphite flakes, vs 0.2 W/mK for the non-modified thermoset polymer.

A 3-terminal VO_2-based realization of an artificial synapse

E. Anouchi, T. Yamin, A. Sharoni
Department of Physics & Institute of Nanotechnology and Advanced Materials, Bar Ilan University, Ramat Gan, 5290002, Israel
eanouchi@gmail.com
* Corresponding Author

Abstract

Realization of an artificial brain-like computer, known as “neuromorphic computation”, is a major challenge of today's electronic industry, necessary for low-power artificial intelligent applications. Mimicking neuron-like operations and incorporating them efficiently in computers requires abilities that are not easily achieved within the CMOS framework. One element is the artificial synapse, a non-volatile multi-state programmable device, that is able to connect to many elements (fan-out). We present a realization of such an artificial synapse using three-terminal FET-devices based on a VO_2 channel. VO_2 is a correlated oxide with a temperature-driven insulator to metal transition near room temperature. In our device the insulator and metal states act as a read and write switch, accordingly. The low-temperature insulating resistance acts as the synapse state that can be modified in a nonvolatile and reversible manner *only* in the high-temperature metallic state of VO_2, by application of a gate voltage. We will present the properties of our artificial synapse and how, to our understanding, field induced oxygen motion is the main driving mechanism.

Making FTO behave like ITO

Efrat Shawat Avraham, David Keller, David Cahen

ZabanLab, BINA and Chem. Dept., Bar-Ilan Univ., Ramat Gan

Transparent conductors are critical components in flat-panel displays and other high-volume, large-area optoelectronic devices (a ~US$ 6.10^9 / yr market). This market is dominated (~65%) by Indium Tin Oxide, ITO, composed primarily of Indium, the price and availability of which are a major issue. An obvious alternative, Fluoride-doped Tin Oxide (FTO), holds only a few % of the global market, despite its superior chemical stability and containing only abundant, readily available elements. The main reason is FTO's surface roughness (15-25 nm), which is large compared to that of ITO (2-4 nm).

Have been researching how to reduce FTO surface roughness to that of ITO, while maintaining its other qualities, to make it suitable for devices that today require the smoother, less stable, more expensive, and less earth-abundant ITO. Earlier we used libraries (i.e., assemblies of material on a common substrate, where one or more parameters of the deposition process [and, thus, one or more physical properties] are varied systematically over the area of the library) of SnO_2 layers with systematically varying thickness gradient, on top of a common FTO substrate, prepared by pulsed laser deposition. We found that a few 10s of nm of SnO_2 on the FTO reduced its surface roughness up to 3 x, while mostly maintaining its other qualities.[1]

We have now found that using spray pyrolysis, followed by annealing in reducing atmosphere, reduces the FTO roughness to that of ITO, from ~15 to ~ 4 nm. Remarkably, the new approach does not change the original electrical (conductance) and optical (transparency) FTO characteristics.

Acknowledgements: We thank Prof. D. Nissim, for use of his laboratory facilties for the annealing and and Dr. Simch Meir for fruitful discussions. This research is supported mostly by a KAMIN grant of the Innovation authority

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Interlayer conduction in graphene based electronics

Elad Koren

Materials science & engineering, Technion – Israel Institute of Technology, Haifa, Israel.

eladk@technion.ac.il

Weak interlayer coupling in 2-dimensional layered materials such as graphite gives rise to rich mechanical and electronic properties in particular in the case where the two atomic lattices at the interface are rotated with respect to one another. A lack of crystal symmetry leads to anti-correlations and cancellations of the p_z orbital interactions across the twisted interface, which gives rise to low friction behavior and low interlayer electrical transport. Using our recent nanomanipulation technology, based on atomic force microscopy, we studied the interlayer electrical conductivity as a function of twist angle between two misoriented graphene layers with unprecedented angular resolution of ~ 0.1°. The angular dependence indicates that the electrical transport across the interface is dominated by a phonon assisted channel which conserve the momentum of conduction band electrons, tunnelling across the twisted Dirac bands. Most intriguingly, the conduction is significantly enhanced within a narrow angular range of less than 0.5º at pseudo-commensurate angles of 21.8º and 38.2º. This provides the first experimental evidence for the existence of a 2-dimensional interface state originating from the coherent coupling of electronic states in the twisted sheets due to commensurate superlattices. Finally, we show that combined electro-mechanical characterization techniques of mesoscopic graphite structures can be uniquely address open fundamental question related to the dielectric interlayer interactions and electronic charge transport through stacking faulted structures.

Soft and Biological Matter – session Chair: Ayelet Lesman

Protein nanofibrils: from pathology to functional materials

Ulyana Shimanovich

Department of Materials and Interfaces,

Weizmann Institute of Science,

Rehovot, 76100,

Israel

E-mail: ulyana.shimanovich@weizmann.ac.il

Keywords: microfluidics, amyloids, self-assembly

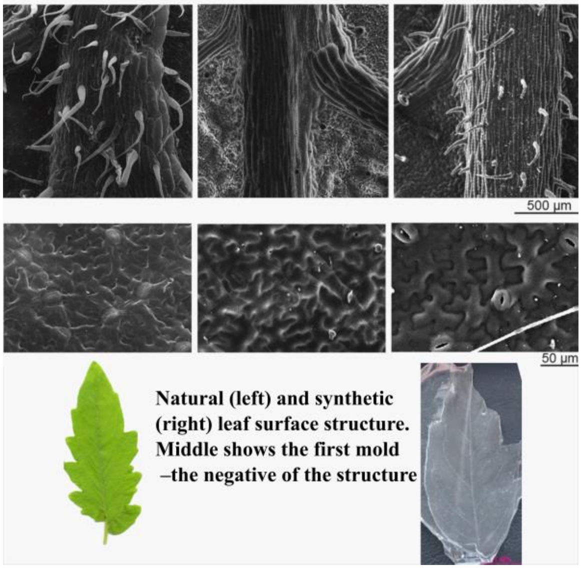
Nanofibrillar forms of proteins were initially recognised in the context of pathology, but more recently have been discovered as the basis of a range of functional materials in nature, including catalytic scaffolds and bacterial coatings. We show that protein nanofibrils can be used to form the basis of monodisperse microgels and gel shells composed entirely of naturally occurring proteins. We probe the potential of these protein microgels to act as drug carrier agents, and demonstrate the controlled release of pharmaceutically active drug-like small molecules, as well as the release of the component proteins by modulation of the level of aggregation of the proteins within the gel. Due to the biocompatibility and biodegredability of natural proteins used in the fabrication of the microgels, as well as their ability to control the release of small and macro-molecules, protein nanofibril microgels represent a new and promising class of functional artificial multi-scale materials generated from natural building blocks.

Maya Kleiman (Volcani Center) -Developing synthetic biomimetic surfaces to study biological interactions

Developing synthetic biomimetic surfaces to study biological interactions

Neta Ginzburg[1], Helen Rombach[2], Pallavi Kumari[1], Tali Sayas[1], Maya Kleiman[1]
[1] Department of Vegetables and Field Crops, Institute of Plant Sciences, Agricultural Research Organization, Rishon Lezion, Israel
[2] Department of Agriculture and Horticulture, Faculty of Life Sciences, Humboldt University Zu Berlin, Berlin, Germany

The field of biomimicry looks at nature for inspiration to find solution, particularly structural solutions, to human problems. In our lab we use biomimetics to better understand nature, and to mimic dynamic interactions in a synthetic system, using plant-pathogen interaction as our model system.
Plant-pathogen interaction is composed of a physical component (due to the plant surface microstructure) and a chemical/molecular one (due to molecular signals expressed on the surface). Studying this interaction using the natural plant, makes it impossible to separate those two components as they are entangled together. However, using a biomimicking synthetic system enables us to study the structural effect separately from the chemical one.
We are replicating tomato leaf microstructure on synthetic polymeric surfaces, studying microorganism response to structural features. Additionally, we are using different polymeric systems to mimic root surface microstructure and test how it affects the pathogeny of root nematodes and pathogenic bacteria. We are also harnessing the ability of these microorganisms to degrade the natural system to develop interacting surfaces that can be degraded in a controlled fashion by them. We see this method as a powerful tool in both better understanding nature and using it to develop interacting dynamic synthetic systems.



Natural (left) and synthetic (right) leaf surface structure. Middle shows the first mold –the negative of the structure

Liposomes Structure-Function at Different Surfaces

Nir Kampf,
Co-authors: Irit Rosenhek-Goldian, Weifeng Lin and Jacob Klein

Department of Materials and Interfaces, Weizmann Institute of Science, Rehovot, Israel

E-mail: nir.kampf@weizmann.ac.il

Liposomes are soft lipid bilayer vesicles that are mostly explored and utilized as dispersion. However, liposomes tend to adsorb on surfaces, acting as surface-modifiers to reduce friction for example. This insofar puzzling since due to the zwitterionic choline lipid head-group, liposomes are neutral in principle. Therefore, the understanding of the adsorption and stability of PC-liposomes on various surfaces is a fundamental question. Liposomes are spherical in solution but our results demonstrate that their structure on the surface can be altered, depending on their composition and surface properties. We used the AFM technique to probe the morphology of various types of liposomes on to a hydrophilic or a hydrophobic surface under aqueous solution. The results demonstrate that liposomes adsorb in a closely-packed configuration onto hydrophilic mica surface, driven by attraction between their exposed dipolar phosphocholine groups and the negatively charged mica surface. More surprising, HSPC liposomes were found to attach on fluorinated, highly hydrophobic, surfaces. We attribute the attraction of the liposomes on the hydrophobic surface to the formation the net negative charged of the hydrophobic surface under water. The stable hydrated liposomes on such surfaces can serve as highly effective boundary lubricants, as was demonstrated using the surface force balance technique.

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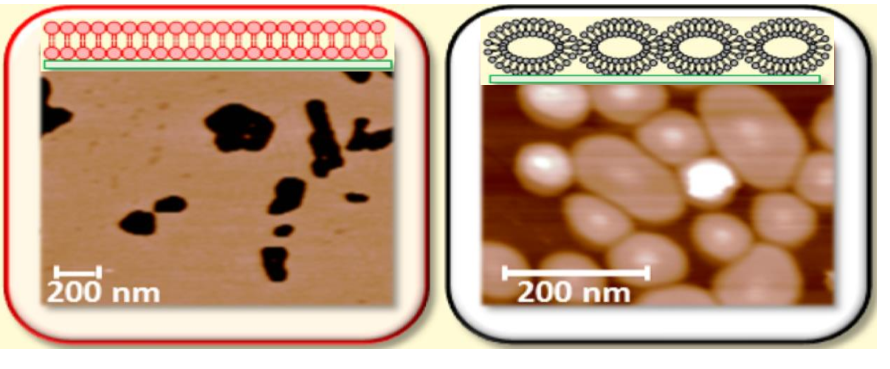


Eyal Golub (UC)- Selective heterobimetallic bridging of distinct protein interfaces via the introduction of metal-specific ligands: A polyhedra case study

Selective heterobimetallic bridging of distinct protein interfaces via the introduction of metal-specific ligands: A polyhedra case study

Eyal Golub[1], Rohit H. Subramanian[1], Julian Esselborn[1], Robert G. Alberstein[1], Jake B. Bailey[1], Jerika A. Chiong[1], Xiaodong Yan[2], Timothy Booth[2], Timothy S. Baker[2], and F. Akif Tezcan[1,3]*

1. Department of Chemistry and Biochemistry, University of California, San Diego, La Jolla, CA, USA

2. Division of Biological Sciences, University of California, San Diego, La Jolla, CA, USA

3. Materials Science and Engineering, University of California, San Diego, La Jolla, CA, USA

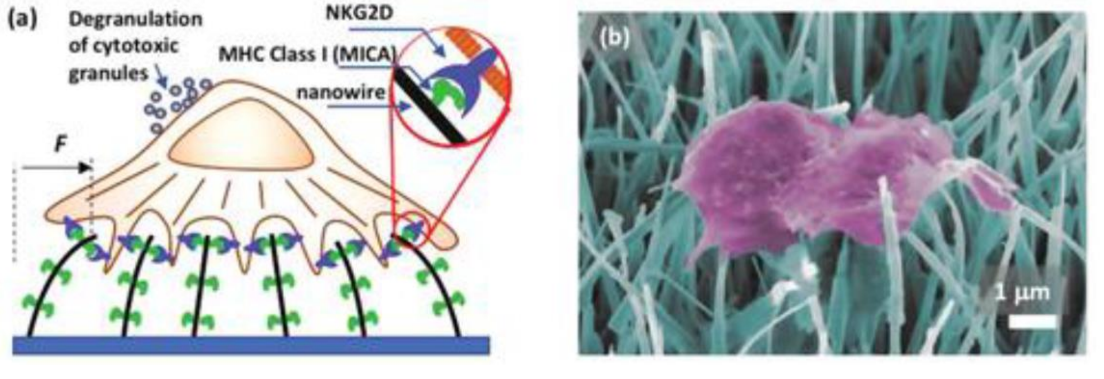
The assembly of proteins in nature either at the discrete oligomer level or higher-order complexes give rise to emergent properties and functionalities that are absent at the single protein level. The inherent asymmetric nature of natively expressed proteins underlies the necessity to form multiple, carefully crafted interprotein interfaces in order to yield symmetric protomers that, in turn, will self-assemble into higher order constructs. Although insertions of non-covalent greasy patches have proven to be an effective tool for binary protein assemblies formation, it is lacking in an effective design to form effectively symmetry axes with C>2 and is also prone to aggregation. As such, an inorganic chemical approach was adopted, whereby interfaces were selectively formed by tailoring the affinity of a specific metal for a desired interface using the Pearson Hard-Soft Acid-Base (HSAB) classification combined with the inherent symmetry imposed by a specific set of lignads. To that end native ligands were used to coordinate Zn^{II} ions and stabilize C2 symmetry nodes, while bioinspired hydroxamic acid was used as a strategic handle to coordinate hard Fe^{III} ions, leading to tris-hydroxamate-Fe^{III} complexes at the C3 nodes. Specifically, this method was successfully implemented in the formation of two types of nanometer-size protein cages exemplifying both its' robustness and design flexibility. The thoroughly characterized cages not only exhibit well-defined structures that are based on the designed heterobimetallic nodes, but also utilize these complexes for a multi-stimuli assembly and disassembly mechanisms of the cages.

Nanoscale Mechanosensing of Natural Killer Cells is Revealed by Antigen-Functionalized Nanowires

Guillaume Le Saux[ab], Netanel Bar-Hanin[ab], Avishay Edri[c], Uzi Hadad[b], Angel Porgador[c], Mark Schvartzman[ab]

[a]Department of Materials Engineering, Ben Gurion University of the Negev, Beer Sheva, 84105, Israel.
[b]Ilse Katz Institute for Nanoscale Science & Technology, Ben Gurion University of the Negev, Beer Sheva, 84105, Israel.
[c]The Shraga Segal Department of Microbiology, Immunology and Genetics, Faculty of Health Sciences, Ben Gurion University of the Negev, Beer Sheva, 84105, Israel.

Cells sense their environment by transducing mechanical stimuli into biochemical signals. Commonly used tools to study cell mechanosensing provide limited spatial and force resolution. Here, a novel nanowire-based platform for monitoring cell forces is reported. Nanowires are functionalized with ligands for cell immunoreceptors, and they are used to explore the mechanosensitivity of natural killer (NK) cells (see figure below). In particular, it is found that NK cells apply centripetal forces to nanowires, and that the nanowires stimulate cell contraction. Based on the nanowire deformation, it is calculated that cells apply forces of down to 10 pN, which is the smallest value demonstrated so far by microstructured platforms for cell spreading. Furthermore, the roles of: i) nanowire topography and ii) activating ligands in the cell immune function are studied and it is found that only their combination produces enhanced population of activated NK cells. Thus, a mechanosensing mechanism of NK cells is proposed, by which they integrate biochemical and mechanical stimuli into a decision-making machinery analogous to the AND logic gate, whose output is the immune activation. This work reveals unprecedented mechanical aspects of NK cell immune function and introduces an innovative nanomaterial for studying cellular mechanics with unparalleled spatial and mechanical resolution.



Schematic drawing of NK activation on MICA-functionalized nanowires. b) SEM of NK cells on MICA-functionalized nanowires.

Protein-based Conductive Materials

Nadav Amdursky

Schulich Faculty of Chemistry, Technion - Israel institute of Technology, Haifa, 3200003, Israel

amdursky@technion.ac.il

Biological charge transfer processes are based on the controlled transport of charges (electrons, protons, ions) across specific pathways within proteins from the nm-scale up to the µm scale. With this biological inspiration, we report here on a new family of conductive and free-standing biological materials. We have used the serum albumin protein to form various types of materials, which were later functionalized in a bioinspired fashion to exhibit efficient electron transport on the centimeter length scales. Furthermore, we show that the protein-based films can be functionalized in different ways for the formation of efficient ionomers with measured ionic conduction of >10 mS/cm at room temperature. Due to the protein-based nature of our materials, it enables us to explore the governing factors and mechanisms of long-range biological charge transport. Nonetheless, our new materials have several attractive properties for their possible integration in various applications. Our materials have high elastic modulus of ~160 MPa, but at the same time they are highly stretchable, capable of stretching more than 4 times their length. They have high resistance to harsh organic solvents and acids, they are very easy to form, and have a very low price tag with materials cost of around $1/cm^2. Currently, we explore the use of the materials for biomedical application (tissue engineering), for organic ionic electrodes and as membranes for fuel cells.

Building a New Materials Toolkit: Using Surface Chemistry to Direct the Morphology and Deposition of Thin Films and Nanoobjects

Amy V. Walker[1*]

[1]Department of Materials Science and Engineering, University of Texas at Dallas, Richardson, Texas, USA
Email: amy.walker@utdallas.edu, web site: http://mse.utdallas.edu/ourteam/faculty/walker-a/

Abstract

Novel and advanced materials and devices for sensors, actuators, molecular and organic electronics, photovoltaics have many exciting applications including in healthcare, electronics, and energy harvesting and generation. However, for these to become integrated into everyday practical devices there are many challenges to be addressed. Perhaps the largest challenge is to direct and control the deposition of materials from the molecular scale to the mesoscale. Further these materials, whether nano-objects or thin films must be integrated into complex functional structures in a predictable and controlled way. In this talk we will describe our recent progress in synthesizing *in situ* with precise placement both nano-objects and films of two-dimensional materials, in particular transition metal dichalcogenides. We exploit our understanding of the common features of gas-phase and solution-based deposition methods to formulate design guidelines to control the *in situ* synthesis and placement of these complex materials with nanoscale precision, and to develop new faster, precise deposition processes.

Plenary talk II: Hanoch Daniel Wagner (WIS) -Recipient of IVS Research Excellence Award -Multiscale nano-bio-composites: Toward stiffer, stronger and tougher materials

Multiscale nano-bio-composites: Toward stiffer, stronger and tougher materials

H. Daniel Wagner
Department of Materials & Interfaces, Weizmann Institute of Science, Rehovot 76100, Israel

ABSTRACT

The biological world is replete with composite structures of various kinds, which could be teaching us important lessons in terms of assembly sophistication and ensuing optimization of mechanical functions in future synthetic composites. In nature the combination of high toughness and stiffness/strength is generally provided by means of multiscale (from nano to macro) fibrous composites, rather than with composite structures at a single scale. This will be clarified by means of examples taken from our recent work with the layered architectures found in sponge spicules, tendon-like multiscale unidirectional structures, and scorpion cuticles. The effect of another key parameter for optimization of composite properties, namely interface design, will be illustrated by means of our recent work on the interfacial adhesion strength in the presence of beads as obstacles leading to crack bifurcation. I will also briefly discuss our research on composite structures that exploit the supreme mechanical properties of individual carbon nanotubes together with the manageability of the microscale carbon nanotube fibers. Time permitting, I will describe just-published results on the high ductility and very large size effects in thin epoxy fibers.

Posters:

	Plasma Science	
P-1001	Daniel Maler – Technion	"Application of photonic doppler velocimetry for velocity measurement of free target accelerated by shock wave"
P-1002	Konstantin Sheverdin – Ariel	Design Off-Axis Confocal Transmission Line for Terahertz Radiation
P-1003	Arujash Mohanty – WIS, Mumbai	"Non-Thermal Guiding for High Intensity Laser"
P-1004	Eitan Levine – WIS	Emittance Reduction by Density Tapering in Laser-Plasma Electron Acceleration
P-1005	Daniel Petukhin – WIS	The effect of pure spin current manipulations on atomic and molecular conductors
P-1006	Sharon Atlas – NRCN/BGU	Optical Diagnostics of Plasma Chemistry Towards a New Waste Treatment Process
P-1007	Ido Barth – HUJI	Kinetic Ladder Climbing and Autoresonant Acceleration of Plasma Waves
P-1008	Mykola Shatalov – Ariel	Investigation of Yttrium doped ZnO films
P-1009	Gilad Marcus – HUJI	Creating and Studying Plasma Structures for Extreme Optics
P-1010	Yang Cao – Technion	The interaction of a ultra-short high-power microwave pulse with preliminarily formed plasma in a cylindrical waveguide
P-1011	Moshe Berreby – Technion/Rafael	Voltage and heat transfer distribution measurements along the constrictor of an arc plasma supersonic wind tunnel
P-1012	Alex Rososhek – Technion	Shock waves generated by underwater electrical explosion of a single wire and planar array
P-1013	Ilan Be'ery – Rafael	Plasma confinement by moving multiple mirrors
P-1014	Arsad Quraishi – Technion	Comparison of PIC and Fluid Simulations for CCRF Discharge with Secondary Electron Emission
P-1015	Ofer Kfir - University of Göttingen	Coherent electron manipulation by whispering-galleryphotons as a path towards stroboscopic attosecond electron-microscopy"
P-1016	Hannah Aharon – BIU	Second Harmonic Generation for surface chemistry using plasmonic structures
P-1017	Hagay Hayun – BGU	Thermal shock resistant electrolyte for cyclable solid oxide fuel cell"
P-1018	Amnon Fruchtman – HIT	Experiments with a Hall Thruster fuelled by Argon
P-1019	Adnan Haj Yhya – Ariel	Non-destructive diagnostic of e-beam
P-1020	Amit Beer - TAU	https://drive.google.com/open?id=1sU5I__lVnVxdFtRkvkNS-usMK-TTCbok

	Microscopy and Spectroscopy of Surfaces and Interfaces	
P-1021	Iital Mordechay - Ben-Gurion University	Novel Materials and Devices for the Study of Mechanical Activity in Human Lymphocytes Cells
P-1022	Chhatrasal Gayner - Technion	Low temperature synthesis of metal incorporated zinc oxide for thermoelectric applications
P-1023	Matan Menahem - Weizmann	Anharmonicity in 2D hybrid halide perovskites
P-1024	Tatyana Bendikov - Weizmann	Imaging with XPS: Advanced Characterization for Advanced Materials and Devices
P-1025	Konstantin Borodianskiy - Ariel	Bioactive coating on Ti-based implants contained Ag antibacterial nanoparticles
P-1026	Alexander Sobolev - Ariel	Bioactive coating on Ti-based implants contained Ag antibacterial nanoparticles
P-1027	Dima Cheskis - Ariel	STM Imaging of deposited graphene oxide on Au substrate
P-1028	Fredy Zypman - Yeshiva	Passive mode scanning probe microscopy for measuring viscoelasticity
P-1029	Vivek Ramakrishnan - Ben-Gurion	Micro-environment dependent nanomechanics of polyfluorinated cationic surfactants containing
P-1030	Yuri Gorodetski - Ariel	Spin-locking plasmonic metasurfaces
P-1031	Chandra Shakher Pathak - Ben-Gurion	Mapping the photocurrent and photovoltage of perovskite films at the nanoscale for stability studies
P-1032	Gil Otis - BIU	Asymmetric induction of e-Zn(OH)2 chiral crystals detected using EPR spectroscopy
P-1033	Maor Asher - Weizmann	Vibrational anharmonicity in organic semiconductors
P-1034	Natali Ostrovsky - Ben Gurion	Direct Imprint of Optical Functionalities on Free-Form Chalcogenide Glasses
P-1035	Ashish Pandey - Ben Gurion	Soft thermal nanoimprint with a 10 nm feature size
P-1036	Liora Maykler - Bar-Ilan	Membranes based on Cyclodextrins nanoparticles for water purification from organic pollutants
P-1037	Heli Levy - Bar-Ilan	Fabrication of microstructures using standing acoustic waves
P-1038	Dina Rosenberg - TAU	Echo Spectroscopy in Gas-Phase Multilevel Molecular Rotors
P-1039	Kamira Weinfeld -Technion	X-Ray Photoelectron Spectroscopy System as a powerful platform for Surface Analysis
P-1040	Dor Harel - Bar-Ilan	Calibrating evanescent-wave penetration depths for biological TIRF microscopy
P-1041	Lee Shelly - BGU	Fabrication and characterization of actinide (Ac = Th, U) doped ceria
P-1042	Honorata Kazimierczak - TAU	Electrodeposition of Zn-SiC nanocomposite layers
P-1043	Arindam Mallick - Ben Gurion	P-type highly conducting and transparent low temperature processed film: A smart combination of wide and narrow band-gap materials
P-1044	Moorthy Maruthapandi - Bar Ilan	Carbon dots initiated polymers of poly (4, 4'-oxybisbenzenamine) and poly (4, 4'-oxybisbenzenamine-pyrrole) macro-nanoparticles for organic dyes adsorption studies
P-1045	Raz Samira-TAU	New Fabrication Methods of Polymeric Nanosamples for in-situ Mechanical Testing in Transmission Electron Microscope
P-1046	Guido Schmitz, University of Stuttgart, Germany	New Tools for Atom Probe Tomography - The modular atom probe
P-1047	Michael Gerasimov	Development of an Artificial Intelligence System for the Design of an Optical Mode Converter
P-1048	Tatyana Kravchuk - Technion	Using TOF-SIMS for researching nanoparticles
P-1049	Aleksei Solomonov, Weizmann I	Probing of lysozyme self-assembly via microfluidics-assided micro- and nano-sized capsules

	Nanomechanics of Materials	
P-1050	Viraj Bhingardive, Ben-Gurion	Site Selective Functionalization of Nanowires For Biological Studies
P-1051	Sivan Tzadka, Ben Gurion	Direct Nanoimprint on Chalcogenide Glasses substrate for Optical Applications
P-1052	Eugen Rabkin, Technion -	Record-breaking strength and solid solution softening in Ni and Ni3Fe nanoparticles
P-1053	Anna Yucknovsky, Technion	Reversible Aggregation of Au Nanoparticles Controlled by Excited State Proton and Hydroxide Transfer
P-1054	Leng-wai Un, Ben-Gurion	Thermo-Optical Nonlinearity of Single Metallic Nanoparticle
P-1055	Paulino Monroy, Ben-Gurion	Modeling two-site H2O2 photo-oxidation on haematite photoanodes
P-1056	Yarden Melamed	Sulfur Coat of Carbon Nanotubes 3D Nano-network for Li-ion batteries Cathodes
P-1057	David Eliyahu Yeshno, TAU	Atomic force microscope-based meniscus-confined three-dimensional electrodeposition

	Epitaxial Films: Science & Technology	
P-1058	Jiawei Xia, Ben-Gurion	Nickel Phosphide Decorated with Trace Amount of Platinum as An Efficient Electrocatalyst for the Alkaline Hydrogen Evolution Reaction
P-1059	Lishai Shoham, Technion	High quality Transparent Conductive Oxide SrVO3 by Molecular Beam Epitaxy
P-1060	Yuanshen Qi, Technion	Solid-state dewetting of iron-carbon thin films and the formation of steel nanowires
P-1061	Amnon Rothman, Weizmann	Kinetics and Mechanism of Planar Nanowire Growth
P-1062	Ilan Baiman, Bar-Ilan	Glass-like relaxation dynamics following the metal to insulator transition of VO2
P-1063	Maayan Perez, Ben Gurion	Chemical Bath Deposition of PbS Thin Films from Acidic Bath

	Scanning Probe Microscopy	
P-1084	Arindam Mallick – BGU	"p-type highly conducting and transparent low temperature processed film: A smart combination of wide and narrow band-gap materials"
	Nanoelectronics and Spintronics	
P-1085	Michael Mirilashvili, Bar Ilan	Fast Fabrication of Decorated ITO as High Performance Hydrogen Sensors

	Surface Science	
P-1075	Joseph Hazan – Technion	" Semi conductive properties of titanium dioxide thin films formed on Ti6Al4V processed by Powder Bed Fusion – Additive Manufacturing. Carrier concentration measured via Mott-Schottky approach"
P-1076	Mitun Das -TAU	Laser based additive manufacturing of ceramic reinforced metal matrix composites
P-1077	Anat Friedman – BGU	"Electrochemical Sensor for Bladder Cancer Detection"
P-1078	Tamir Forsht –WIS	"Surface-Guided Growth of Bi2Se3 Nanowires"
P-1079	Edward Bormashenko – Ariel	"New Investigations of Marangoni-Flow-Driven Self-Propulsion"
P-1080	Amos Bardea – HIT	"A New Method for Chemical Patterning into Non Planar and Closed Volume"
P-1081	Lev Rovinsky – TAU	"Fabrication and Characterization of Alumina and Vertically Aligned Carbon Nanotubes Nanocomposite Materials"
P-1082	Tali Dotan – TAU	"Microelectrodes patterning by supersonic cluster beam deposition (SCBD) and FS laser Processing"
P-1083	Tzuriel Metzger – HUJI	"Utilizing Chiral Induced Spin Selectivity effect to Enantio-separation"

	Soft and Biological Matter	
P-1086	Yuval Agam, Technion	Iron Role in the Electronic Conductivity across Porphyrin doped Serum Albumin Mats
P-1087	Jerry Fereiro, Weizmann	Solid-state Protein-based Reversible Bias-induced Tunneling Current Switch
P-1088	Ganit Indech, Bar-Ilan	Controlling and organizing neuronal networks using magnetic manipulations
P-1089	Nurit Atar, Soreq NRC	Inkjet 3d printing of digital polyimide
P-1090	Margarita Shepelenko, Weizmann	Order and disorder in calcium oxalate monohydrate: insights from first-principles calculations
P-1091	Ofer Manor, Technion	Contributions of surface forces to the deposition of nanoparticles from a volatile carrier liquid
P-1092	Esti Toledo, Ben Gurion	Multifunctional devices for the regulation of cytotoxic activity of natural killer cells
P-1093	David Svetlizky, TAU	Mechanical properties of Bio-Ferrography isolated cancerous cells studied by atomic force microscopy
P-1094	Orlando Marin, Bar Ilan	Colloidal icosahedra and other polyhedra: from synthesis to cross-sectional electron microscopy imaging

	Energy and Sustainability	
P-1064	Alon Shapira, Ben Gurion	Electrically charged tri-stable media with implications to bulk heterojunction in organic photovoltaics
P-1065	Ramesh Nandi – Technion	A Protein Based Thin Film with Mixed Ionic and Electronic Conductivity
P-1066	Roman Nudelman – TAU	Jellyfish -based Smart Wound Dressings Devices Containing in-situ synthesized Antibacterial Nanoparticles
P-1067	Anat Itzhak – BIU	"Can we make Oxide Perovskite/Halide Perovskite Interfaces Selective?"
P-1068	Davide Raffaele Ceratti – WIS	"How A = MA/FA/Cs cations modify the surface and bulk Self-Healing of APbBr3 perovskites and determine their stability prop"
P-1069	Anoop KM – BGU	"Sunlight concentration-dependent degradation of perovskite solar cells"
P-1070	Einat Hauzer – TAU	"Novel protein-gold nanoparticles for solar thermal-powered water desalination system based on the hyperthermia process"
P-1071	Liel Abisdris – BGU	"FORMATION OF CARBON NITRIDE FILMS USING ELECTROPHORETIC DEPOSITION OF SUPRAMOLECULAR ASSEMBLIES FOR ENHANCED PHOTOELECTROCHEMICAL CELL PERFORMANCE"
P-1072	Yonatan Hamo – WIS	"Charge trapping and releasing in multicolor electrochromic nanoscale assemblies"
P-1073	Pallavi Singh - Indian Institute of Science	"Higher open-circuit voltage and improved intrinsic stability of methylammonium perovskite cells via bulky Acetamidinium cation substitution"
P-1074	Adi Azoulay – BGU	" New Paradigm for Materials Design: Synthesis of Carbon Nitrogen Phosphorus Materials Based on Melamine-Phosphate Single Crystals with Sequence Encoded Properties"