Bar-Ilan University
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BINA Annual Internal Conference
9 February 2015

7:45 – Departure from BIU

8:30 – 9:00 - Refreshments

Session One: 9:00 – 11:00
9:00 – 9:10- Greetings
Prof. Yuval Garini

***Session Chair* – Eyal Preter**, *Zadok*

9:10 - 9:35 **Dr. Hagay Shpaisman**
Directed Assembly of Materials

9:35 – 10:00 **Dr. Moti Fridman**
Lasers as the fastest computer in the world

10:00 - 10:25 **Dr. Sharon Shwartz**
X- ray quantum and nonlinear optics

10:25 - 10:50 **Prof. Ronit Sarid**
Kaposi's Sarcoma-Associated Herpesvirus and Herpes Simplex Virus: Study of the Infectious Cycle by Using Cell and Molecular Biology, Imaging, Biochemical and Nanotechnology Approaches

10:50 - 11:05 **Coffee Break**

11:05 - 12:05 **Scientific improvisation**

12:05 - 14:15 **Lunch Break and Poster Session**

Session Two: 14:15 – 15:00
***Session Chair* – Adam Ginsburg**, *Zaban*

14:15 - 14:40 **Hadas Alon and Idan Bakish**
Visualization of Self Assembled Monolayers (SAMs) on Silica-on-Silicon Surfaces

14:40 - 15:10 **Itzhak Fabian**
על התפר שבין אקדמיה ותעשיה

15:10 - 15:25 **Coffee Break**

Parallel Session: 15:25 – 16:25

Bio-medicine and bio-physics
***Session Chair* – Meital Cohen**, *Tzur*

15:25 - 15:40 **Merav Antman-Passig**, *Shefi*
Directing neurite growth in collagen gel 3-dimensional neuronal culture

15:40 - 15:55 **Idit Feder**, *Fixler*
Extracting nanophotonics optical tissue properties from full scattering profile of circular medium

15:55 - 16:10 **Lihi Musbat**, *Toker*
The action spectroscopy lab

16:10 - 16:25 **Anat Vivante**, *Garini*
The effect of structural proteins on chromatin dynamics - using advanced life imaging methods

Materials and magnetism
***Session Chair* – Yiftach Frenkel**, *Kalisky B.*

15:25 - 15:40 **Elran Baruch-El**, *Yeshurun*
Dendritic flux instabilities in YBCO films exposed to an ultra-fast field ramp

15:40 - 15:55 **Chandan Ghanty**, *Aurbach*
Structural Changes Upon Charge/Discharge of Li[Ni-Co-Mn]O_2 Electrodes Studied by In-situ XRD and Nano-Beam Electron Diffraction

15:55 - 16:10 **Shani Guttman**, *Deutsch*
Faceted liquid emulsion droplets of oil in water

16:10 - 16:25 **Miri Sinwani**, *Tischler*
Anisotropic Raman Spectra of Semiconducting Rubrene Crystals

16:25 – 17:00 **Prize Giving & Closing Words**

17:00 – Departure to BIU

17:45 – Estimated Arrival to BIU

Session One

Directed Assembly of Materials

Dr. Hagay Shpaisman

Department of Chemistry

Our lab aims at researching novel ways of generating micro/nano-scopic structures and understanding how these structures could be further manipulated. We intend to get better understanding of the underlying scientific principles that govern these processes while developing these techniques for envisioned useful applications.

Our methods utilize:

- Optical traps
- Standing surface acoustic waves
- Shear forces in microfluidic channels

These methods hold great promise for creating on demand tailor made systems where size, shape and composition could be precisely controlled.

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Lasers as the fastest computer in the world

Dr. Moti Fridman

Faculty of Engineering

Classical computers are almost at the limit and quantum computers are still fat a way. Between them there is a third type of computers: probability computing. Lasers can be made into such computers. I will present this topic and how we can make a regular laser into a computer which is equivalent to a regular computer with 10^25 processors.

X- ray quantum and nonlinear optics

Dr. Sharon Shwartz

Department of Physics

Kaposi's Sarcoma-Associated Herpesvirus and Herpes Simplex Virus: Study of the Infectious Cycle by Using Cell and Molecular Biology, Imaging, Biochemical and Nanotechnology Approaches

Prof. Ronit Sarid

The Mina & Everard Goodman Faculty of Life Sciences

Kaposi's sarcoma, the most common AIDS-associated malignancy, is caused by the human herpesvirus, KSHV. A rare type of B cell lymphoma and a subset of muticentric Castleman's disease are also arising from KSHV infection. Nevertheless, the details of KSHV infection and pathogenesis remain unclear. HSV-1, another human herpesvirus, is a common infectious agent that occurs worldwide and infects humans of all ages. The outcome of HSV-1 infection includes a wide variety of clinical manifestations, ranging from asymptomatic infection to oral cold sores and severe encephalitis.

Our studies involve five major areas:

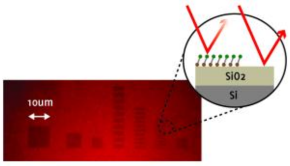
1. Viral gene culprits: Characterization of viral genes and their protein products involved in KSHV pathogenesis.
2. Tracking virus entry, uncoating, assembly and egress by using recombinant viruses that express selected virion-associated proteins fused to fluorescent tags.
3. Tracking the nucleolar compartment and the involvement and modifications of nucleolar components during the infectious cycle.
4. Viral structure: Define how multiprotein virion assemblies associate and interact. This could potentially lead to the discovery of novel approaches to inhibit virion disassembly and assembly for antiviral interventions.
5. Inhibition of virus infection by using composite nanoparticles or microspheres that block the attachment of the virions to host cells.

Session Two

Visualization of Self Assembled Monolayers (SAMs) on Silica-on-Silicon Surfaces

Hadas Alon, Idan Bakish, **Josh Nehrer, Assaf Y. Anderson, Chaim N. Sukenik, Avi Zadok, and Doron Naveh**
Faculty of Engineering and Department of Chemistry

The sophisticated machinery located in the Nanotechnology Center gives the impression that it's possible to "see" everything – even very small ("nanometric") things. While this is true in almost all cases today, the instances where we can really see very small structures with the naked eye are few and far between. We report below an outstanding example where the naked eye is enough.



Self-assembled monolayers (SAMs) of organic molecules are widely employed in surface chemistry and biology, and can serve as ultra-fine lithographic resists. Due to their small thickness (only a few nanometers), the analysis of patterned monolayer surfaces typically requires thorough point-by-point characterization using various kinds of scanning probe microscopy.

Over the last few years, several groups have reported the direct observation of single-layer graphene using standard, bright-field microscopy, when the films are deposited on silica-on-silicon substrates. Our work addressed the possibility of extending the principles behind the visualization of graphene to patterned SAMs.

We have found that SAMs are simply and directly observed using a bright-field optical microscope. If the lateral features are large enough, they can often be seen with the naked eye. Features as narrow as 500 nm are properly recognized.

The monolayers modify the spectral reflectivity pattern of a silica-on-silicon thin film, and introduce a contrast in visible wavelengths between bare and monolayer-coated regions of the substrate. This method can also distinguish between regions of single-layer and bi-layer coatings.

The joint work was published in Optical Materials Express

Idan Bakish is a former student of Prof. Avi Zadok, he is currently working as an optical engineer at ConsumerPhysics, a company that develops the first molecular sensor for consumer electronics.	Hadas Alon is a Ph.D student in the lab of Prof. Chaim Sukenik and Dr. Doron Naveh currently working on integrated SAM/Graphene devices.

על התפר שבין אקדמיה ותעשיה

Itzhak Fabian

Guest Lecturer

Parallel Session: Bio-medicine and bio-physics

Directing neurite growth in collagen gel 3-dimensional neuronal culture

Antman-Passig Merav and **Shefi Orit**

Faculty of Engineering

The ability to manipulate and direct neuronal growth has great importance in the field of tissue engineering, both for neuronal repair and potential medical devices. In-vivo, neurons grow and develop neurites in a 3-Dimensional (3D) extra cellular matrix (ECM) surrounding. Thus, imitating the 3D environment within a natural material as collagen is most important to simulate in-vivo conditions.

We designed and developed a method to grow neurons in a 3D environment. A collagen hydrogel system was chosen as a 3D ECM analog to best mimic the natural environment of cells.

We compared the neuronal growth in 3D to a 2D model and showed that neurons grown in 3D collagen gels develop significantly longer dendritic trees and neurites, while number of neurites originating from cell soma was smaller in 3D collagen gels. To manipulate neuronal growth we developed a method to align collagen matrix via inducing strain on collagen gels. We showed fiber directionality by analysis of light microscope images via Fast Fourier transform and by SEM imaging. Finally, we evaluated leech neurite extension within aligned gels. Using this method we've directed neuronal growth coinciding with collagen matrix orientation. We found no significant change in neurite lengths in aligned gels compared to control gels, proving cell growth and behavior does not change except direction of growth.

We have also developed a tunable platform to direct neurite growth in 3D by embedding nanoparticles in a collagen gel which operate as topographic cues to guide neurite growth. Both these methods presents a promising neuronal repair system in a realistic environment.

Extracting nanophotonics optical tissue properties from full scattering profile of circular medium

Idit Feder, Rinat Ankri and Dror Fixler

Faculty of Engineering

Human tissue is one of the most complex optical media since it is turbid and nonhomogeneous. Most methods for measuring light-tissue interaction focus on the volume reflectance while very few measure transmission. Moreover, their set-ups are commonly complex; they require calibration, use two or more wavelengths, or are based on iterative calculations or sample scanning.

We suggest a new nanophotonics method based on the collection of the ejected light at all exit angles, to receive the full scattering profile. We simulate the light propagation in a heterogeneous cylindrical tissue and obtain the full scattering profile. In addition we built a unique set-up for noninvasive encircled measurement. We use a laser, a detector and tissues-like phantoms presenting different diameters and different reduced scattering coefficients.

Our method reveals an isobaric point, which strongly depends on optical properties and linearly depends on the exact tissue geometry. Furthermore, while adding nanoparticles to the tissue our new method can detect it due to the change they cause in the reduced scattering coefficient. In our previous work, nanoparticles have been defined as contrast agents for diagnostics and treatment of different physiological conditions, such as cancer and atherosclerosis. These findings can be useful for non-invasive and simple diagnostic of the fingertip joint, ear lobe and pinched tissues.

The Action Spectroscopy Lab

Lihi Musbat, S. Ytzhak and Yoni Toker

Department of Physics

Understanding the photo-properties of biochromophores, the molecules used by living organisms in order to interact with visible light, involves comparison of high level quantum chemical computations with experiments. Most experiments, however, are performed on chromophores in solution or within the protein, and these complicated environments are extremely hard to simulate. We use action spectroscopy in order to study the photo-absorption and excited state dynamics of truly isolated chromophores and use an ion mobility spectrometry in order to study the geometry of those molecules. In our lab we are building two systems: an action spectrometer that combines an ultrafast laser, a cold ion source, an electrostatic ion beam trap (a Zajfman trap), a VMI electron spectrometer and an electrostatic analyzer. The second system is an ion mobility spectrometer that combines ESI source, 2m drift tube and mass spectrometer. So, we will combine those technique and will be able to create a complete picture of the isomerization process.

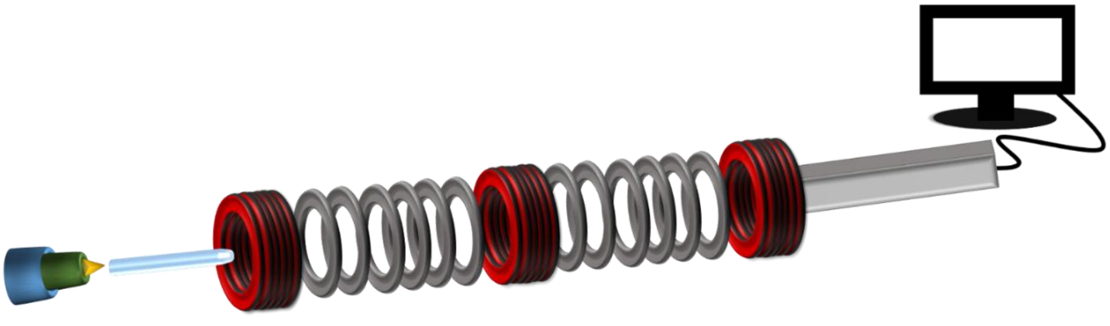


Figure 1: The ion mobility spectrometer (IMS-IMS)

The effect of structural proteins on chromatin dynamics - using advanced life imaging methods

Anat Vivante, Irena Bronshtein, Eldad Kepten, Itamar Kanter and Yuval Garini

Department of Physics

In eukaryotic cells, tens of thousands of genes are packed in a small volume of the nucleus. The genome is organized in chromosomes, which occupy specific nuclear volumes referred to as chromosome territories. This organization is maintained, even though there are no sub-compartments in the nucleus.

The organization of the genome in the nucleus is believed to be crucial for cellular functions such as gene regulation. Therefore, studying the mechanisms and the proteins responsible for chromosome territories is extremely important. The dynamics of the nucleus content is fundamental for understanding its appropriate function, and the nuclear structure is strongly related to the dynamic properties.

We use life imaging methods in order to characterize the dynamic properties of the chromatin and the organization of the genome in living cells. More specifically, we use single particle tracking of telomeres dynamics within short and long time scales, and Continuous Fluorescence Photobleaching (CP) measurements which provides information on mobility\binding properties of proteins. We compare the effect on chromatin dynamics caused by depletion of different structural proteins.

Chromatin diffusion in normal cells is found to be slow and anomalous, earlier studies have shown that depletion of lamin-A protein results in faster dynamics and the chromatin diffusion transforms from anomalous to normal diffusion. The depletion of LAP2α slows the chromatin dynamics and reduces the fraction of bound lamin-A.

These observations strongly suggest that the dynamic structure of the chromatin in the nucleus is mediated by different structural proteins such as Lamin-A, LAP2α, Lamin-B, and BAF. Mapping the proteins that are responsible for chromosome territories is a great challenge that we are now pursuing.

Parallel Session: Materials and Magnetism

Dendritic flux instabilities in YBCO films exposed to an ultra-fast field ramp

E. Baruch-El , M. Baziljevich, T. H. Johansen , A. Shaulov and Y. Yeshurun

Department of Physics

We have recently developed a novel magneto-optical system that enables real time imaging at rates of ~ 70,000 frames per second. The system is also capable of very fast field ramping, at rates exceeding 3000 T/s. This new system has been exploited in the study of flux avalanches, focusing on dendritic flux patterns in YBCO films. We report on first observation of dendritic avalanches in these films triggered by rapid field ramping and discuss effects of different substrates on dendritic formation. The ability to routinely generate dendritic avalanches allows the first study of the experimental conditions for the instability, in particular the thresholds temperatures and ramp rates for the appearance of dendrites. The results will be discussed in the framework of recent turbulent dynamics theories.

Structural Changes Upon Charge/Discharge of Li[Ni-Co-Mn]O_2 Electrodes Studied by In-situ XRD and Nano-Beam Electron Diffraction

Chandan Ghanty, M. Talianker, J. Grinblat, I. Perelstein, O. Haik, B. Markovsky, D. Aurbach

Department of Chemistry

In this work, we have studied the electrochemical behavior of electrodes comprising Ni-rich materials Li[NiCoMn]O_2 (NCM) and their structural characteristics upon cycling in Li-cells. By using in-situ X-ray diffraction technique it was found that the formation of different phases of hexagonal and monoclinic crystal structures namely H1, H2, M and H3 is reversible during charge/discharge processes. Nano-beam electron diffraction data of cycled electrodes have revealed a partial conversion of layered structure to spinel phase upon prolonged cycling of the NCM materials with relatively high content of manganese ions. However, with high nickel containing materials, no formation of secondary phases like NiO or spinel upon cycling was detected. Electrochemical impedance studies of Li[NiCoMn]O_2 electrodes at various potentials along with the their characterization by Raman spectroscopy and DSC were used to examine the capacity fading mechanisms upon cycling.

Faceted liquid emulsion droplets of oil in water

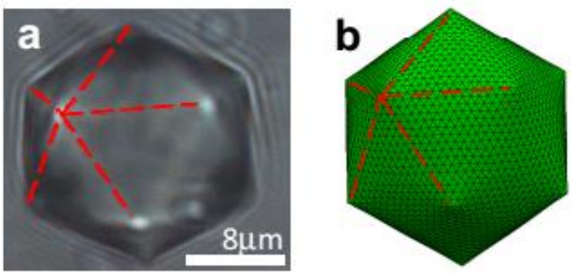
Shani Guttman, Moshe Deutsch and Eli Sloutskin

Department of Physics

Among all possible shapes of a volume V, a sphere has the smallest surface area A. Therefore, liquid droplets are spherical, minimizing their interfacial energy γA for a given interfacial tension γ>0. We demonstrate that liquid oil [$CH_3(CH_2)n\text{-}2CH_3$, hexadecane] emulsion droplets in water, stabilized by a common surfactant (C18TAB, octadecyltrimethylammonium bromide) adopt icosahedral and other faceted shapes, tunable by temperature T, above the bulk melting temperature of the oil Tm. Although emulsions have been studied for centuries no faceted droplets have ever been detected.

We attribute the observed transition from a spherical to an icosahedral shape to the interplay between γ and the elastic properties of the interfacial monomolecular layer, which in these systems crystallizes 10-15oC above Tm. Moreover, we demonstrate that upon further cooling this `interfacial freezing' effect makes γ switch its sign, leading to a spontaneous splitting of droplets and growth of their surface area, reminiscent of the classical spontaneous emulsification, yet driven by a completely different physical mechanism.

The observed phenomena allow deeper insights into the fundamentals of molecular elasticity to be gained, with the tunable stability of these emulsions opening new horizons for a wide range of revolutionary nanotechnological applications, from self-assembly of complex shapes to new delivery strategies in bio-medicine.



Buckling of the liquid droplets in the elasticity-dominated regime.

Anisotropic Raman Spectra of Semiconducting Rubrene Crystals

Miri Sinwani and Yaakov Tischler

Department of Chemistry

We report the intrinsic Raman spectra of Rubrene red and yellow crystals which actually represent the crystallographic orientations (020) and (002) respectively. We show that in the low frequency range (50 – 250 cm-1) only rubrene red crystals are characterized with a Raman shift at 217 cm^{-1}, which perfectly matches DFT calculations that until now were not confirmed by experimental observations. Furthermore, their Raman shifts at higher frequencies (800 – 1800 cm^{-1}) are significantly more intense than shifts obtained by rubrene yellow crystals. To strengthen our findings, we performed co-located Raman and PL mapping at Rurbrene yellow crystals borders and detected Raman spectra which correlate with the Raman shifts of rubrene red crystals originating from the crystallographic c-axis. Finally, during vertical Raman mapping, we observed a pronounced intensity increase of the Raman shift peak at 217 cm^{-1} when the Raman excitation was focused onto the top surface of the crystal, strongly suggesting the possibility of Surface Enhanced Raman Scattering phenomenon.

Posters

Advanced Materials for Li Ion Batteries, Magnesium Batteries and Supercapacitors

From the lab of Doron Aurbach

Department of Chemistry

Poster No. 1

Here are some of the main projects that are being worked on:

1. Thermal Behavior of Several Cathode Materials EC-DMC/LiPF6 and LiTFSI Solutions Studied by DSC.
2. New MWCNT-Activated Carbon Composite for EDLC Electrodes
3. High-Energy Lithium Rich Cathode Materials $Li[MnNiCo]O_2$
4. High energy density V2O5 (140 mAh/gr) and MoO_3 (220mAh/gr) cathodes for Mg^{2+} fast intercalation
5. Improving the stability of $LiNi_{0.5}Mn_{1.5}O_4$ as a cathode material for 5 V Li-ion batteries by metal oxide coatings

Quantum and Statistical Mechanics in Mesoscopic and Nanoscopic Systems

Ariel Eisenbach, Bat-el Friedman, Shaul Leiman, Yishai Schreiber, Arik Vasserman and Shahaf Aharoni and Richard Berkovits

Department of Physics

Poster No. 2

We are interested in theoretical aspects of quantum mechanical systems in various dimensions and conditions, analytically and numerically.

- Entanglement Entropy
- Disorder and Interactions in Quantum Wires
- Harper model and Quasi-Disorder
- Topological Insulators
- Statistics of Density matrices
- Exotic Quantum Structures

In spite of its age, quantum mechanics and theoretical solid state physics still hold surprises to those who are willing to open up to new perspectives.
Come and see our poster!

Nano Photonics and its biological applications

From the lab of Dror Fixler

Faculty of Engineering

Poster No. 3

Fixler's lab deals with theoretical and practical models for reconstructing the optical properties of participating media by nano photonic tools. Our theory is based on a robust generalization of the diffusion theory; Gerchberg-Saxton algorithm; dipole-dipole approximation and other methods. On the practical side we use lasers, LEDs and microscopes. Human tissue is one of the most complex optical mediums since it is nonhomogeneous. Its optical properties are unknown and vary in different tissue arias and physiological states. Because of all of the above, *in vivo* imaging is a difficult task. In Dror Fixler's lab we deal with this difficulty by focusing on detection rather than imaging. We use methods witch probe the tissue properties by means of the diffusion reflection profile, adding nano partials as contrast agent, the full scattering profile and its isobaric point or iterative phase multiple measurement reconstruction techniques. Furthermore, we use changes in optical parameters, such as fluorescence life time and fluorescence anisotropy to probe the biological surroundings. In Dror's lab we are able to fabricate Gold nano particles (spheres and rods), organic nano particles (Vitamin B12, Penicillin and Methylene Blue) as well as tissue like phantoms. The applications for these methods include diagnosis of diseases such as cancer and atherosclerosis, examination of different physiological parameters, visualizing enzyme activity and early stage cell mutation detection.

Studying Biological Processes with Microscopy Based Methods

Liat Altman-Rosenfeld, Eldad Kepten, Irena Bronshtein-Berger, Eugeni Brozgol, Shira Gilboa, Moshe Lindner, Hilla Naaman, Efrat Roth, Anat Vivante and Yuval Garini

Department of Physics

Poster No. 4

The appropriate functioning of living cells depends on a variety of dynamic processes that necessitates delicate motion, transportation, association and disassociation in time and space.

We study dynamic processes in vitro and in vivo by applying different research tools based on microscopy techniques.

Single particle tracking (SPT) allows the characterization of dynamic processes on the single particle level with nanometer spatial resolution. We use SPT methods to examine the organization of the genome in living cells and to find proteins responsible for genome organization.

In the TPM (Tethered Particle Motion) approach, we extract physical properties of biological polymers and their interactions with different molecules by using SPT of a bead attached to it. By implementing a fast Quad Photo Diode (QPD) to the existing system, we plan to extend the measurement rate up to 10 KHz.

We use Fluorescence Recovery After Photobleaching (FRAP), Fluorescence Correlation microscopy (FCS) and Continuous Photobleaching (CP) to study mobility and interactions of biological molecules inside the cellular environment. For example, we use FCS to measure diffusion of different proteins.

Optical microscopes cannot visualize details much finer than about half the wavelength of light. Therefore, we are building a super resolution STED microscope to enable us to identify structures and measure dynamics inside the cell.

Combating Bacterial Infections with Sonochemically Synthesized Zn/Mg-CuO Nanocomposites based Bandages and Ointment

Hilla Hakak, Archana R. Deokar, Yakov Shalom, Ehud Banin and Aharon Gedanken

Department of Chemistry

Poster No. 5

Conventional antibiotic therapies are becoming less efficient to antibiotic-resistant bacterial strains, eventually lead to increased mortality rate. With this motivation herein we made an attempt to synthesize a zinc/magnesium-doped copper oxide (Zn/Mg-CuO) nanocomposite (NCs) based antibacterial ointment/bandages to eradicate the current scenario of antibiotic-resistance. The optimization of processing conditions, the specific reagent ratio, and the precursor concentration results in the formation of uniform nanoparticles of ~ 100-300 (Mg-CuO) and 30 nm (Zn-CuO). Zn/Mg-CuO NCs were characterized by HR-SEM, XRD, and ICP. The antibacterial studies of the Zn-CuO NCs based ointment was evaluated using the principle of disk diffusion against gram-positive (S. aureus and S. epidermidis) and gram-negative (P. aeruginosa) bacterial strains. Zn-CuO based ointment (5 wt %) shows significant antibacterial activity against S. epidermidis (4 mm) compared to S. aureus (1 mm) and P. aeruginosa (1 mm). Gram-negative P. aeruginosa shows a unique phenomenon of feathered zone (1.5 cm) around Zn-CuO ointment. A substantial enhancement of ~1000 times in the antibacterial activity of Mg-CuO NCs coated cotton fabric was observed compared to CuO NPs coated fabric after 30 min of exposure to gram-positive S. aureus. Zn/Mg-CuO NCs based antibacterial ointment/bandages might prove as a promising candidate for inhibition or killing of bacteria at wound site.

Gerber's lab on chip

Glick Y., Ben-ari Y., Schwartz N., Nevenzal H., Ronen M., Kipper S., Golodenitzki R., Chen D., Avrahami D., Barbiro-michaely E. and Gerber Doron

The Mina & Everard Goodman Faculty of Life Sciences

Poster No. 6

Microfluidics, also known as lab-on-a-chip, provides unique advantages such as reduced sample and reagent consumption, improved analysis speed, increased sensitivity etc. Microfluidics is employed in many research areas, including biochemistry, biophysics, and cell biology. Integrated microfluidics, refers to chips with thousands of micromechanical valves, enabling high throughput experiments.

We specialize in the development of integrated microfluidic applications for proteomics, as briefly presented hereby:

1. We created a human protein array and screened against viral proteins from HCV, HDV and RSV. We discovered important interactions, currently at different stages of validation.
2. DNA-protein energy landscapes can be accurately determined using our 8-Mer and 12-Mer oligos libraries. We are using these systems to study gene regulation.
3. CpG methylation is important for differentiation and gene expression in higher eukaryotes. We are creating a methylation assay for screening the human proteome in order to discover new regulators DNA methylation.
4. Post-translational Modifications assays compatible with our protein arrays were developed for Ubiquitination and phosphorylation. We are currently focusing on screening for phosphorylation on membrane proteins.

Our main goal is to create a significant footprint of microfluidic applications in proteomics.

Scanning SQUID microscopy - A sensitive look at magnetism at the nanoscale

From the lab of Beena Kalisky

Department of Physics

Poster No. 7

Research of magnetism at the nanoscale requires development of sensitive and local magnetic characterization techniques, that can look at individual nanomagnetic objects. In our lab we study basic questions about magnetism and superconductivity - like emerging phenomena at interfaces such as LAO/STO, magnetism of nanoparticles and vortex dynamics in superconducting thin films .

Superconducting Quantum Interference Devices (SQUIDs) are highly sensitive magnetic flux detectors. Using the scanning SQUID microscope we can simultaneously measure, for example, small ferromagnetic islands and follow complex and small current paths in the sample. Also, by applying local magnetic field, we can detect a paramagnetic response from localized spins and track small traces of superconductivity. Measuring these simultaneously provides a powerful unique view of nanoscale physics.

Single cell genomics for cancer research and regenerative medicine

Itamar Kanter, Gal Tam, Ben Aloni, Irena Bronshtein and <u>Tomer Kalisky</u>

Faculty of Engineering

Poster No. 8

The mission of our lab is to develop experimental and computational approaches to understand stem cell biology, tissue regeneration, and cancer at the single cell level. We are using high throughput single cell technologies such as microfluidic single cell qPCR and RNA sequencing to search for new targeted therapies for cancer.

Adult tissue-specific stem cells are small populations of cells that reside in key locations within each tissue and are responsible for its maintenance and regeneration through carefully controlled proliferation and differentiation. In cancer, where the regeneration mechanism has been distorted, the tumors are maintained and regenerated by a small sub-population of cancer stem cells that are most likely responsible for relapse and metastasis. However, with contemporary technologies, it is challenging to locate and study the stem cells, which are a small minority.

In order to study the cellular composition of tissues and tumors, we are using a combination of single cell genomic technologies such as microfluidic single cell qPCR and RNA sequencing to measure the expression of multiple genes simultaneously in hundreds of individual cells. We then use computational analysis to map the repertoire of cell populations in the tissue or tumor and to find unique molecular markers for its stem cell population. These markers can be used as prognostic biomarkers or drug targets that will preferentially target the cancer stem cell subpopulation.

Here we will show some initial results from a collaborative project with Prof. Benjamin Dekel's group from the Sheba Medical Center, in which we study kidney tissues and tumors at the single cell level.

Comparative study of the electronic structure of Co-based mixed and single valence compounds: Search for efficient PV materials

Vijay Singh, Monica Kosa, Koushik Majhi and Dan Thomas Major

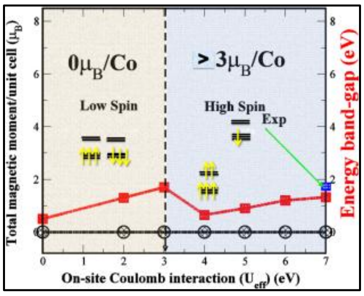
Department of Chemistry

Poster No. 9

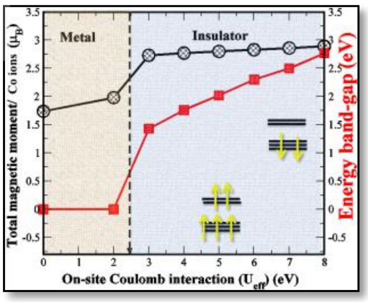
Cobalt oxide, Co3O4, is a potential PV candidate with optical absorption in the visible region. Additionally, Co3O4 exhibits intriguing chemical and catalytic properties. Therefore, it has great potential in novel renewable energy applications. From a theoretical point of view, Co3O4 is a challenging material. First principles density functional theory (DFT) and a many-body Green's function method have been employed to elucidate the electronic, magnetic and photonic properties of a spinel compound Co3O4. We have employed a range of theoretical methods, including pure DFT, DFT+U, a range-separated exchange-correlation functional (HSE06), as well as many-body Green's function theory (i.e. the GW method). We compare the electronic structure and band-gap of Co3O4 with available photoemission spectroscopy and optical band gap data and confirm a direct band-gap of ca. 0.8 eV. Furthermore, we have also studied the optical properties of Co3O4 by calculating the imaginary part of the dielectric function (Im(ε)), facilitating direct comparison with the measured optical absorption spectra.[1] As a continuation of our previous study, and to understand the merit of the mixed valence compound Co3O4 (having both Co2+ and Co3+ ions), we analyse the two single valence compounds, Co2O3 where the Co-ions are in the +3 oxidation state and CoO, where the Co-ions are in the +2 oxidation state. The phase diagram for the ground state of both Co2O3 (a) and CoO (b) compounds as a function of U has been obtained [refer Figure below]. We are also exploring how the desirable properties for solar photoconversion can be obtained by controlling the alloy compositions, i.e. the In@Co3O4, where reductions in the band-gap and enhancement of the optical absorption is found. Therefore, we envisage that our work will assist us in interpreting the mixed valence compound nicely to engineer new photovoltaic materials.

[**1**]. Singh, V.; Kosa, M.; Majhi, K.; Major, D. T., Putting DFT to the Test: A First-Principles Study of Electronic, Magnetic, and Optical Properties of Co_3O_4. *J. Chem. Theory Comput.* **2014,** *11*, 64-72.

(a)



(b)



Development and application of an avian embryo model for the assessment of cancer-targeting nanoparticles

Grinberg, Igor, Tennenbaum Tamar, Corem-Salkmon Enav, Rudnick-Glick Safra, Levy Itay and Margel Shlomo

Department of Chemistry

Poster No. 10

The standard assays for evaluating the performance of tumor imaging involving human tumor xenografts in immunodeficient mice. However, assessment of new imaging agents requires a substantial number of tumor-bearing animals, which is both expensive and time-consuming. We have explored the use of tumors grown on the chorioallantoic membrane (CAM) of embryonic chicken eggs to test the performance of bioactive, fluorescent nanoparticles in solid tumors. The avian embryo model is less expensive, and allows for imaging of a larger number of tumors in a shorter time period, without use of animals for mandatory initial experiments.

Chirality at the nanoscale and biomimetic chemistry with antifreeze proteins

Eitan Elfassi, Gila Levi, Ido Fuchs, Irena Nemtsov, Liora Werber, Magali Saul, Ortal Lidor-Shalev, Shira Adler, Yochai Basel and Yitzhak Mastai

Department of Chemistry

Poster No. 11

The research interests in our group can be divided into two main areas: (i) the preparation and application of nano-chiral surfaces for enantioselective processes and (ii) biomimetic chemistry with antifreeze proteins.

Chirality at the nanoscale

This research concerns fundamental studies of chiral surfaces based on ultrathin molecular architectures, such as chiral self-assembled monolayers (SAMs), chiral thin films of metal oxide prepared by ALD, chiral mesoporous silica and carbon and chiral polymeric nanoparticles for many chiral applications. The group is also working on the development of new analytical methods to probe chirality at the nanoscale. We pioneered the development of near-field scanning optical microscopy (NSOM) and isothermal titration calorimetry (ITC) for the determination of chirality at the nanoscale.

Biomimetic chemistry and antifreeze proteins

The overall aim our research is to advance our understanding of the structure and behavior of water and the interactions of macromolecules with water. To this end, we use synthetic macromolecules, e.g. double-hydrophilic block copolymers and peptides that mimic the structure and functionality of antifreeze proteins (AFP). Recently they demonstrated high antifreeze activity of short segments of type I antifreeze protein instead of the whole protein. Our approach of using short segments of the protein simplifies the correlation between antifreeze protein characteristics such as hydrophilicity and hydrophobicity and the effect of those characteristics on the antifreeze mechanism. In addition, we use antifreeze proteins as model system for biomineralization that enables us the preparation of biominerals for examples CaCO3 with unique features and antifreeze surfaces.

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Development of an Effective Delivery System for Gene Silencing- From Trypanosome to Man

E. Lellouche, L. L. Israel , E. Kurlander, V. A. Asher, S. Attal, D. Eliaz, A. Dolitzky, J.-P. Lellouche and S. Michaeli

The Mina & Everard Goodman Faculty of Life Sciences

Poster No. 12

In this study, we developed a highly innovative nanoscale reagent based on functional superparamagnetic maghemite (γ-Fe2O3) nanoparticles (NPs) that are surface-doped by coordinating lanthanide Ce3/4+ cations using high-power sonochemistry (CAN-γ-Fe2O3). Thereafter, via the unique coordinative chemistry enabled by doped [CeLn]3/4+ cations/complexes, a polycationic polyethyleneimine (PEI) polymer phase was bound to the maghemite NP core resulting in an efficient binding of siRNA molecules.

In mammalian cells, these NPs are amenable to silence mRNA, microRNA and long non-coding RNAs (lncRNA) without any toxicity. The NPs penetrate and silence a variety of human cancer cell lines, such as pancreatic, ovarian, lung and osteosarcoma cancers, and also hard-to-transfect cells which are reluctant to standard transfection methods, such as human leukemic cells and primary megakaryocytic cells. Recently, in an orthotopic ovarian cancer model, we found that the intraperitoneal injection of these NPs carrying specific siRNA against the overexpressed PLK-1 kinase resulted in a decrease in the tumor progression and prolonging the mice lifespan.

In addition, we explore the use of telomerase silencing as anti-cancer treatment. Silencing of nuclear RNAs can be achieved but the mechanism is unknown. In our studies, we demonstrate that nuclear silencing of human telomerase RNA and the lncRNA MALTAT1 is dependent on cell cycle progression and may take place after nuclear breakdown when the nuclear and cytoplasmic compartments are in direct contact.

The second nano-project in our group is developing a carrier for silencing genes in the protozoan parasites Trypanosoma brucei. Using PEI-PAMAM dendrimer we demonstrate the silencing of a variety of genes. In addition, we demonstrate that CAN-γ-Fe2O3 NPs bound to PEI are toxic to trypanosomes and can be used as anti-parasitic drugs in both T. brucei and Leishmania parasites.

Nanoelectronics with 2D Materials

Moshe Kirshner, Ori Bass, Omry Cohen, Hadas Alon, Vlada Artel, Anna Peled, Chen Stern, Mark Oksman and Doron Naveh

Faculty of Engineering

Poster No. 13

Layered materials emerged as one of the most promising platform for future nanoelectronics technology. Following the success of graphene, a single atomic layer of carbon atoms, showing a record-high charge mobility, the investigation of ultrathin layered materials has provided a rich source of promising functionality for advanced electronics. Among this class of layered materials are insulators such as hexagonal boron nitride, transition metal dichalcogenide semiconductors, superconductors and topological insulators.

Our group encompasses the synthesis of such materials and the fabrication of electron devices from them. Topological insulators are being prepared and utilized for ultrafast lasers (in collaboration with Moti Fridman and Avi Zadok) and for advanced sensors and detectors. Graphene is being processed into interconnects in integrated circuits, detectors, lasers and image sensors. MoS_2 is being investigated for applications in low-power electronics and spintronics.

One of the main efforts of the group is to develop novel techniques that are common to all building blocks of electronics and include local patterned doping and bandgap engineering of such atomically thin materials. These studies are multidisciplinary in nature and involve high skills from the fields of engineering, chemistry and physics.

The Fascinating Synthesis of Nanostructures - Nanotubes, Nanofibers, Graphene, etc.

From the lab of Daniel Nessim

Department of Chemistry

Poster No. 14

The synthesis of carbon nanotubes (CNTs), carbon nanofibers (CNFs), and graphene from catalyst on substrate using chemical vapor deposition (CVD) has massively progressed in the past decade, especially the ability to control the nature of these structures on many length scales and in many aspects of their composition and morphology. Their pristine exceptional mechanical, thermal, and electrical properties, coupled with the possibility of chemical functionalization to alter their bulk or surface properties (e.g., superhydrophobicity), make them a candidate of choice for a wide array of applications, such as additives or scaffolds for battery and supercapacitor electrodes, reinforcing elements of electrically-conductive polymer composites, sensors, future electronics, etc. The poster will illustrate many different structures such as mm-tall, dense carpets of crystalline and vertically aligned CNTs on insulating and metallic substrates, self-delaminating and superhydrophobic 3D mats of CNFs, high-quality few layers graphene on nickel substrate, etc.

The Golden Era: Gold nanoparticles for Theranostic applications

Adi Vegerhof, Atara Schreiber, Eran Barnoy, Malka Shilo, Oshra Betzer, Rinat Meir, shmulik Schwartz, Tamar Dreifuss, Menachem Motiei & Rachela Popovtzer

Faculty of Engineering

Poster No. 15

The development of biocompatible nanoparticles for molecular imaging and targeted therapy is an area of considerable current interest across a number of disciplines. Nanoparticles are expected to play a major role in the future of medical theranostics due to their many advantages over the conventional contrast agents and over small-molecular-weight drugs, such as prolonged blood circulation time, controlled biological clearance pathways and specific molecular targeting capabilities. In this presentation, we will share our recent work with gold nanoparticles towards enhanced delivery of nanoparticles to solid tumors, the development of molecular and functional nanoparticle-based CT contrast agents and nanoparticles that can cross the Blood Brain Barrier (BBB). In addition, the use of gold nanoparticles for in vivo cell tracking will be presented for cancer immunotherapy and neuropsychiatric disorders.

Light Chemistry @ the Nanoscale

From the lab of Adi Salomon

Department of Chemistry

Poster No. 16

We fabricate and synthesize nano scale metallic structures which are able to trap the light to a very small area (tens of nanometers) at any frequency in the UV-VIS and IR region. Those structures enable us to play with light at the submicron scale and beyond the diffraction limit. Molecules located on those 'hot spots' (metallic structures) experience a very strong field, and their photochemical properties may be altered. We study these hybrid systems (molecules+ metallic structures) by linear and nonlinear spectroscopy means which are accessible in our lab. As part of the INREP group we do real time imaging of electrode's battery surfaces to learn on the electrochemical processes occurring in batteries.

Kaposi's Sarcoma-Associated Herpesvirus and Herpes Simplex Virus: Study of the Infectious Cycle by Using Cell and Molecular Biology, Imaging, Biochemical and Nanotechnology Approaches

Inna Kalt, Anastasia Gelgor, Nofar Nachum, Dana Dünn-Kittenplon, Yana Yegorov, Chen Gam zo Letova, Hadar Assraf and Ronit Sarid

The Mina & Everard Goodman Faculty of Life Sciences

Poster No. 17

Kaposi's sarcoma, the most common AIDS-associated malignancy, is caused by the human herpesvirus, KSHV. A rare type of B cell lymphoma and a subset of muticentric Castleman's disease are also arising from KSHV infection. Nevertheless, the details of KSHV infection and pathogenesis remain unclear. HSV-1, another human herpesvirus, is a common infectious agent that occurs worldwide and infects humans of all ages. The outcome of HSV-1 infection includes a wide variety of clinical manifestations, ranging from asymptomatic infection to oral cold sores and severe encephalitis.

Our studies involve five major areas:

1. Viral gene culprits: Characterization of viral genes and their protein products involved in KSHV pathogenesis.
2. Tracking virus entry, uncoating, assembly and egress by using recombinant viruses that express selected virion-associated proteins fused to fluorescent tags.
3. Tracking the nucleolar compartment and the involvement and modifications of nucleolar components during the infectious cycle.
4. Viral structure: Define how multiprotein virion assemblies associate and interact. This could potentially lead to the discovery of novel approaches to inhibit virion disassembly and assembly for antiviral interventions.
5. Inhibition of virus infection by using composite nanoparticles or microspheres that block the attachment of the virions to host cells.

Nanometric cues for neural engineering - promoting and directing neuronal growth

From the lab of Orit Shefi

Faculty of Engineering

Poster No. 18

The ability to manipulate neuronal growth has great implications for both neuronal repair and for the potential design of modern computational devices. Previous studies have identified processes that take place during neuronal growth that influence the geometry of the neuronal dendrites and axons. A key factor is the ability of the sensory-motile growth cones at the tips of growing processes to measure environmental cues. In our lab we study neuronal interactions with nano-scale physical and chemical cues as signals for promoting and directing neuronal growth. We grow neurons in the presence of nanoparticles and on substrates patterned with nanotopographic cues of different shapes, sizes and materials and study the effects on neuronal growth. We demonstrate that neuronal processes, which are of micron size, have strong interactions with topographical cues even as low as 10 nm and the interaction strength clearly depends on the cues' height. Using magnetic nanoparticles we are able to promote differentiation, manipulate the dendritic tree and network formation. As a more realistic platform for neuronal regeneration in vivo we study 3D neuronal cultures in hydrogels, embedded with the nanometric signals. We show that the treated gels lead to directed promoted neuronal growth. The therapeutic potential of the growth promoting effects of the 2D and 3D platforms will be presented. In addition, we develop methods for controlled drug delivery. We use several delivery models to introduce drug carriers into tissue, in culture and in vivo.

Transport Phenomena as Signatures of Phase Transitions in Quantum Matter

Efrat Shimshoni, Pavel Tikhonov, Ofer Shlagman and Naama Kochva

Department of Physics

Poster No. 19

Electronic systems with strong interactions exhibit a rich variety of quantum phases. Especially in systems with effectively low-dimensions (thin films and wires, chain-like structures in magnetic materials etc.), quantum effects are manifested by the formation of states of matter such as superconductors, spin-liquids, topological liquids and quantum solids. The fine tuning of a system parameter (e.g. an external magnetic or electric field) can induce a phase transition between two radically different collective states. Most remarkably, in some cases such phase transitions are accompanied by a dramatic change of conduction properties.

Our research group focuses on the development of theoretical understanding for these phenomena, using methods of quantum field theory. Examples include:

1. Models for the edge excitations of graphene at the N=0 quantum Hall state, where quantum phase transitions between distinct magnetic phases is reflected in electric transport properties.
2. We study the mechanism of intriguing magneto-thermal effects, observed in the thermal conductivity of spin-ladder system. Our model accounts for the coupling of phonons to quantum spin fluctuations, leading to the emergence of hybrid spinon-phonon degrees of freedom.
3. The Nernst effect in thin superconducting strips close to a superconductor-insulator transition is studied in terms of quantum tunneling of vortices.

Directed Assembly of Materials

From the lab of Hagay Shpaisman

Department of Chemistry

Poster No. 20

Our lab aims at researching novel ways of generating micro/nano-scopic structures and understanding how these structures could be further manipulated. We intend to get better understanding of the underlying scientific principles that govern these processes while developing these techniques for envisioned useful applications.

Our methods utilize:

- Optical traps
- Standing surface acoustic waves
- Shear forces in microfluidic channels

These methods hold great promise for creating on demand tailor made systems where size, shape and composition could be precisely controlled.

Physics of Colloids and Emulsions

From the lab of Eli Sloutskin

Department of Physics

Poster No. 21

In our lab, we study the physics of colloids, employing modern resonant-scanning confocal microscopy, holographic optical tweezing, light scattering techniques and analytical centrifugation, to understand the collective behavior of micron-sized particles in a molecular solvent. Such particles, known as colloids, mimic the behavior of atoms and molecules, while being at the same time sufficiently large, so that the individual colloids are readily resolved, in motion, in the bulk of a dense suspension. Colloids form fluids[1], crystals, glasses, and gels[2], allowing an unprecedentedly detailed insight into the physics of these states of matter to be gained. When the particles are heavier than the solvent, colloids form random granular packings, providing important links between the physics of granular matter and the thermodynamics of simple fluids; these links have been recently studied in our lab[3].

Additional research directions at our lab include studies of noise-induced pattern formation during sedimentation of nanoparticle suspensions[4], as also unique interfacial phenomena in emulsions, where a hexagonally-packed interfacial nano-layer makes sub-mm sized liquid droplets adopt faceted shapes, such as icosahedra and tetrahedra. Hexagram (Magen-David) - shape droplets are observed as well.

[1] Fluid suspensions of colloidal ellipsoids: direct structural measurements, A. P. Cohen, E. Janai, E. Mogilko, A. B. Schofield, and E. Sloutskin, *Phys. Rev. Lett.* **107**, 238301 (2011)

[2] Non-crystalline colloidal clusters in two dimensions: size distributions and shapes, E. Janai, A. B. Schofield, and E. Sloutskin, *Soft Matter* **8**, 2924 (2012)

[3] Dense colloidal fluids form denser amorphous sediments, S. R. Liber, S. Borohovich, A. V. Butenko, A. B. Schofield, and E. Sloutskin, *PNAS* **110**, 5769 (2013)

[4] Critical onset of layering in sedimenting suspensions of nanoparticles, A. V. Butenko, P. M. Nanikashvili, D. Zitoun, and E. Sloutskin, *Phys. Rev. Lett.* **112**, 188301 (2014).

Surface Chemistry

From the lab of Chaim Sukenik

Department of Chemistry

Poster No. 22

One of the areas most influenced by the "nano-revolution" of the past 30 years is the study of the structure and reactivity of interfaces. The specific aspects of such phenomena currently under investigation in our group involve two very different kinds of interfacial constructs: self-assembled monolayers comprised of organic molecules and oxide thin films with nanometric thickness. We are studying the impact of these ultra-thin surface layers on the physical and chemical behavior of surfaces and interfaces with applications ranging from controlling mechanical properties to imparting unique reactivity and catalytic capabilities. The substrates involved range from polymeric materials to electronic and photonic devices.

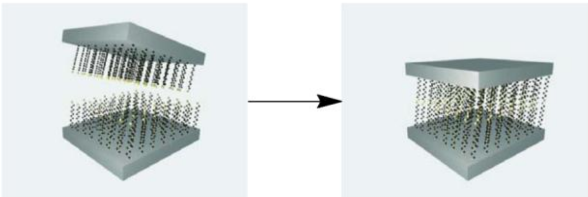


Figure 1 Bonding of Si to Si using functionalized SAMs

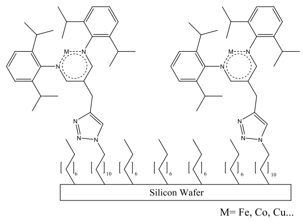


Figure 2 Catalytic SAMs

Organic monolayers are being used for the covalent bonding of electronic and photonic wafers (Figure 1), for controlling interfacial electron transport, for modifying important new materials like graphene and for creating immobilized organometallic catalysts (Figure 2). Applications include the ability to optimize the function of microfluidic devices and to enhance the performance of electronic and photonic devices. Nanoscale oxide films are being studied for their ability to coat

novel materials like carbon nanotubes (Figure 3) and to modulate the stiffness, scratch resistance and durability of polymers (Figure 4) ranging from low cost polyolefins to specialty ophthalmic lens materials. They also can control surface properties like adhesion and friction. Potential applications include improved performance eye-glasses, reduced permeability plastic pipes, and improved performance coatings for aerospace applications.

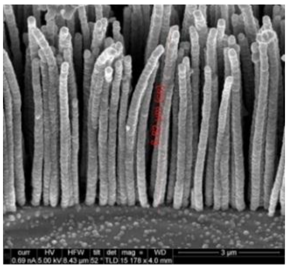


Figure 3 SEM of oxide-coated CNTs

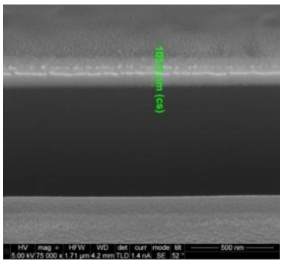


Figure 4 Cross-sectional SEM of oxide coated polymer

Direct Measurement of the Isomerization Barrier of the Isolated Retinal Chromophore

From the lab of Yoni Toker

Department of Physics

Poster No. 23

The retinal protonated Schiff base (RPSB) chromophore is the photo-detector which plays the key role in all known forms of animal vision. The chromophore acts as an optical switch – upon photon-absorption it undergoes a photo-isomerization.

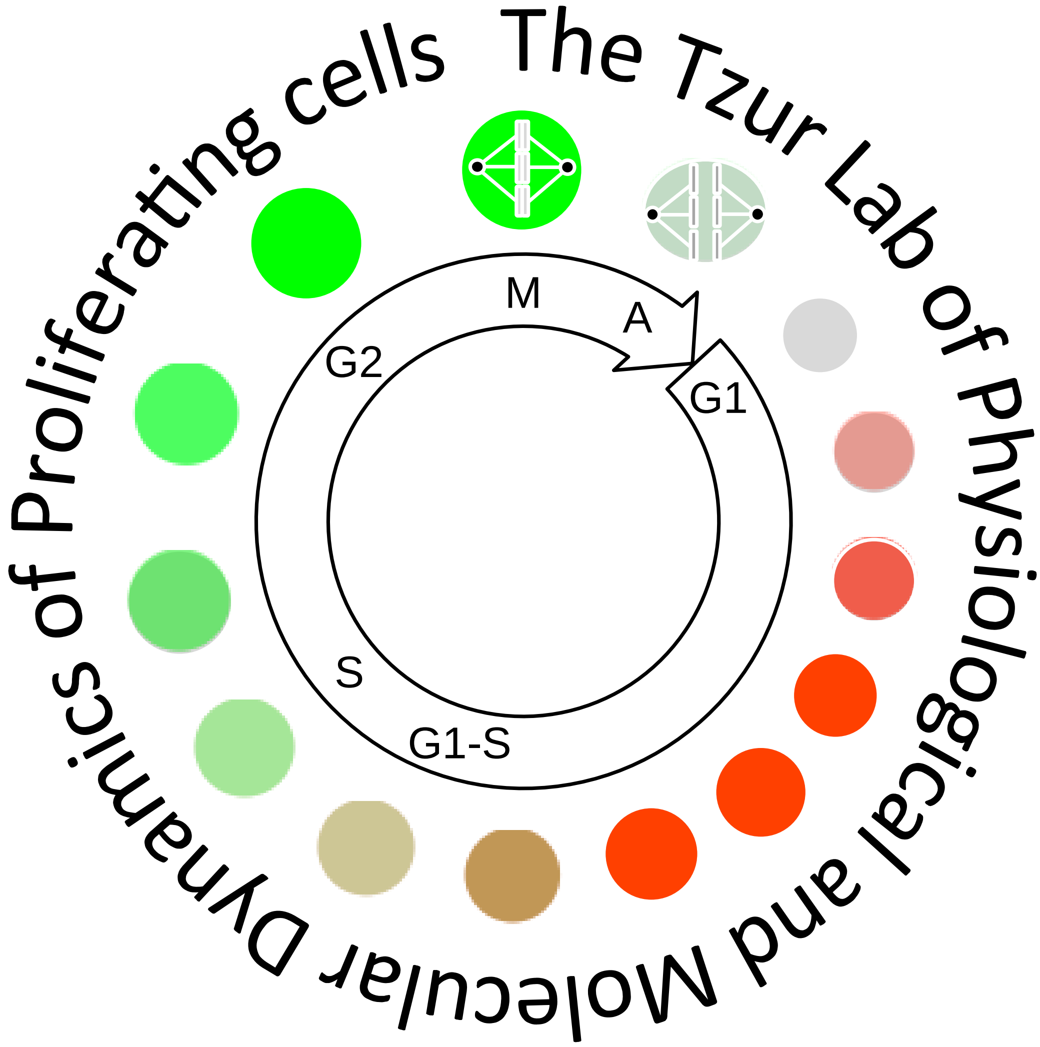
Using two stages of ion mobility spectroscopy (IMS-IMS) we have measured the internal barrier energies for isomerization of the isolated chromophore and show that they are significantly lower than within opsin proteins.

The Tzur Lab of molecular and physiological dynamics of proliferating cells

From the lab of Amit Tzur

The Mina & Everard Goodman Faculty of Life Sciences

Poster No. 24



Progress in photovoltaics – materials & concepts

From the lab of Arie Zaban

Department of Chemistry

Poster No. 25

As the world's energy consumption is rapidly growing the use of finite amount of natural resources is enormous and is dwindling quickly. One possible way to face this problem is the use of solar energy, the use of the sun power in order to generate electricity, which would reduce the dependence of the world's energy on these natural resources. So far, there are not many kinds of commercial solarl cells available, as there are many issues to overcome relating to cell performance, stability of materials, and device costs. In our poster, we will present progress in a few fields of photovoltaics. Starting with perovskites, a new and emerging discipline in photovoltaics for the past three years, an organic/inorganic device which recently reached over 20% efficiency. We will continue with a new approach for photovoltaic devices based solely on metal oxides, and demonstrate the route to deal with these promising but yet complex materials. Using advanced methods like combinatorial material science, and cutting edge fabrication and measuring equipment, we hope to take our research and bring the world to a better tomorrow.

Fiber-optic sensors and integrated photonic devices

From the lab of Avi Zadok

Faculty of Engineering

Poster No. 26

The research group of Prof. Avi Zadok in the Faculty of Engineering is conducting research in two main areas: fiber-optic sensors and integrated photonic devices. On the fibers side, we are able to employ a standard telecommunication optical fiber as an effective sensing nerve, in which every segment becomes an effective independent thermometer and / or a gauge of mechanical strain. Our measurements setups reach a range of several km, spatial resolution of 2 cm, and a sensitivity of 1 °C or 20 ppm of mechanical deformation. The measurements combine between careful control of nonlinear optical propagation effects, and elaborate signal processing algorithms. The principles are employed in the monitoring of various structures in which the fibers are embedded, such as roads, composite material parts for the aerospace sector, etc. Additional activities include novel concepts for laser range finders, all-optical processing of radar waveforms, and fiber-based monitoring and analysis of liquids.

On the photonics devices side, we combine between silicon and nonlinear glass media in the realization of integrated-photonic filters, for processing within high-rate optical communication networks. We also look at the functionalization of electro-optic materials by self-assembled monolayers, and investigate nonlinear propagation effects in specialty glass waveguides.

The group currently consists of four doctoral students and seven M.Sc. students. Since 2010, it has one doctoral graduate and seven M.Sc. graduates.

Nano photonics for data manipulation, super resolved imaging and bio-sensing

From the lab of Zeev Zalevsky

Faculty of Engineering

Poster No. 27

Our research focuses on super-resolution, optical data processing, remote sensing, nano-photonic devices and phase retrieval.

In the biomedical super resolution field, we use gold nanoparticles as contrast agents in a variety of applications for compound cellular imaging, in order to pave the root for understanding cellular functions and design effective therapies for medical applications. We also use post processing techniques in order to achieve super-resolution in localization microscopy.

Also in the super resolution field, we use time multiplexing in order to overcome the diffraction resolution limit of an imaging system. We sacrifice part of the time domain in order to gain spatial information. We design special encoding patterns, or use the background of imaging scenery as an encoder.

In the remote sensing projects we aim for non-invasive and contactless biomedical monitoring. Different bio- medical parameters monitoring such as heart rate, blood pulse pressure, remote estimation of alcohol in the blood stream, non-invasive monitoring of glucose concentration in blood, bones fracture detection and measurement of intra ocular pressure was already demonstrated. The technology is based on the extraction and separation of remote vibration sources by tracking of temporal changes of reflected secondary speckles produced in the subject when being illuminated by a laser beam.

The research in the nano-photonic devices is extensive. One of the designed devices is an all optical silicon based modulator. Such a device can be extremely applicable as the silicon is material of choice in the electronic industry, however most of the available modulators are made out of different materials, making their integration with silicon extremely difficult. We were able to create such modulator with silicon based Fabry-Perot interferometer and increased the intrinsic c-Si finesse to 10, instead of the uncoated silicon finesse of 2.5. The work also includes plasmonic devices realizing plasmonic nano circuitry and incorporating plasmonic nano antennas for efficient wireless transmission on processing chips.

The phase retrieval projects focus on the improvement of phase retrieval algorithms, inspired from other field of research, as well as development of new applications using reconstructed phase for bio-medical imaging implementations, such as x-ray-like non-invasive palm bone structure imaging.

The Science of Inorganic Nanoparticles

Masha Alesker, Gregory Gershinsky, Yelena Gershinsky, Gal Grinbom, Yana Miroshnikov, Anya Muzikansky, Pilkhaz Nanikashvili, Shlomi Polani, Meital Shviro, Lilach Stram, Hadar Tsapari, Valeria Yeremiaev,

From the lab of David Zitoun

Department of Chemistry

Poster No. 28

The aim of the laboratory is to synthesize inorganic nanomaterials for electrochemical, magnetic and colloidal studies. The research group uses reactive metal-organic compounds and studies their reactivity to yield metallic nanostructures. We have demonstrated that properly designed organometallic precursors could be decomposed to form metallic coatings directly on almost any substrate with unique control. The organometallic syntheses lead to "clean surface" monodisperse nanoparticles and tailored interfaces. We have brought such control to the shape and crystallographic facets of the nanocrystals. This approach has been applied to monometallic and bimetallic systems. These transition metal nanocrystals have been of particular interest in that they display high electrocatalytic activity in alkaline membrane fuel cells.

The advanced inorganic syntheses are also used to elaborate electrode materials with higher specific energy. One of the challenges in energy storage research is the design and study of new electrode materials and efforts to understand their mechanism for lithium uptake. The nanomaterials offer a unique platform with active elements and probes so that real-time measurements actually map the electrodes and reveal the nature of their interfaces.

Biological applications of AFM (some examples)

Arkady Bitler

Equipment Center, Surface Analysis Unit

Poster No. 29

Atomic Force Microscopy (AFM) holds exceptional place in biological researches. This is due to its ability to provide micro- and nanoscale structural information in natural physiological environment. The information can be acquired with an unprecedented resolution down to the molecular and - under certain conditions - to the atomic level. **In the same time it is not only microscope but also an efficient tool to explore various physical properties (elasticity, adhesion and dissipation, electric and magnetic characteristics) at the nanoscale.** Another useful feature of AFM is the ability to visualize and quantify various processes (time-resolved AFM) taking place at the biological sample surface. Moreover a coupling of AFM with computerized data processing allows gaining some additional information about sample structure and properties both in static and time-dependent state. Few examples of these applications are demonstrated in this presentation. These include time course of lipid membrane changes during its interaction with HIV fusion protein gp41 and corresponding quantitative kinetics, evaluation of single collagen molecule (triple-helix) elasticity, high resolution morphology and elasticity and adhesion map of live *Group B Streptococcus* near the peptidoglycan synthesis center in physiological conditions and some others. These examples can serve as introduction to the world of numerous applications of AFM.