



מכון טכנולוגי חולון
Holon Institute of Technology

Auditorium,
Building 6, HIT

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8:30-17:30

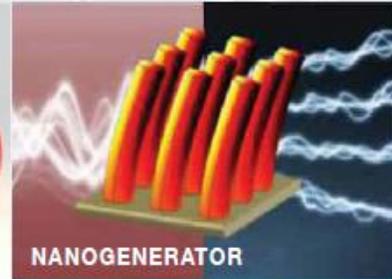
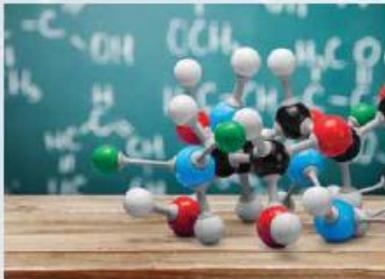
el-tan Technologies Ltd.



3rd International Symposium

NANOTECHNOLOGY FROM ACADEMIA TO INDUSTRY 2017 NTAI 2017

Nano - Bio / Medical
Nano - Energy | Nano - Education



BOOK OF ABSTRACTS

el-tan Technologies Ltd.



אוניברסיטת הברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM



The development of novel medical tools, sustainable energy systems, electronics and photonics are among the greatest challenges of the 21st century. Nanotechnology based on nanomaterials and nanoscience potentially can provide these solutions. The 3rd international symposium NTAI 2017 will be dedicated to the fields of Bio-Nano and Nano-medicine for medical applications, Nano energy and Nano-education. This meeting will bring together people from both academia and industry to share their experience in nanoscience research which already led to industrial applications, or to elucidate how nanoscience could serve to foster development of nanotechnology-based products.

Organizing Committee:

Prof. Reshef Tenne | Weizmann Institute of Science

Dr. Alla Zak | Faculty of Sciences

Dr. Amos Bardea | Faculty of Engineering

Dr. Alex Laikhtman | Faculty of Sciences

Dr. Alex Axelevitch | Faculty of Engineering

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08:30-09:00 **Registration, Coffee and Poster Mounting**

Ground floor, 6th building, HIT-Holon Institute of Technology

09:00-09:15 Opening Session

09:00-09:05 Greetings by **Prof. Eduard Yakubov**, President HIT

09:05-09:10 Greetings by **Prof. Yosef Ben Ezra**, Dean of the Faculty of Engineering, HIT

09:10-09:15 Greetings by **Prof. Ezra Zeheb**, Dean of the Faculty of Sciences, HIT

09:15-09:50 Plenary Lecture

Prof. Itamar Willner, Hebrew University of Jerusalem (HUJI)

Recent Advances in DNA Nanotechnology

Chair: Prof. Reshef Tenne, Weizmann Institute of Science (WIS)

09:50-10:50 Session 1 - Nano-Medicine, Bio-nano and Applications

Chair: Dr. Amos Bardea, HIT

09:50-10:20 **Keynote speaker: Prof. Uri Sivan, Technion**

Water and the Hydrophobic Interaction in X10,000,000 Magnification

10:20-10:50 **Dr. Meltem Sezen, Sabanci University, Turkey**

*Advanced Electron/Ion Microscopy Based Nanostructuring and Nanoanalysis
Applications for Dental Materials and Bioceramic Nanocomposites*

10:50-11:10 Coffee Break and Poster Session

11:10-12:10 Session 2 - Nano-Medicine, Bio-nano and Applications

Chair: Dr. Alexander Axelevitch, HIT

11:10-11:40 **Prof. Nissim Garti, Hebrew University of Jerusalem (HUJI)**

Novel Molecular Liquid Architectures as Delivery Vehicles for Bioactives

11:40-12:10 **Dr. Ilana Cohen, Medinol, Ltd.**

Medical Devices, Nanotechnology and Beyond

12:10-13:10 Session 3 - Teaching Nanotechnology**Chair: Prof. Uri Sivan, Technion****12:10-12:40 Prof. Ron Blonder, Weizmann Institute of Science (WIS)***Nano Goes to School: Bridging the Gap Between Contemporary Research and School Science***12:40-13:10 Prof. Miri Barak, Technion***Project-Based Nanotechnology: Examining Knowledge Construction and Motivation to Learn***13:10-14:10 Lunch and Poster Session****14:10-15:40 Session 4 - Nano-Energy****Chair: Prof. Alla Zak, HIT****14:10-14:40 Prof. Ashwin Ramasubramaniam, University of Massachusetts, Amherst, USA***Graphene-Supported Pt Nanoparticles as Efficient Fuel-Cell Catalysts - the First-Principles Study***14:40-15:10 Prof. Yair Ein-Eli, Technion***Towards Higher, Thinner, Flexible and Loaded Li-ion Batteries***15:10-15:40 Prof. Sabrina Sartori, Oslo University, Norway***Nanoconfined Hydrides for Vehicular Hydrogen Storage***15:40-16:00 Coffee Break and Poster Session****16:00-16:40 Distinguished Plenary Lecture****PROF. SUMIO IIJIMA, Meijo University, Japan***Carbon nanotubes: Science and Technology***Chair: Prof. Itamar Willner, Hebrew University of Jerusalem (HUJI)****16:40-17:40 Session 5 - "Nano-Energy"****Chair: Dr. Alexander Laikhtman, HIT****16:40-17:10 Keynote speaker: Prof. Marius Enachescu, University Politehnica of Bucharest***Novel Reactor for Synthesis of Carbon Nanotubes, Carbon Nano-Onions and Graphene and Nanotubes Applications in Photovoltaic Cells***17:10-17:40 Dr. Miles Page, PO-CellTech, Ltd.***Low-Cost Fuel Cells from Hydroxide Exchange Membranes***17:40-18:00 Poster Awards and Closing Remarks**

BM1

Plenary Lecture:

Recent Advances in DNA Nanotechnology

Itamar Willner,

Hebrew University of Jerusalem, Israel

BM2**Water and the Hydrophobic Interaction in X10,000,000
Magnification****Uri Sivan**

Department of Physics and the Russell Berrie Nanotechnology Institute – Technion, Israel

The governing role of hydrophobic interactions in countless biological phenomena and technological systems, including protein folding, transmembrane proteins, cell membranes, detergents, paints, decontamination of pollute water, and more, has motivated extensive theoretical and experimental efforts aimed at deciphering the microscopic foundations of this interaction. Yet, after more than a century of extensive research a full predictive theory of this elusive phenomenon is still missing, largely due to the lack of suitable experimental techniques capable of probing the interface between hydrophobic surfaces and water at high enough resolution. In the talk, I will present our recent explorations of this interface using an ultra-high resolution atomic force microscope built in-house for the task and disclose compelling evidences that the hydrophobic interaction reflects a phase transition taking place in the medium when two hydrophobic surfaces approach each other to within a few nanometers. Microscopic characterization of this transition and its essential ingredients will be presented and discussed.

BM3**Advanced Electron/Ion Microscopy based Nanostructuring and Nanoanalysis Applications for Dental Materials and Bioceramic Nanocomposites****Meltem Sezen and Feray Bakan**Sabanci University Nanotechnology Research and Application Center (SUNUM), Istanbul,
Turkey

The fast development in nanotechnologies has assigned high resolution imaging and precise chemical analysis based electron microscopy applications as the inseparable part of advanced research. Especially, Focused Ion Beam (FIB) technology is used in various research fields, e.g., materials science, chemistry, medicine, biology and pharmacology for site specific analysis, ion milling, deposition, micromachining, prototyping, manipulation and TEM specimen preparation. FIB/SEM platforms allow for the collection of numerous 2D data from the ion-milled cross-sections across the material, by which structural and physical information can be constructed in 3D. By this means, it is possible to determine the elemental, chemical and/or morphological distribution from hundreds of microns, down nanometers in a specific volume. In addition to TEM sample preparation, this method provides fast and informative analysis of dental tissues and bioceramic nanocomposites, such as bone grafts and artificial bone structures, having tubular channels, porous networks, compositional distributions and micro cracks. In this study different applications of electron and ion beam based nanostructuring were applied on human tooth, HAp-BN nanocomposites, dental/bone implants and grafts. Complementary analyses on these materials were carried out using TEM, AFM and Raman Spectroscopy techniques for a detailed examination of morphology and chemistry.

BM4**Novel Molecular Liquid Architectures as Delivery Vehicles for Bioactives****Nissim Garti**

Casali Center of Applied Chemistry, The Institute of Chemistry, The Hebrew University of Jerusalem, Israel

Our studies in the last decade are aimed to develop novel liquid vehicles fully-dilutable with water that exhibit high loading capacity of the bioactives and generic drugs. The 'tailor-made' novel molecular vehicles can enhance the delivery of the bioactives across human membranes.

The vehicles are based on molecular architectures of surfactants and other FDA-permitted compounds embedded in the vehicles. The designed nanostructures can be unique modified swollen micelles (no oil), microemulsions, biopolymers solutions, lyotropic liquid crystals, sponge phases, biopolymer amphiphilic gels, embedded dendrimers, oleogels, etc.

The structures are self-assembled, spontaneously formed, thermodynamically stable, bacteriology-free and monodispersed.

In this presentation we will demonstrate progress that was made in determination of the prerequisites for constructing the mesophases and the correlation between the bioactives and the 'tailor-made' structures.

Compositions, type and nature of the interfaces and cores, physical and chemical characteristic of the structures were studied by advanced analytical techniques. Phase transitions and loading mechanism, along with 'on-demand' discharge, or release, of the bioactives will be discussed.

Several examples of drugs solubilized by this technology will be presented.

BM5**Medical Devices, Nanotechnology and Beyond****Ilana Cohen**

Medinol Company, Israel

Coronary artery disease affects patients worldwide and is major cause of morbidity and mortality. Coronary artery stenting is the treatment of choice for patients requiring coronary angioplasty. Stents, and particularly drug eluted stents reduce the risk of restenosis, but may be associated with the hazard of late stent thrombosis (LST).

In the frame of this meeting, the evolution of nanotechnology in the stents development and industry, thrombosis treatment, will be reviewed.

Coronary stents are tubular devices placed by a delivery system within a coronary blood vessel for the treatment of patients with coronary artery disease. Stents support a segment of a blood vessel or any other anatomical lumen to preserve or regain its patency. Coronary stents are one of the most used implantable medical devices in the USA.

Several types of stents are currently on the market: bare metal stents (BMS) that belong to the first generation of stents and still in use in some countries, drug-eluting stents (DES) – the second generation and bio-resorbable vascular scaffolds (BVS) that are the third generation of stents, and still under development and clinical trails

As nanotechnology applications in the field of medical devices span a wide range of extremely diverse products, the applications in the stents field holds great promise.

Several nanocoated metal and drug-eluting stents for the treatment of patients with coronary artery disease are currently available.

An over view on the different techniques will be shared, focusing on technologies of stent drug nanocoating, inkjet of drug nanodroplets, polymer free nanocoating, nanofiber covering, nano-analyses after implantation and clinical prospective to nanotechnology treatment in the coronary stent world.

Ed1**Nano Goes to School: Bridging the Gap Between Contemporary Research and School Science****Ron Blonder**

Department of Science Teaching, Weizmann Institute of Science, Israel

Currently there is a growing body of knowledge examining learning science through contemporary research and cutting-edge development of scientific ideas, e.g., nanoscience and nanotechnology (Jones, Blonder, Gardner, Albe, Falvo, & Chevrier, 2013). According to this approach, students have high interest and motivation to learn modern aspects of science, and they gain high-order skills and conceptual understanding as well. It should be noted that this approach is very challenging for science teachers, who need to continuously participate in professional development programs to update their knowledge. Contemporary research also provides an authentic view into the way scientists conduct their research (Blonder & Sakhnini, 2015). In the lecture I will describe the example of integrating nanoscience and nanotechnology in school science. I will present research results examining questions, such as: What should be taught if we wish to teach nanoscience (Sakhnini & Blonder, 2015, 2016)? How it should be taught (Blonder & Sakhnini, 2012)? What are the advantages? What are the limitations? How do they influence students' motivation and interest towards science? And how are teachers influenced by the integration of contemporary research in their teaching (Blonder & Mamlok-Naaman, 2016)?

References:

Blonder, R., & Mamlok-Naaman, R. (2016). Learning about teaching the extracurricular topic of nanotechnology as a vehicle for achieving a sustainable change in science education. *International Journal of Science and Mathematics Education, 14*, 345-372. doi:10.1007/s10763-014-9579-0

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Sakhnini, S., & Blonder, R. (2016). Nanotechnology applications as a context for teaching the essential concepts of NST. *International Journal of Science Education, 38*(3), 521-538. doi:10.1080/09500693.2016.1152518

Ed2**Project-Based Nanotechnology: Examining Knowledge Construction and Motivation to Learn****Miri Barak**

The Faculty of Education in Science and Technology, Technion, Israel

Learning nanotechnology is challenging since it is an interdisciplinary subject, in which science, engineering, and technology are conducted at the nanoscale. It is even more challenging to learn it online from distance. The current lecture presents an instructional framework and lessons learned from a course in nanotechnology and nanosensors that was delivered as a massive open online course (MOOC). The MOOC offers free learning materials that can be accessed not only by university-affiliated students, but also by participants from all over the world who are interested in learning about the next generation of technological devices. A mixed methods research was conducted to examine the role of project-based learning in the process of knowledge construction and motivation to learn nanotechnology. The study compared between two groups of learners: university-affiliated students and general participants. Findings indicated positive attitudes about learning in a project-based MOOC, especially with relation to gaining work experience. Findings also indicated that in a project-based setting, the general participants were mostly driven by a desire to establish connections with peers, whereas university-affiliated students were mostly motivated by their interest in the subject matter. This study provides insights about cultural and epistemological aspects of nanotechnology education in a multicultural setting.

E1**Graphene-Supported Pt Nanoparticles as Efficient Fuel-Cell Catalysts a First-Principles Study****Ashwin Ramasubramaniam**Department of Mechanical and Industrial Engineering
University of Massachusetts Amherst, Amherst, USA

Platinum and Pt-group metals are widely used as anode materials in fuel cells due to their high activity and selectivity. Complementarily, carbonaceous materials such as activated carbon and carbon black and, more recently, nanostructured forms of carbon such as nanotubes and graphite nanofibers are widely used as catalyst supports because of their high surface areas, excellent electrical conductivity, resistance to corrosion, and structural stability. In recent years, numerous experiments have shown that sub nanometer Pt nanoparticles supported on graphene exhibit increased stability, uniform dispersion, tolerance to CO poisoning, and exceptionally high activity for oxidation reactions, making them attractive candidates as electrocatalysts in direct methanol fuel cells, proton exchange membrane fuel cells, and hydrogen fuel cells. Guided by rapid advances in computational modeling, a fundamental understanding of support effects on the catalytic activity of nanoparticles is now emerging and holds much promise for rational catalyst design.

Here, we focus on the adsorption and reaction thermodynamics of the methanol decomposition reaction (MDR) on graphene-Pt nanocomposites, which is of immediate relevance to the design of improved anode materials for direct methanol fuel cells. Using first-principles density functional theory modeling, we investigate the adsorption and reaction thermodynamics of MDR intermediates on defective graphene-supported Pt nanoclusters. We find that support-induced shifts in catalyst electronic structure correlate well with an overall change in adsorption behavior of MDR intermediates and that the reaction thermodynamics are modified in a way that suggests the potential of greater catalytic activity. We also find that adsorption energy predictors established for traditional heterogeneous catalysis studies of MDR on macroscopic crystalline facets are equally valid on catalyst nanoclusters with irregular, low-symmetry surface morphologies. Our studies provide theoretical insights into experimental observations of enhanced catalytic activity of graphene-supported Pt nanoclusters for MDR and suggest promising avenues for further tuning of catalytic activity through engineering of catalyst–support interactions.

E2**Towards Higher, Thinner, Flexible and Loaded Li-ion Batteries****Yair Ein-Eli**

Department of Materials Science and Engineering and Nancy & Stephen Grand Technion Energy Program (GTEP), Technion, Israel

Electrochemical systems are being thought as the solution for the vast demand for high energy density in both portable and stationary devices. Such systems hold a great promise, while pressure on researchers grows as the need for more “juice” in mobile device (from small hand held electronic to large mobile systems as EV) dramatically increase as technology is rapidly evolving.

In this talk, we will describe a possible transition from copper and aluminum current collectors into carbon nano tube (CNT) tissues. Such transition may substantially reduce the overall weight of the battery, and at the same time would allow more volume in the cells to be subsequently loaded with the active electrode materials. We will describe the processes needed for implementing CNT tissues in Li-ion batteries, as well as overcoming the massive irreversible capacity associated with the buildup of the solid electrolyte interphase (SEI) onto both the graphite and the CNT surfaces.

E3**Nano-Confined Hydrides for Vehicular Hydrogen Storage****Sabrina Sartori**Department of Technology Systems – Section for Energy Systems, University of Oslo, Oslo,
Norway

One of the most promising routes towards a hydrogen economy is the use of hydrogen as energy vector for vehicular and stationary applications in the form of solid storage materials, such as hydrides. Practical utilization of these compounds is challenging because of their slow kinetics and high thermodynamic stability and thus far none of the studied materials satisfactorily meets the targets set by the U.S. Department of Energy for the vehicular applications.

Much emphasis has been placed on the synthesis of nano-sized particles as an alternative way to improve the properties of the hydrides. Due to the characteristics of these nano-confined composites, powder X-ray and neutron diffraction were not useful in analysing the data and some doubts were raised concerning the effective inclusion of the hydrides inside the pores of the scaffolds. We therefore proposed the use of small-angle scattering as a method to investigate the new class of nano-confined hydrogen storage materials.

We demonstrated via small-angle neutron scattering (SANS) the successful wet or melt infiltration of $\text{Mg}({}^{11}\text{BD}_4)_2$, NaAlD_4 , MgD_2 and a mixture of $\text{Li}^{11}\text{BD}_4\text{-Mg}({}^{11}\text{BD}_4)_2$ into nano-carbon templates. Depending on the hydride and/or the scaffold used, the particle sizes were found to range from 1 to 6 nm. Combining SANS and *in situ* small-angle X-ray scattering (SAXS), it was possible to underline important differences in the morphology and surface area of the hydride particles during heating when they are confined in the nano-porous scaffolds, compared to their values in the bulk state. Kinetic and thermodynamic effects due to the nano-confinement will be discussed in view of the application of these materials for vehicular hydrogen storage.

Distinguished Plenary Lecture:

Carbon nanotubes: Science and Technology

Prof. Sumio Iijima, Meijo University, Japan



E4**Novel Reactor for Synthesis of Carbon Nanotubes, Carbon Nano-Onions and Graphene, and Carbon Nanotubes Applications in Photovoltaic Cells****Marius Enachescu**

Center for Surface Science and Nanotechnology, University Politehnica of Bucharest, Romania
Email: marius.enachescu@upb.ro

A review of our achievements in the field of single-walled carbon nanotubes (SWCNTs) synthesis by means of pulse laser vaporization will be presented. Statistic results about the influence of different technological parameters on the SWCNTs synthesis will be reported. A new laser ablation chamber designed for Kr-F excimer laser experiments and a new route for target preparation will be reported. Based on our best knowledge, there is no reported data about the possibility of using only graphite cement for target preparation in such experiments. In our experiments, the use of this graphite precursor has eliminated the need for pressing or hot pressing treatments.[1,2] Comparison in between this new route and the classic one in terms of SWCNTs production will be reported. We will report results about the influence of the ablation target composition on the formation of SWCNTs as well as the influence of the carrier gas used in the experiments. Finally, tuning the target composition as well as the ablation parameters we were able to synthesize SWCNTs, carbon nano-onions and graphene using the same reactor. These studies were done on graphite targets undoped or doped with metallic catalysts such as mono-component dopants such as Co, Ni, Pt or bi-component dopants like Co/Ni or Co/Pt. All reported results are based on morphological and structural characterization performed by Transmission Electron Microscopy, micro-Raman spectroscopy and Thermogravimetric analysis. Finally, will be presented our initial steps in the implementations of the third generation solar cells using SWCNTs we produce.

1. P-M. Bota, D. Dorobantu, I. Boerasu, D. Bojin, M. Enachescu, *Materials Research Innovations*, vol. **19**, no. **1**, 33 (2015).
2. P-M. Bota, D. Dorobantu, I. Boerasu, D. Bojin, M. Enachescu, *Surface Engineering and Applied Electrochemistry*, vol. **50**, no.**4**, 294 (2014).

E5**Low-Cost Fuel Cells from Hydroxide Exchange Membranes****Miles Page**

PO-CellTech Ltd, Israel

In the race to decarbonize the consumer automotive industry, battery-electric vehicles (including all-electric and plug-in hybrid vehicles) have made significant inroads with Tesla currently showing the way in all-electric battery vehicles.

Meanwhile, production-scale Hydrogen Fuel Cell Vehicles (FCEV's) have finally hit the roads in California, Germany and Japan. FCEV's have some natural advantages over battery vehicles – most significantly, the ability to decouple vehicle range from the size of the device, and the ability to “refuel” in a few minutes rather than much longer battery charging times. However, if they are to be commercially successful there are two critical factors that need to be overcome: The cost of the fuel cell engine, and the hydrogen distribution network.

Today the fuel cells of choice for the automotive industry are based on Proton Exchange Membranes (PEM): These fuel cells have high power density, run at low temperatures (<100°C) and are well-suited to the dynamic power outputs demanded in powering an automobile. However significant cost barriers limit their market potential including high manufacturing and material costs, especially, large amounts of platinum required in the electrocatalyst and fluorinated polymer membranes.

Fuel Cells based on Hydroxide Exchange Membranes provide significant potential to alleviate these key cost barriers – most especially the ability to work with non-platinum catalysts and low-cost hydrocarbon membranes. The approach comes however with significant, fundamental scientific / technological challenges at the meso-scale where interwoven organic and inorganic nanomaterials are interwoven to make up the membrane-electrode assembly which is the heart of the fuel cell device. In this talk I will examine these challenges perspective and recent progress in hydroxide exchange membrane fuel cell performance.

P1**Directed Assembly of Nano Particles by a Modulated Photo-Induced Microbubble**

Nina Armon¹, Udi Greenberg¹, Michael Layani², Shlomo Magdassi² and Hagay Shpaisman¹

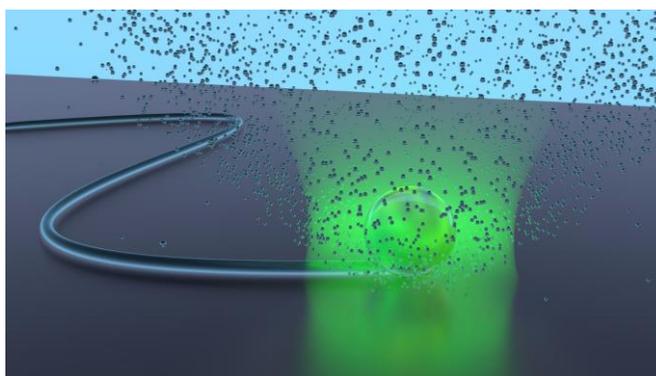
¹Chemistry Department, Institute for Nanotechnology and Advanced Materials, Bar-Ilan University, Ramat-Gan, Israel

²Casali Center for Applied Chemistry, Institute of Chemistry, The Hebrew University of Jerusalem, Jerusalem, Israel

The laser induced microbubble technique (LIMBT) has been previously demonstrated for assembly of various materials. The principle of this method is that a microbubble formed by laser heating leads to material deposition at the bubble/substrate interface. Moving the focused beam relative to the sample results in the migration of the microbubble and constant deposition of additional material. The major limitation of this technique is its instability, resulting in non-continuous deposition.

Here we show how modulation of the laser, thus controlling the construction and destruction rate of the microbubble, allows formation of significantly thinner and more continuous patterns. We verify the continuity of the formed patterns by measuring the conductance of deposited metallic nanoparticles.

We furthermore apply this improved technique to construct more complex structures than previously possible using metals, oxides, polymers and various combinations of the former (hybrid structures). This exemplifies the ability of this method to be used for various foreseen applications such as transparent conductors and sensors.



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P2**First Principles Based Computations of The Scattering of Ar from A LiF(001) Surface [1,2]****Asaf Azuri and Eli Pollak**

Chemical Physics Department, Weizmann Institute of Science, Israel

Scattering of particles from surfaces is a useful tool for probing surfaces. Detailed experimental results for the scattering of Ar from a LiF(001) surface are available for more than 10 years [3,4]. The angular distribution which is associated with the scattering along the [100] surface direction possesses a double peak asymmetric structure. As the incident energy of the Ar atom is decreased the peak-to-peak distance and the asymmetry of the angular distribution are increased. On the other hand, the scattering process along the [110] surface direction yields a uni-modal structure, where as the incident energy of the Ar atom is decreased the angular distribution is shifted towards lower scattering angles.

In the current presentation we suggest a realistic approach to model the aforementioned scattering process. A precise fit to the 3 dimensional ab-initio potential of the Ar-LiF(001) system is suggested and the classical dynamics is worked out numerically. A quantitative agreement with experimental results and a better understanding of the scattering process are achieved. Several lessons come out of this study: (1) The functional form of the realistic potential is unravelled. (2) The corrugation of the potential along the [100] surface direction is much stronger than above the [110] surface direction which affects largely the measurements of bi- and uni-modal structures of the angular distributions. (3) We show the effect of the second horizontal dimension (y) on the in-plane (x, z) angular distribution. (4) The scattering along the [110] surface direction takes place especially above the lines which connect the Li or F atoms, whereas the scattering along the [100] surface direction is 3 dimensional where the Ar atom travels temporarily in the y direction while it is in the vicinity of the surface.

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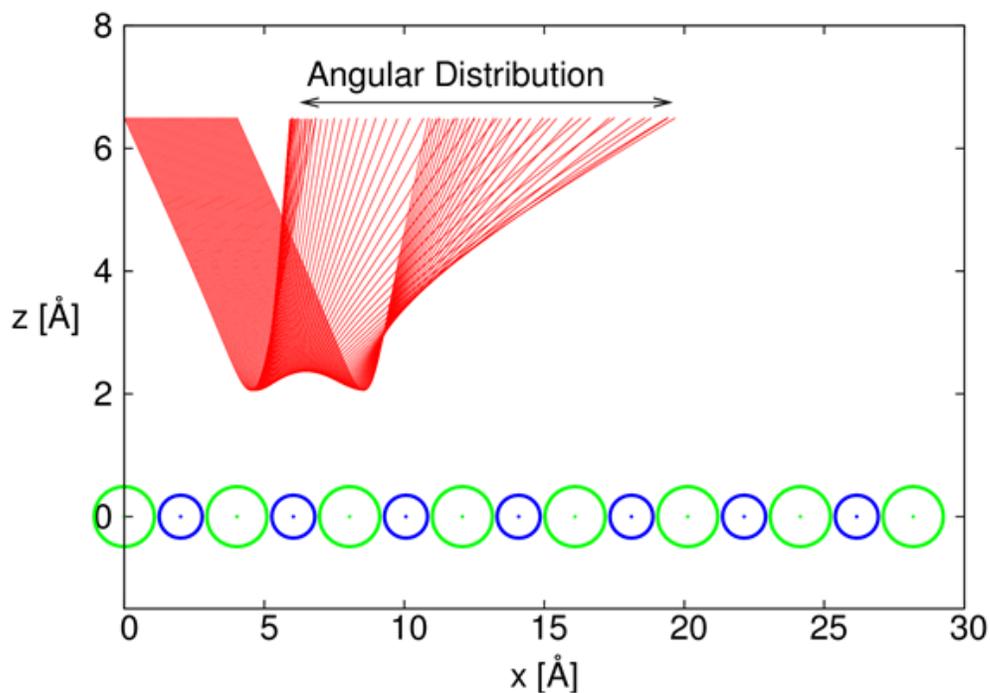


Fig.1: The 2D scattering process of Ar from the LiF(001) surface along the [100] surface direction. Red lines represent trajectories of the Ar atom.

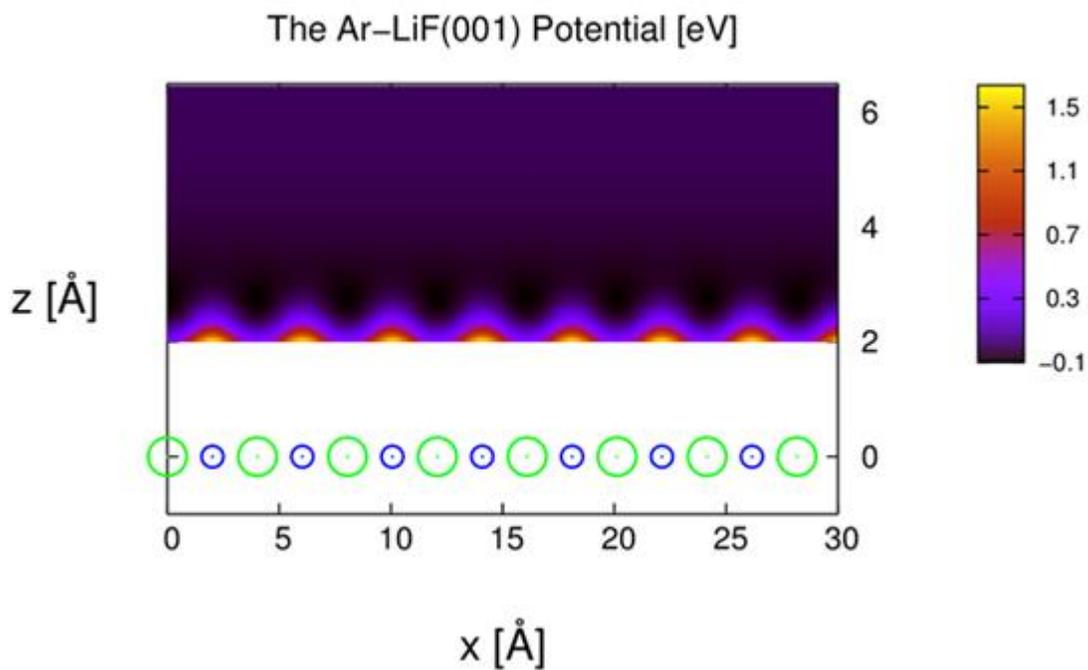


Fig.2: The Ar-LiF potential exactly on top of the line which connects the atoms.

P3**Origin and Structure of Polar Domains in Doped Molecular Crystals*****Ido Azuri,¹ Elena Meirzadeh,¹ Yubo Qi,² David Ehre,¹ Andrew Rappe,²
Meir Lahav,¹ Igor Lubomirsky,¹ Leeor Kronik¹**¹Weizmann Institute of Science, Israel²University of Pennsylvania, USA

Doping is a primary tool for the modification of the properties of materials. Occlusion of guest molecules in crystals generally reduces their symmetry by the creation of polar domains, which engender polarization and pyroelectricity in the doped crystals. Here we describe a molecular-level determination of the structure of such polar domains, as created by low dopant concentrations (<0.5%). The approach comprises crystal engineering and pyroelectric measurements, together with dispersion-corrected density functional theory and classical molecular dynamics calculations of the doped crystals, using neutron diffraction data of the host at different temperatures. This approach is illustrated using centrosymmetric α -glycine crystals doped with minute amounts of different L-amino acids. The experimentally determined pyroelectric coefficients are explained by the structure and polarization calculations, thus providing strong support for the local and global understanding of how different dopants influence the properties of molecular crystals.

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P4

Composite Metal-Organic Assemblies: Redirecting Electron Transfer

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Chemical modification of conductive surfaces with composite molecular assemblies brings about new and useful properties. This work focuses on understanding and controlling electron transfer in molecular materials, which is demonstrated by the formation of electrochemical rectifiers, photoelectrochemical cells, and photovoltaic devices. We use redox-active metal-polypyridyl complexes and organic chromophores to construct our composite materials utilizing Pd(II)-pyridine coordination chemistry. These materials can pass electrons selectively in directions that are determined by their molecular composition and nano-scale arrangement. The electron transfer processes can be made dominantly uni- or bidirectional. Unidirectional and opposite ET is achieved and controlled by generating well-separated and homogeneous layers of complexes having different redox potentials that thermodynamically allow either oxidation or reduction. Combining the individual components of these materials into one film, bidirectional current flow through different pathways was demonstrated.¹ Furthermore, we introduce a method to structurally modify our assemblies using light and by that, modify the nature of the electron transfer processes. In this process, we conduct a photochemical reaction that results in a reduced degree of conjugation through the assemblies and an increased porosity. Higher porosity allows a more efficient mass transport within the assemblies, thereby, enhancing the electrochemical communication.²

The ability to reversibly switch the properties of materials using external stimuli is an important concept in contemporary materials science, as it opens the route towards the development of new functional materials. Dual-stimuli responsive metal-organic assemblies were used for reversible charge storage systems in solution and solid-state. The nano-scale surface arrangement of the complexes enables mutual redox reactions that result in charge trapping when performed in the dark and, subsequently, charge release upon irradiation.

By using pyridine coordination chemistry with metal ions, we have shown that different and functional molecular assemblies can be formed. The discussed assemblies allow for interface engineering and provide great control of the resulting properties.

[1] R. Balgley, S. Shankar, M. Lahav, M. E. van der Boom, *Angew. Chem. Int. Ed.*, **54**, 12457 (2015).

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P5

Morphology Effect on Charge Transport in Doped Bovine Serum Albumin Self-Assembled Monolayers

Edith Beilis^{1,2}, Yonatan Horowitz^{3,4}, Alon Givon⁵, Gabor Somorjai^{3,4}, Hagai Cohen^{6*},
Shachar Richter^{*1,5}

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Direct exploration of the mutually interfering morphological and charge transport characteristics in self-assembled monolayers (SAMs) is reported. The challenges encountered by these cross-dependencies are addressed by means of surface spectroscopy techniques, combined such as to consistently account at high sensitivity for a broad range of surface properties. Applied to doped bovine serum albumin (BSA) SAMs, we show how the BSA conformation, its dehydration and monolayer assembly are all correlated. Moreover, the electrical properties, transport and charge trapping, are highly affected by the SAM compositional and structural state, with a specific roll of water molecules. Our results reveal and further demonstrate a useful approach to the complex challenges presented by (bio) molecular electronics

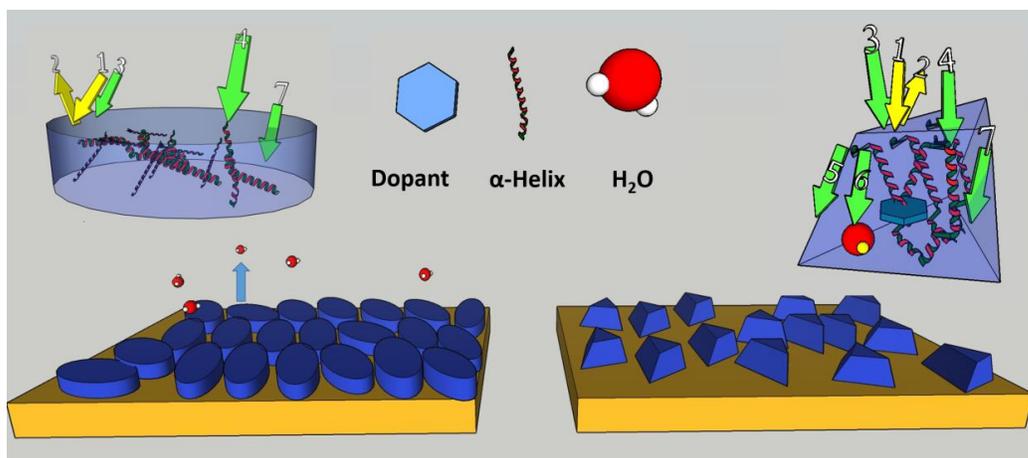


Figure 1: Schematic illustration of the charge transport mechanism and its coupling to morphology and doping.

P6

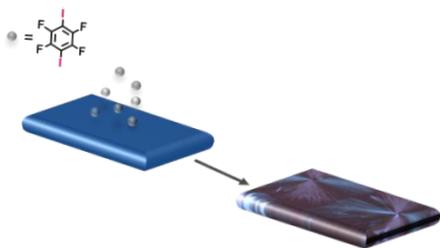
Formation of 3D Halogen-Bonded Networks

O. Chovnik¹, L. J. W. Shimon², M. Lahav¹ and M. E. van der Boom¹

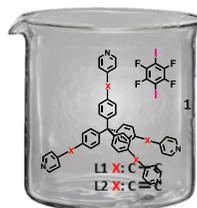
¹The Weizmann Institute of Science, Department of Organic Chemistry, Rehovot, Israel.

²The Weizmann Institute of Science, Department of Chemical Research Support, Israel.

Ordered 3D molecular networks have a wide range of potential applications such as gas storage,¹ gas separation,² and sensing.³ Examples of porous solids are metal-organic frameworks (MOFs), covalent organic frameworks (COFs), and hydrogen-bonded organic frameworks (HOFs). The main interaction driving the assembly of the building blocks in MOFs, COFs, and HOFs is coordinative, covalent, or hydrogen bonding, respectively. An intermolecular interaction that can compete with the hydrogen bond is the halogen bond. Halogen bonding (XB) is a non-covalent interaction that is particularly interesting due to its directionality, bond strength, and structure-directing capabilities.^{4,5} This work is focused on utilization of halogen bonding in preparation of porous solids in a solvent-assisted and solvent-free assemblies.⁶ XB-based 3D networks **L1·1** and **L2·1** with continuous channels of 347 Å³ and 432 Å³ per unit cell, respectively, were constructed from tetrahedral pyridine-based ligands **L1**, **L2** and 1,4-diiodotetrafluorobenzene (**1**) in a solvent-assisted approach. Our solvent-free approach⁷ resulted in the formation of halogen-bonded crystalline films. The surface-mediated halogen bonding-based assembly resulted in a different arrangement of the components compared to the bulk, suggesting an alternative pathway to the network formation on solid supports.



Solvent-free approach



Solvent-assisted approach

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P7

Spherical Inorganic Cells: Versatile Rationale for Uniquely Deliberated Confinement at The Nanoscale

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The unique spherical nanocapsules/Keplerates of the type $\{ \{ (\text{Mo})\text{Mo}_5 \}_{12} \text{M}'_{30} \}$ ($\text{M}' = \{ \text{Mo}^{\text{V}}_2 \}$, V^{IV} , Cr^{III} , Fe^{III}) (more generally: (pentagon)₁₂(spacer/ligand)₃₀) allow – due to their exceptional structural features and easy variations/derivatizations – versatile chemistry and applications as well as the option to study new phenomena of interdisciplinary interest.¹ In this poster we specially refer on the interesting neutral/charged species of $\{ \{ (\text{Mo}^{\text{VI}})\text{Mo}^{\text{VI}}_5\text{O}_{21}(\text{L})_6 \}_{12} \{ \text{Fe}^{\text{III}}(\text{H}_2\text{O})\text{L} \}_{30} \}$ ($\text{L} = \text{H}_2\text{O}/\text{CH}_3\text{COO}^-/\text{Mo}_2\text{O}_8^{9-}$) **1a**/type² not only because of their tremendous unusual magnetic properties which exhibit spherical networks based on corner-shared M'_3 triangles causing geometrical frustration analogous to that of the planar Kagomé lattices but also for their behavior as unique weak polyprotic acids owing to the external water ligands attached to the M' metal centers. In the second part we refer to the fact that the capsule $\{ \{ (\text{Mo}^{\text{VI}})\text{Mo}^{\text{VI}}_5\text{O}_{21}(\text{H}_2\text{O})_6 \}_{12} \{ \text{Mo}^{\text{V}}_2\text{O}_4(\text{CO}_3) \}_{30} \}^{72-}$ **2a**³ containing 30 carbonate ligands is a potential starting reagent for the synthesis of novel capsules with weakly coordination ligands such as fluoride ions $\{ \{ (\text{Mo}^{\text{VI}})\text{Mo}^{\text{VI}}_5\text{O}_{21}(\text{H}_2\text{O})_5\text{F} \}_{12} \{ \text{Mo}^{\text{V}}_2\text{O}_4(\text{F})(\text{H}_2\text{O}) \}_{30} \}^{69-}$ **3a**.⁴

¹ A. Müller, P. Grouzerh, *Chem. Soc. Rev.*, **2012**, *41*, 7431.

² A. Müller, S. Sarkar, S. Q. N. Shah, H. Bögge, M. Schmidtman, S. Sarkar, P. Kögerler, B. Hauptfleisch, A. X. Trautwein, V. Schünemann, *Angew. Chem. Int. Ed.*, **1999**, *38*, 3238.

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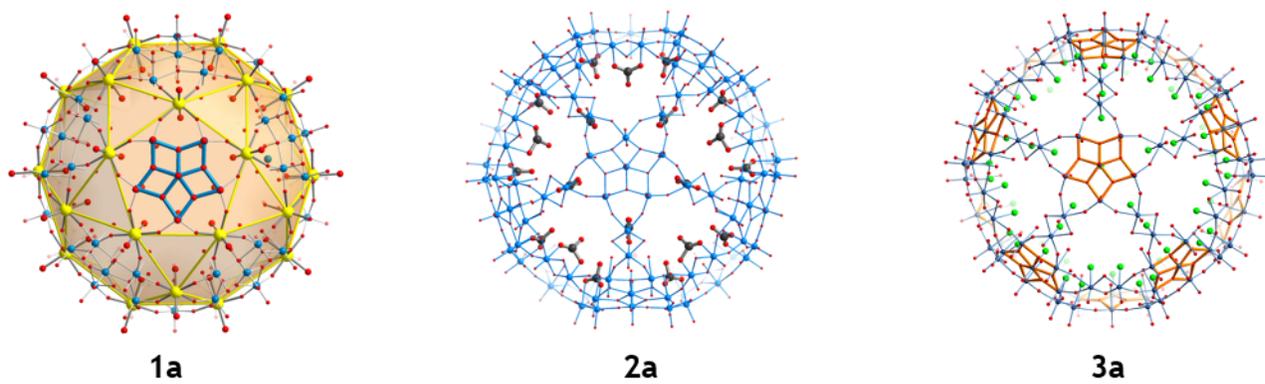


Fig. Ball-and-stick representation for the structures of **1a**, **2a** and **3a**

P8**Electronic Nose for Quality Monitoring of Black Tea****Saptarshi Ghosh^{a,*}, Bipan Tudu^a, Nabarun Bhattacharyya^b and Rajib Bandyopadhyay^a**^a Dept. of Instrumentation and Electronics Engg. Jadavpur University, Kolkata, India^b CDAC-Kolkata, Salt Lake Electronics Complex, Kolkata, India^{*} Faculty of Science, Holon Institute of Technology, Israel

While tea ranks only next to water in the pedigree of globally consumed beverages, the quality monitoring of tea leaves in the industries is conventionally monitored through organoleptic perceptions of tea tasters. The error prone subjective process inspired the development of electronic nose prototypes (E-Nose), which provide a scientific validation to the estimations of the tasters. However, the standard E-Nose prototypes utilize an aggregation of commercial chemical sensors and rely on the cross-interference of these sensors towards the volatile organic compounds emanated from black tea. In the present work we report on development of indigenous metal oxide semiconductor (MOS) sensors with tailored attributes specifically for detecting the emanated volatile organic compounds (VOC) with high odour activity values within the aroma *viz* linalool, geraniol, methyl salicylate and trans-2-hexenal. Subtle variations in the VOCs concentrations change the entire aroma profile among different batches of tea. Specifically we developed tin dioxide (SnO₂) and zinc oxide (ZnO) based sensors for selectively detecting the VOCs. The response and the specificity for these sensors were enhanced through incorporation of additives and rendition of distinct morphologies. The sensing materials were electronically and structurally characterized by established techniques known by material researchers. **Figure 1(a-b)** shows a collation of the microscopic images for three such ZnO and SnO₂ based sensing nanomaterials. The mechanism for detection of the MOS sensors involves iteration of chemisorption of oxygen adatoms followed by the oxidation of the target analyte by these adatoms and subsequent release of trapped electrons. Therefore the additives were introduced which would facilitate the catalytic oxidation of the analytes. For example, decoration of gold nanoparticles on the surface of ZnO flakes (**Figure 1(b)**) resulted in multifold increase in the sensitivity of these sensors towards linalool compared to their pristine counterpart. Altering the morphology in the nanoscale also had a profound effect on the sensitivity as flake like structures provided higher surface area and consequently larger active sites for the target analytes to get oxidized. Specifically, five sensor compositions, namely BaO-SnO₂, SrO-SnO₂, Ag₂O-SnO₂, Au

decorated SnO_2 and La_2O_3 loaded SnO_2 sensors showed better performance compared to others. Initially the performances of the sensors were calibrated towards low concentrations of the VOCs before exposing them discreetly to the different grades of black tea with varying aroma quotient. The sensors with optimal performance were then introduced within the array of the electronic nose. Initially the E-Nose comprised of five commercial sensors procured from Figaro Inc. Gradually the indigenous sensors could successfully replace three commercial sensors in the array and the present version of the E-Nose dedicated for black tea quality monitoring comprise of a hybrid array. A schematic diagram of the electronic nose has been presented in **Figure 2**. Standard soft computing techniques are utilized on the data generated by the E-Nose to determine the efficacy of the prototype in classifying different grades of black tea with varying aroma quotient.

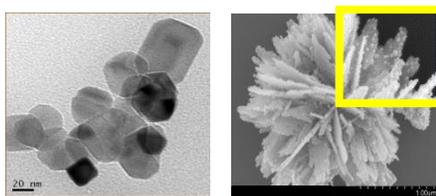


Fig. 1. Microscopic images of (a) BaO-loaded SnO_2 (b) pristine ZnO nanoflakes and (c) gold nanoparticle decorated ZnO nanoflakes

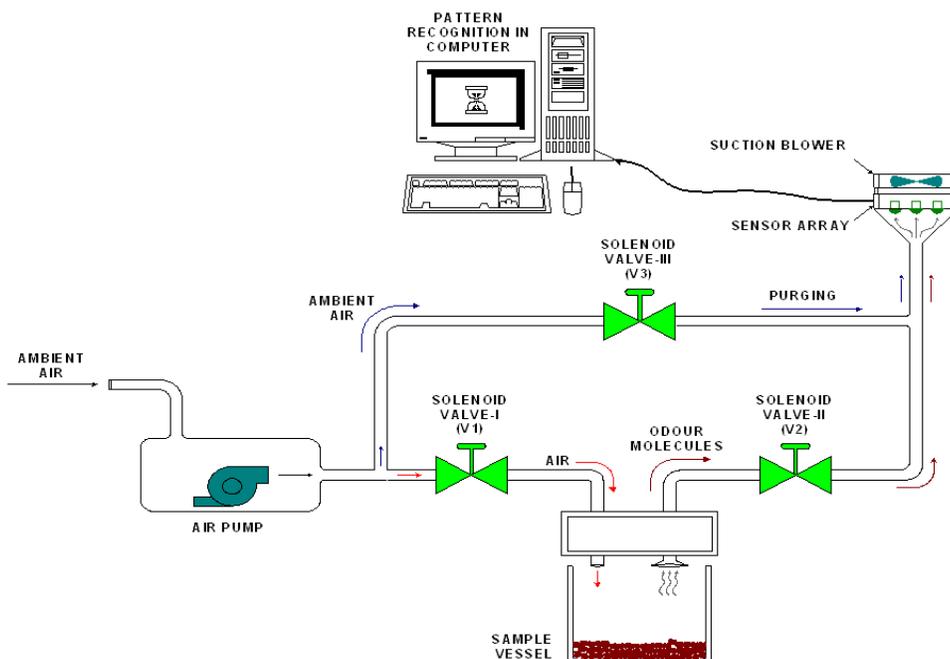


Fig. 2. Schematic diagram of an electronic nose prototype

P9

The Development of Novel Carbon Dots Based Materials for Physical and Biological Applications

Vijay Bhooshan Kumar¹, Ze'ev Porat², Doron Aurbach¹, Ehud Banin³, Vilas G. Pol⁴, Orit Shefi⁵, Yaron Shavtal³, David Karasik⁶ and Aharon Gedanken^{1*}

(1) BINA, Department of Chemistry, Bar-Ilan University, Israel. (2) Division of Chemistry, Nuclear Research Center-Negev, Israel. (3) BINA, Faculty of Life Sciences, Bar-Ilan University, Israel (4) School of Chemical Engineering, Purdue University, West Lafayette, USA. (5) Faculty of Engineering, Bar-Ilan University, Ramat Gan, Israel (6) Faculty of Medicine in the Galilee, Bar-Ilan University, Safed, Israel

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One-step sonochemical synthesis of carbon dots (C-dots), which is carried out by sonication of pristine polyethylene glycol (PEG-400) for 0.5-3 hour. It demonstrates how various experimental parameters, such as the sonication time, the temperature and the amplitude of sonication affect the size of the C-dots (2-10 nm) and their fluorescence. The highest measured quantum yield of emission was ~16-44%. Similarly, we synthesized C-dots doped with metals (Ga, In, Sn) and non-metals (N, P, S) for various applications, such as supercapacitor, Lithium ion rechargeable battery, biodiesel production, bio-imaging, antibacterial activity, Neural cell growth, and gene delivery. The synthesized C-dots were coated on polythene, Si-wafer and activated carbon (AC). C-dots were used for bio-imaging, whereas AC/C-dots were used as supercapacitors. Electrodes made of AC/C-dots demonstrated specific capacitance of $0.185 \text{ F.g}^{-1}.\text{cm}^{-2}$, almost 3 times higher than unmodified carbon. The Sn@C-dots@Sn nanoparticles were synthesized and directly deposited on the copper foil current collector as a promising anode for Li-ion batteries. The letter, C-dots modified SrO NPs was prepared from the Sr-based salt ($\text{Sr}(\text{NO}_3)_2$) and to study their physical, chemical and catalytic behavior. This catalyst (SrO-C dot composite) is very useful as a catalyst for biodiesel production from the cooked waste oil and *Chlorella vulgaris* microalgae. Similarly, TiO_2 materials was synthesized and used for photocatalytic activity. The Ga doped in C-dots (Ga@C-dots) and used for antimicrobial activity against free-living *P. aeruginosa* bacteria. Ga@C-dots was reflected full inhibition of the bacterial growth at the much lower concentration of Ga within Ga@C-dots. We also observed that cells grown on a Ga@C-dots@Ga-coated substrate exhibit a 196% increase in the number of branches originating from the soma (SH-SY5Y cells).

P10**Continuous Formation of Colloids by Optical Traps****Erel Lassnoy, Omer Wagner, Eitan Edri and Hagay Shpaisman**

Chemistry Department, Institute for Nanotechnology and Advanced Materials
Bar-Ilan University, Israel

Recently we have demonstrated how optical traps can influence colloidal formation by coalescence or partial fusion of nucleation seeds and oligomers during emulsion polymerization, leading to control over size and shape of the colloids.

Here, we present a novel method that allows continuous controlled fabrication by optical traps of colloids. We use the Holographic Optical Trapping (HOT) method to form multiple optical traps inside a micro-fluidic device. As the emulsion/suspension flows through the micro-channel, multiple colloids are formed at the location of the optical traps. Once the drag forces on a colloid exceeds the trapping force it will leave the optical trap, and a new colloid will start forming. This novel lab-on-chip approach will allow us to fabricate tailor made on demand colloidal suspensions.

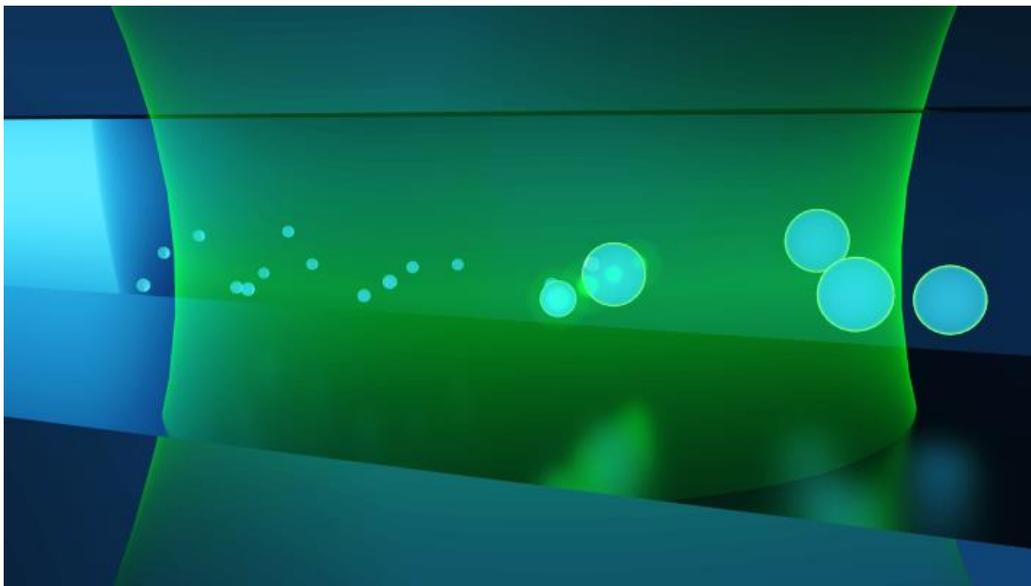


Illustration of optical traps directing colloidal growth inside a micro-channel.

P11**Open-Framework Metal Phosphate as Novel Photocatalyst for The Hydrogen Evolution Reaction from Water-Methanol Mixtures**

Marco Serra, Herme G. Baldovi, Ferran Albarracin, Mercedes Alvaro and Hermenegildo Garcia*

Instituto Universitario de Tecnología Química CSIC-UPV, Universidad Politecnica de Valencia, Valencia, Spain

In the search for novel photocatalysts for hydrogen production, we report herein the preparation, semiconductor properties and photocatalytic activity for the hydrogen production from water-methanol mixtures of doped framework phosphates, based on titanium or iron. Titanium dioxide is the most widely used photocatalyst for hydrogen production from water. Its main limitation consists in the lack of photocatalytic activity under visible light irradiation. One strategy to overcome this problem consists in using as photocatalyst Ti^{3+} -self-doped TiO_2 that presents an absorption in the visible range. Open-framework V-doped, mixed-valence titanium phosphate are characterised by an intense absorption spanning all the visible wavelength range caused by the presence of Ti^{3+} centers in equimolar ratio respect Ti^{4+} .

This long wavelength absorption band allows the photocatalytic production of hydrogen under visible light irradiation. $\alpha\text{-Fe}_2\text{O}_3$ is a promising photocatalyst for the generation of hydrogen from water due to a good absorption in the visible range, a large abundance and its lack of toxicity. The main drawback consists in a low stability and a low reduction potential of its conduction band electrons (-0.4 eV vs. NHE) making the reduction of water to H_2 thermodynamically uphill. To overcome this barrier it is necessary to submit the $\alpha\text{-Fe}_2\text{O}_3$ photoanode to a bias potential of about 1 V. In this context we report the synthesis and photocatalytic activity of doped framework iron phosphate, which is characterized by a higher band gap that allows the production of hydrogen from water-methanol mixtures in the absence of an external bias, without the needing of any co-catalyst. The materials were characterised by transient electron absorption spectroscopy that has allowed detecting the state of charge separation upon the excitation in the UV or in the visible regions in relation to the presence of dopant element. The flat band potential and the charge carrier density were determined by impedance spectroscopy. These results are promising for the development of novel photocatalytic materials based on framework metal phosphate

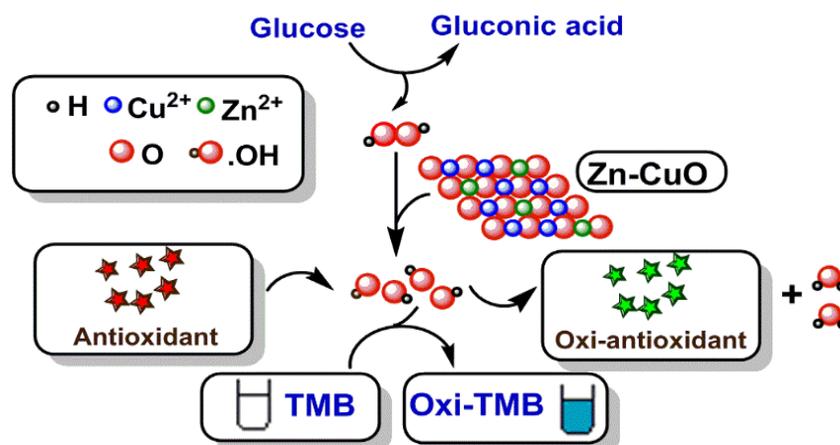
P12

CU_{0.89}ZN_{0.11}O as a Peroxidase-Mimicking Nanozyme with High Sensitivity for Glucose and Antioxidant Detection

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Nanomaterial-based enzyme mimetics (nanozymes) is an emerging field of research that promises to produce alternatives to natural enzymes for a variety of applications.¹ The search for the most cost-effective and efficient inorganic nanomaterials, such as metal oxides, cannot be won by pristine CuO.² However, unlike CuO, the Zn-doped CuO (Zn-CuO) nanoparticles reported in this paper reveal superior peroxidase-like enzyme activity. This places Zn-CuO in a good position to participate in a range of activities aimed at developing diverse enzyme applications.³ The peroxidase-like activity was tested and confirmed against various chromogenic substrates in the presence of H₂O₂ and obeyed the Michaelis–Menten enzymatic pathway. The mechanism of enhanced enzymatic activity was proved by employing terephthalic acid as a fluorescence probe and by electron spin resonance. The nanozyme, when tested for the detection of glucose, showed a substantial enhancement in the detection selectivity. The limit of detection (LOD) was also decreased reaching a limit as low as 0.27 ppm. Such a low LOD has not been reported so far for the metal oxides without any surface modifications. Moreover, the nanozyme (Zn-CuO) was utilized to detect the three antioxidants tannic acid, tartaric acid, and ascorbic acid and the relative strength of their antioxidant capacity was compared.



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P13

1×8 Photonic Power Splitter Based on Multimode Interference in Gallium-Nitride – Silica Slot Waveguide Structures

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In this paper, we demonstrate a visible light 1x8 power splitter using an MMI based on gallium nitride (GaN)- silica (SiO₂) slot waveguide structures. GaN based slot waveguide device has a low transmission loss in the visible range (0.1-0.4dB/cm). Therefore, the novelty of this design is the low power losses that can be obtained using GaN slot waveguide structures. Thus, the device can be very useful for visible light communication system. Multimode interference based devices are significant building blocks for photonic integrated circuits due to their simple structure, low excess loss, large optical bandwidth, and low polarization dependence. Slot waveguide structures are based on a combination of low-index material and high-index material that create the total internal reflection (TIR) by using a low-index layer (slot area) that is surrounded by two high-index layers and with the TIR effect we can guide the light into the slot waveguide structure.

Numerical optimizations were carried out on the device parameters using the full vectorial-beam propagation method (FV-BPM). Simulation results show that the proposed device can be used to divide optical signal energy uniformly in the visible range into eight output ports.

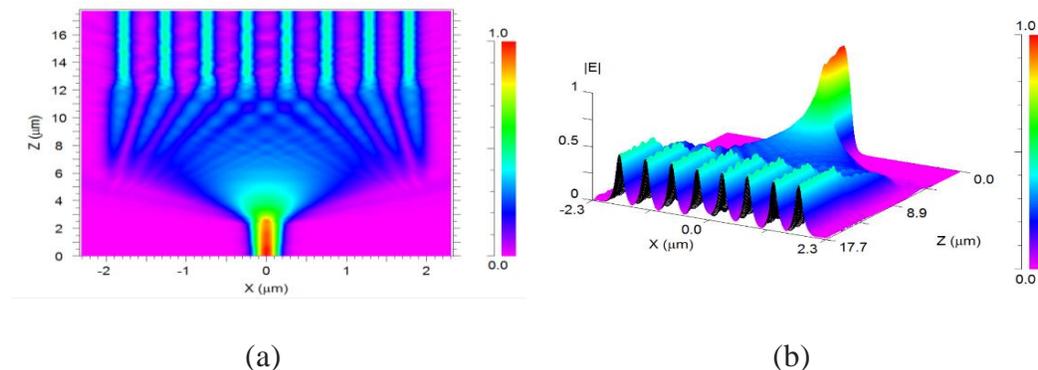


Figure 1. The propagation profile of the electric field for the 1 × 8 MMI power splitter at x - z plane: (a) 2D; (b) 3D.

P14

Photonic Properties of Nanolayers From Extracts of Macrocarpa Leaves

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In recent years we have investigated photonic activation processes by bleaching Chlorophyll 3D-bulk solutions and analyzed the different kinetics of these processes in the UV and visible spectral bands [1].

The objective of the current investigation is to obtain optically active 2D solid nanolayer arrays of dyes from plants extracts, for spectral photonic uses, since bio-inspired photonic applications experience and promise a great development [2].

We deposited the thin films on glass substrates and studied them in the visible band by spectrometry, optical and DELI microscopy [3]. The extracts dried samples investigated here were obtained from fresh leaves of the Carissa Macrocarpa plant, either untreated or solvated in Ethyl Alcohol.

The optical measuring setups used, allowed the samples to be illuminated by one or more light sources for analyzing the absorbed, reflected and transmitted light and fluorescence lines.

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P15**Synthesis and Characterization of Nanostructured TiO₂ Electrodes Used as Anode in Lithium Batteries**

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Worldwide high demand for batteries as power sources for various industrial fields led to intensified research in order to identify new materials used mainly in lithium batteries (LiBs). The use of titanium dioxide (TiO₂) as the anode material in LiBs may be an easier way to reduce the cost of such systems. Titanium dioxide is environmentally friendly, readily available, inexpensive and nontoxic. The most common method to produce TiO₂ nanotubes, providing a good control of the diameter and length of the nanotubes is the anodic oxidation. In the present work are shown results on getting the nanostructured electrodes based on the titanium oxide by anodic oxidation of the substrates of titanium, in solutions of 0.5 M H₂SO₄ and 1.4 M H₃PO₄ using different voltages anodization (0V, 20V, 30V, 40V, 50V) [1]. For the electrochemical characterization were used techniques like potentiodynamic polarization and electrochemical impedance spectroscopy. All measurements were performed in a 3% NaCl solution. Scanning electron microscopy (SEM) and EDX spectra were used for the morphological characterization of the different forms of titanium oxide. Nanostructured TiO₂ films showed a good resistance to corrosion. Electrochemical impedance data have revealed the oxide layer structure consisting of a compact oxide layer and an outer layer of TiO₂ nanotubes. The nature of the electrolyte and the applied voltage changed the diameter and length of TiO₂ nanotubes.

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P16**Tubular Photoactive Gold Nanoparticle Assemblies**

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Nanotubes of WS₂ (INT-WS₂) have been uniformly decorated with 5 nm tetraoctyl ammonium bromide stabilized gold nanoparticles (AuNP). The interparticle distance of AuNP is 2 nm. This self-assembly process is likely to be driven by the lattice matching between the nanotube outer wall and AuNP and strengthened by the affinity of disulfide binding with Au. The optical band gap of INT-WS₂ can be varied from 1.82 eV for the bare nanotube to 1.75 eV for full AuNP coverage. AuNP decorated nanotubes are further functionalized with robust pyridine-based ruthenium complexes. The complexes adhere and link the surface-bound AuNPs through ligand exchange. The resulting network of AuNPs forms a coherent, tubular shell that persists even after complete removal of the underlying INT-WS₂ with hydrogen peroxide. The oxidation process is studied by electron microscopy and optical microscopy. Raman spectroscopic measurements of the single-walled AuNP tube shells depict the presence of the metal complex. The mechanical properties of the AuNP-tubes are studied by AFM-based nanoindentation. This study indicates tubular structure is elastic in nature with stiffness dominated by interactions between the AuNPs.

P17

Zn Doped CuO Nanoparticles Based Surfaces and Compounds Exhibit Enhanced Antibacterial and Antibiofilm Activity

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Increase in nosocomial infections and bacterial antibiotic resistance raises major concerns worldwide. Many of the hard to treat infections involve biofilm and this raises the need for innovative solutions. In the current study, Zn-CuO ($Zn_{0.12}Cu_{0.88}O$) nanoparticles (NPs) compounds and surfaces were examined for their antibacterial and antibiofilm properties. These included (i) coated urinary catheters, (ii) a water-soluble PEGylated nano-graphene-oxide formulation to increase the dispersion of the Zn-CuO NPs and (iii) a topical ointment. The NPs based ointment was able to effectively reduce biofilm formation as well as eradicate existing biofilm. As for the urinary catheters, the NPs were coated on the catheter surface using a sonochemical method. The coated catheters displayed promising biocompatibility as assessed *in vitro* by low cytotoxicity, negligible associated cytokine secretion and no detectable irritation. The Zn-CuO coated catheters were found to display high antibiofilm activity in an *in vitro* flow model and *in vivo* using a rabbit model. Rabbits catheterized with uncoated catheters scored positive for Catheter Associated Urinary Tract Infections (CAUTI) by the fourth day while rabbits catheterized with Zn-CuO coated catheters did not exhibit CAUTI or remained completely uninfected for the whole duration of the 7-day experiment. The rabbit *in vivo* assay also supported the biosafety of the ZnCuO NPs. Finally, we deposit the insoluble ZnCuO on NGO-PEG sheets to generate the NGO-PEG-ZnCuO novel complex, thus increasing their solubility and bioavailability. The soluble NGO-PEG-ZnCuO complex displayed high antibacterial activity with no cytotoxicity. Taken together, these data highlight the potential of Zn-doped CuO nanocomposites to serve as an effective antibacterial and antibiofilm compound for a range of medical applications.

P18**Harnessing Solar Thermal Energy for Renewable Fuel Production**

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Bioethanol is one of the most promising transportation fuels with economic, environmental, and energy benefits. Currently, global ethanol is produced mainly from sugar- and starch-based feedstocks, however it can also be produced in large quantities from agricultural waste and biomass. Successful utilization of solar energy for bioethanol production from biomass has the potential to solve the fuel shortage problem. Solar energy provides an important alternative energy source, even if only a portion of this energy source is harnessed for heating applications.

Our work focuses on developing energy efficient, sustainable, and continuous-flow bioethanol production based on solar thermal energy. A solar reactor was developed to perform the fermentation reactions. Aqueous starch solution (5 wt%) was charged into the reactor bed loaded with baker's yeast (*Saccharomyces cerevisiae*) and amylases, resulting in 84% of the theoretical ethanol yield (0.5 M) after two months. Reusability of the yeast was confirmed for at least two months without loss in biocatalytic activity. The process was scaled up to 15 wt% starch fermentation, producing 1.3 M ethanol which was demonstrated as a potential and sustainable fuel for direct ethanol fuel cells (DEFCs) at 303-363 K. Additionally, the secondary metabolite glycerol was fully reduced to a value-added product 1,3-propanediol (1,3-PDO), which is the first example of a fungal strain converting glycerol *in situ* to 1,3-PDO.

The batch process of bioethanol production was further developed to a continuous-flow process. When aqueous glucose solutions (10-40 wt%) were fed into the reactor containing *S. cerevisiae*, high ethanol yields (88-91% of the theoretical yield) were obtained, indicating the atom efficiency of the process. The yeast bed was always in solid-state condition and glucose was the only nutrient supplied for the yeast. Produced bioethanol was separated from the yeast bed soon

after its formation by evaporation-condensation. The bioethanol produced from 20 wt% glucose fermentation (2 M) was demonstrated as a potential fuel for alkaline-acid DEFCs at 303-333 K.

The current study explores new avenues for decentralized power supply based on solar thermal energy and demonstrates an energy-efficient methodology for bioethanol production. Harnessing solar energy for driving the fermentation reaction makes the current process economically feasible and environmentally friendly. Moreover, the special design of the reactor that facilitates *in situ* separation of ethanol from the fermentation broth is industrially appealing and adoptable for large scale production.