From the Editors

We are pleased to forward you this new edition of NanoNews with recent updates and stories from the Center. In particular, in our featured article we are highlighting the research activity of Prof. Dan Peer who is leading the new consortium on Nanomedicines for Personalized Theranostics. This is a $M 11.5 project recently initiated at the Center.

Inside:
Research News / 5
Prizes and Awards / 8
New Researchers / 9
New Faces / 10
New Equipment / 10

Featured article

Hyaluronan grafted lipid-based nanoparticles as RNAi carriers for cancer cells

Dalit Landesman-Milo1,2, Meir Goldsmith1,2, Shani Levitin –Ben Arie1,2, Bruia Witenberg1,2, Emily Brown1,2,3 Sigalit Leibovitch4, Shalhevet Azriel4, Sarit Tabak4, Vered Morad4 and Dan Peer1,2, ‡

1 Department of Cell Research and Immunology, George S. Wise Faculty of Life Sciences, Tel Aviv University, 2 Department of Biological Engineering, Massachusetts Institute of Technology; 4 Harlan Biotech Israel Ltd

The silencing of genes via small interfering RNAs (siRNAs) can affect the expression of virtually any protein in a cell, and thus this process can become a potential therapeutic modality to treat a variety of human diseases, ranging from cancer and genetic disorders to viral infections. While siRNAs are routinely used for in vitro experiments to elucidate the activity of genes and proteins, there is no clinically approved product that utilizes siRNAs based therapeutics, despite the great potential it holds [1; 2; 3]. Multiple tasks are needed in order for the RNAi molecules to act in the appropriate target cells. To fulfill some of these tasks, RNAi molecules (such as siRNAs or miRNAs) must be encapsulated in nanoscaled carriers that will be delivering it into the appropriate target cells in vivo [4]. It is the mission of the nanocarrier to protect the RNAi molecules from the hostile environment which surrounds them in the circulation and at the same time enabling it to enter the cell cytoplasm [5; 6]. Today, most RNAi carriers are utilizing cationic molecules and are based on charge interactions with the negatively charged RNA. While these reagents work extremely well in vitro, in most types of cells, cationic molecules are non-natural, highly immunogenic and will result in dramatic adverse effects when introduced systemically. Some reported adverse effects of the cationic formulations include robust pro-inflammatory response, induction of interferon responsive genes, complement and lymphocytes activation, mitochondrial damage and interference with coagulation cascade. The mechanism underlining the robust inflammatory response was recently reported. The agonizing Toll-like receptor 4 by the cationic formulations play a major role in this immune toxicity [7; 8; 9; 10; 11], as well as in evoking mitochondrial damage [12].

In order to enable safe in vivo therapeutic gene silencing without the robust
pro-inflammatory response, we devised a non-cationic lipid transfection strategy based on the glycosaminoglycan, hyaluronan (HA) that is grafted on the surface of lipid-based nanoparticles (HA-LNPs). HA, a naturally occurring glycosaminoglycan, is one of the major components of the extracellular matrix (ECM). It is found in many tissues such as skin, joint tissue (in synovial fluid) and eyes [13; 14]. HA is known as a bioadhesive compound capable of binding with high affinity to both cell-surface and intracellular receptors, to ECM components and to itself. In cancer cells, binding of HA to its receptors is involved in tumor growth and spreading. CD44 regulates cancer cells proliferation and metastatic processes [15].

In addition, disruption of HA–CD44 binding was shown to reduce tumor progression. Administration of exogenous HA resulted in arrest of tumor spreading. HA is a non-toxic and non-immunogenic compound, already approved for use in eye surgery, joint therapy and wound healing. Coating small unilamellar liposomes with HA stabilizes these particles in a cycle of lyophilization and rehydration [16], provides selective targeting to tumors expressing the HA receptors [17; 18; 19], and presents a scaffold for conjugation of other ligands to the surface for further improving the selectivity to cell surface receptors [20].

HA-LNPs were originally developed as vehicles for delivering small molecules chemotherapeutics to target cells in vivo [18; 19; 21; 22]. Herein, we report a simple approach for delivering siRNAs into cancer cells using HA-LNPs that do not induce immune activation.

**Table 1: Structural characterization of HA-LNPs and control, non-coated particles, LNPs**

<table>
<thead>
<tr>
<th>Particle type</th>
<th>Lipid composition (% mole/mole)</th>
<th>Average size (nm)</th>
<th>Average Zeta potential (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNPs</td>
<td>Soy PC (60%), DPPE (20%)</td>
<td>138.87 ± 1.12</td>
<td>-8.89 ± 0.40</td>
</tr>
<tr>
<td>HA-LNPs</td>
<td>Soy PC (60%), DPPE (20%)</td>
<td>131.03 ± 1.42</td>
<td>-19.2 ± 0.76</td>
</tr>
</tbody>
</table>

**HA-LNPs are specifically taken up by cancer cells**

Almost all cancer cells highly express HA receptors, CD44 and CD168 [15; 23]. To examine the uptake of HA-LNPs into cancer cells, we used the human lung adenocarcinoma A549 cell line as our in vitro model cells. We first tested the expression of CD44 in A549 cells by flow cytometry. Figure 1a shows high CD44 expression on these cells. We then incubated HA-LNPs and separately LNPs with the cells, and they were washed as detailed in the experimental section. Confocal microscopy analysis was used to identify the HA-LNPs inside the cells cytoplasm (Figure 1b). The significant uptake is strongly correlated with the presence of HA on the particles surface, as opposed to the control, the uncoated particles LNPs (Figure 1c), which demonstrated a weak cellular uptake. The significant difference between the two types of LNPs resides by the covalent coating with HA. CD44 is the surface receptor that binds HA and is over expressed on various cancer cells, including A549. We have previously shown that high molecular weight HA (700KDa and above)

**Figure 1: HA-LNPs are specifically taken up by cancer cells.**

A representative histogram of CD44 expression in A549 cells is presented (a). Cells were stained with isotype control antibody (red curve), or with pan-CD44 clone IM7 (dark blue curve) as listed in the experimental section. Control, non-stained cells are also presented (light blue). Representative confocal images of HA-LNPs and control, non-coated LNPs internalizing into A549 cell line are presented (b & c). Cells were seeded onto 6 well plates. 25 μg of HA-LNPs (b), or control, non-HA-coated particles, LNPs (c) were added to the cells and incubated for 1 hour at 37°C. Hoechst reagent (H 33342) diluted 1:10,000 was used for nuclei staining. LNPs were pre-labeled with Rhodamine-DPPE to detect the LNPs intracellular pathway. The internalization was performed using a Zeiss confocal microscope (Meta 510).
that is covalently attached to LNPs, have high affinity to CD44 receptors by a surface plasmon resonance study [23].

**HA-LNPs entrapping siRNAs against P-gp selectively silence P-gp in cancer cells.**

For examining the capability of HA-LNPs for carrying siRNAs and inducing gene silencing in cancer cells, we entrapped siRNAs against P-gp (served here as a surrogated marker) and removed the unentrapped siRNAs, as described in the experimental section. The efficiency of encapsulation was 23.9 % ± 2.5, thus, the total siRNA concentration that was entrapped in the particles was 70nM. In order to probe for knockdown, we utilized as our model cells the human ovarian cell line, NCI-ADR/Res (NAR), which are highly resistant to chemotherapeutics and express a high level of the P-gp extrusion pumps as part of their drug resistance mechanism. In addition, these cells highly express CD44 on its surface as we have previously shown [23]. We quantified the knockdown level at the mRNA level, using real-time quantitative PCR (Figure 2a), and at the protein level using flow cytometry analysis (Figure 2b). QPCR was determined 6 days post transfection, flow cytometry analysis was performed 7 days post transfection. HA-LNPs entrapping P-gp-siRNAs reduced mRNA levels of this gene by ~50% and subsequently also decreased P-gp protein levels. As negative controls, we used free P-gp- siRNAs, LNPs entrapping P-gp siRNAs, and HA-LNPs encapsulating Luciferase-siRNAs, an irrelevant siRNA that was acting as a control for demonstrating the specificity of the P-gp siRNA. All controls did not reduce mRNA (Figure 2a) or protein levels of P-gp, respectively.

**HA-LNPs do not induce a pro-inflammatory response in human PBMCs**

One of the major hurdles in translating many of the novel delivery strategies for RNAi into new therapeutic modalities is unacceptable immuno-stimulation that may induce a robust pro-inflammatory response, possibly leading to cytokine storm and even to death. This hyper stimulation could be attributed to the RNAi payload, the nano-vehicle, or the combination of the nano-vehicle that is entrapping the RNAi payload [10; 26]. In order to evaluate the safety profile of HA-LNPs as a future drug delivery vehicle, an ex vivo cytokine induction study was performed using the human PBMCs, which examined the secretion of major inflammatory cytokines. The secretion level of three different inflammatory interleukins was tested using IL-6 and TNF-alpha as a model for the innate immune response, and IL-10 as a model for the late immune response. The results are summarized in Tables 2 and 3. Neither the HA-LNPs nor the control, uncoated LNPs caused an elevated secretion of both innate and late cytokines response in two different time points, 2 hours (Table 2) and 24 hours (Table 3) post incubation with these particles. As a positive control, we used the Toll-like receptor 4 (TLR4) natural ligand, lipopolysaccharides (LPS) that secreted high levels of both TNFa and IL-6 already 2 hours post incubation with an increase after 24 hours of exposure to the LPS. IL-10 was secreted

![Figure 2. HA-LNPs entrapping siRNAs selectively silence P-gp in cancer cells.](image)

Transfection was performed 24 hours post cell seeding as detailed in the experimental section. The cells were treated with free P-gp-siRNA, LNPs entrapping luciferase-siRNA or P-gp-siRNA which served as controls or with HA-LNPs encapsulating P-gp-siRNA or luciferase-siRNA. 6 days post transfection the cells were analyzed for mRNA levels using real time PCR (a); * denoted p< 0.001. P-gp protein level was assayed using flow cytometry. A representative histogram is presented (b). Red curve: basal P-gp level in the cells; Orange curve: P-gp level 7 d post transfection , treatment with HA-LNPs (P-gp-siRNA); and light blue - isotype control (p-gp – isoclass matched) antibody.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>TNF-α (pg/ml)</th>
<th>IL-10 (pg/ml)</th>
<th>IL-6 (pg/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative control (PBS)</td>
<td>N.D.*</td>
<td>N.D.*</td>
<td>N.D.*</td>
</tr>
<tr>
<td>Positive control (LPS 1mg/ml)</td>
<td>840.41 ± 67.01</td>
<td>N.D.*</td>
<td><strong>20860.75 ± 2974.03</strong></td>
</tr>
<tr>
<td>LNPs</td>
<td>N.D.*</td>
<td>N.D.*</td>
<td>N.D.*</td>
</tr>
<tr>
<td>HA - LNPs</td>
<td>N.D.*</td>
<td>N.D.*</td>
<td>N.D.*</td>
</tr>
</tbody>
</table>

Values are expressed as means ± S.E.M. Significantly different: P < 0.01.
* N.D. - not detectable
** Upper limit of quantification.
after 24 h, as expected. The findings that HA-LNPs or LNPs do not stimulate the innate immune arm or the adaptive arm via an increase in the cytokine secretion levels are in a good agreement with our previous published work with murine immune cells [23].

To conclude, here we have shown that HA-LNPs could be a safer alternative for commercializing cationic transfection reagents for targeting cancer cells. HA-LNPs do not trigger cytokine release from human PMBC's, and therefore should not elicit an immune response in the body. At the same time, the HA coating confers specific targeting properties to the HA-LNPs and ensures that HA-LNPs will only affect specific cells. Taken together, our results show that the strategy of HA-LNPs is a promising delivery approach for safe delivery of RNAi in inducing gene silencing in cancer cells. This paper was accepted for publication in Cancer Letters on-line. This work was supported in part by grants from the Israeli Centers of Research Excellence (I-CORE), Gene Regulation in Complex Human Disease, Center No. 41/11, by the MAGNET program Rimonim, by the FTA: Nanomedicine for Personalized Theranostics, and by the Leona M. and Harry B. Helmsley Nanotechnology Research Fund awarded to D.P.

References
Producing a surface with an ultra-dense array of addressable nanoscopic elements that is perfectly ordered over macroscopic length scales is a formidable challenge. The self-assembly of diblock copolymers (BCP), two chemically dissimilar polymers joined together, is emerging as a promising route to generate templates and scaffolds for the fabrication of nanostructured materials, and offers a potential solution to this challenge. Furthermore, it has been considered as a legitimate next-generation microelectronics lithography technique for insertion at the sub-22 nm technology nodes.

Nano-imprinting lithography is a new method for macroscopic alignment of BCP on molecular scale and was used by Andelman’s collaborators P. Guenoun and J. Daillant from the Saclay research center of the CEA (the French atomic energy commission) in France. It can be used as a tool for locally controlling the self-assembly of BCP and determining the precise position of the phase-separated domains. The idea behind the Nano-Imprint Lithography technique is shown schematically in Figure 1. A hard and structured mold is pressed into the BCP film at temperatures higher than the glass temperature of the polymer, inducing the preferred nano-structures in the BCP film.

Self-consistent-field theory (SCFT) was used in our modeling, done in collaboration with H. Orland, also from CEA Saclay, to explore how lamellar phases of symmetric BCP are aligned and oriented in a Nano-Imprinting Lithography setup. A gradual temperature quench was performed from a temperature exceeding the order-disorder temperature into the strong segregation region. With the simulated Nano-Imprinting mold, we found a perfect perpendicular lamellar structure, shown in Figure 2(a). As a further check, we compared the Nano-Imprinting setup with a BCP film confined between two neutral and flat surfaces. As can be seen in Figure 2(b), in the latter case, the film contains many in-plane defects when the same gradual temperature quench process is repeated. Without the Nano-Imprinting mold, it is possible to obtain perpendicular lamellae, but only with many in-plane defects that cannot be eliminated by annealing. On the other hand, with the Nano-Imprinting mold, wetting of the vertical groove wall induces perfect perpendicular ordering with minimal amount of defects over large lateral distances.

The agreement between the experimental results and the theory gives hope that Nano-imprint Lithography can be used in the future to control and manipulate patterns as required in the microelectronic industry. The method is high throughput and low cost, and can achieve sub-10 nm resolution.

Wettability study of nanodroplets is an important research field, exhibiting different properties compared to those of macroscopic drops. Properties of macroscopic liquid drops could be averaged over nano-scale inhomogeneities, which are of particular significance in case of nanodroplets. Furthermore, the macro-scale properties are varied with reduction of drop size down to the nano-scale. Beyond the fundamental significance of wettability study for nucleation and growth processes, there is a large technological relevance to nanofluidic technology, soft lithography, lab-on-a-chip devices and biotechnological applications. Device miniaturization would require the understanding of the physical phenomena associated with nano-scale and in particular the role of boundary conditions. The development of innovative experimental wettability methods for the nano-scale and in-situ dynamic characterization is thus important from both theoretical and practical aspects.

Macro-scale imaging of liquid drops is usually carried out by optical microscopes, including confocal microscopes and goniometric devices for contact angle derivation. Micro and nano-scale imaging require alternative methods, which overcome the submicron Rayleigh resolution limit. Wetting properties of bulk sample surfaces at sub-micron resolution can be carried out in Environmental Scanning Electron Microscope (ESEM) using reflected secondary electrons, while the sample is under environmental conditions according the water-vapor equilibrium phase diagram. Pioneering results have been obtained at TAU by in-situ ESEM imaging of liquid marbles (with E. Bormashenko, AUC) and by droplet line tension derivation (with G. Rosenman, TAU). Other possible ESEM wettability topics include picoliter liquid flow through carbon nanotubes, contact angle hysteresis and Cassie-Baxter to Wenzel transition for textured solid surfaces. Recently, wet scanning transmission electron microscope (wet-STEM) detector in ESEM has been incorporated for imaging of nanoparticles in liquid and for mini-emulsions. Thus, instead of ESEM reflected mode, which is suitable for bulk samples, wet-STEM provides studying of thin films and particles at transmitted wet-mode with improved resolution.

The quantitative method for wettability study at nanoscale is here shown, based on wet-STEM detection of transmitted electrons [1-2]. The quantitative information of the nanodroplet shape and contact angle was obtained by fitting Monte Carlo simulation results for transmitted electrons with the experimental wet-STEM results using a calibration sample [Fig. 1]. The characterization was suitable for the initial stages of nanodroplet condensation.

Figure 1: Polystyrene water diluted spheres on grid (1 μm bar): (a) nanodroplet condensation at 2° C and 5.4 torr (b) calibrated profile along the center of the nanodroplet and the calibration nanoparticle together with the MC simulations

Figure 2: Dropwise nucleation and growth stages on a self-supported water film (2 μm bar): (a) t=13 s, (b) t=27 s, (c) The droplet growth radius at constant 94% RH for two nanodroplets ("1" and "2" in fig. 2a).
The light was linearly polarized parallel to one of the antenna groups, inducing traps in that group and not interacting with the antennas normal to it. Optical spectral characterization of both antenna groups was performed both before and after the trapping and the normalized results are presented in the accompanying figure. The observed change in the spectral behavior of parallel antennas indicates that selective trapping indeed occurred.

Acknowledgement is given to the Nano and Materials Centers at Tel-Aviv University for supporting the ESEM facility.

References

Optically induced Dielectrophoresis for nano-particle trapping using nano-antennas

Yuval Yifat, Michal Eitan, Zeev Iluz, Amir Boag, Yael Hanein, and Jacob Scheuer

A major challenge in current nanotechnology is the ability to manipulate, assemble and trap nanoparticles on large scale surfaces. A consistent method for trapping nano-particles and facilitating nanostructure assembly would be an enabling technology for nanotechnology and nano-fabrication applications.

The researchers illuminated an array of gap-dipole nanoantennas immersed in a solution of IPA with 50nm Au nano-particles. The wavelength of the laser light was set to the resonance wavelength of the nanoantennas, creating a high gradient electric field localized at the gap and at the edges of the antennas, which then serves as sub-wavelength optical traps due to dielectrophoresis. The arrays were fabricated with antennas in two orthogonal directions.
Prizes and Awards

- **Prof. Abraham Nitzan** received the EMET Prize from the AMN Fund.

- **Prof. David J. Bergman** received the Landauer Medal of the International ETOPIM Society from the ETOPIM (Electrical, Transport, and Optical Properties of Inhomogeneous Media) International Society.

- **Prof. Guy Deutscher** was awarded the IVS Excellency Award for Research by the Israel Vacuum Society.

- **Prof. Yoram Dagan** received the Israel Physics Society Prize for young faculty members from the Israel Physics Society.

- **Prof. Karen Avraham** was awarded the Teva Prize for Groundbreaking Research in the Field of Rare Diseases by Teva Pharmaceuticals Industries Ltd.

- **Prof. Dan Peer** received the Breakthrough Award 2012 from the Kenneth Rainin Foundation.

- **Prof. Ehud Gazit** received the 2012 Elected Fellow of the Royal Society of Chemistry (FRSC).

- **Prof. Yosi Shacham** was awarded the Distinguished International Chair Professor from the Feng Chia University, Taichung, Taiwan.

- **Prof. Noam Eliaz** was elected the Eshbach Visiting Scholar from the McCormick School of Engineering and Applied Science, Northwestern University.

- **Prof. Noam Eliaz** was elected the NACE Fellow from the NACE International.

- **Dr. Oded Hod** was elected a Member of the Israel Young Academy by the Israel Academy of Sciences and Humanities.

- **Prof. Yael Hanein** was elected a Member of the Israel Young Academy by the Israel Academy of Sciences and Humanities.

- **Dr. Roy Beck-Barkai** received the Biochemical Society Oral Communication Prize (2012) from the Biochemical Society.

- **Dr. Zahava Barkay** received the MSA award 2012 (for paper presentation) from the Microscopy Society of America.

- **Dr. Tal Dvir** received the Alon Fellowship from the Israeli Academy of Science.

- **Dr. Roey J. Amir** received the Allon Fellowship from the Council for Higher Education of Israel.

- **Dr. David Sprinzak** received a prestigious grant from the Human Frontiers Science Program.

- **Gilad Cohen** received an Excellence certificate for M.Sc studies in Electrical Engineering from the Engineering Faculty, Tel Aviv University.

- **Leonid Lrasovitsky**, a M.Sc. student in the Materials and Nanotechnology program and a member of Prof. Gil Rosenman’s group was awarded the best student poster prize at the IVS (Israel Vacuum Society) Meeting of 2012.

- **Shoshy Mizrachy**, a Ph.D. student in Prof. Dan Peer’s group, was accepted to the HOPE meeting in Life Sciences 2013 where she will have the opportunity to engage in interdisciplinary discussions with Nobel Laureates and other distinguished world-class scientists.

This year’s Nano Post-Doctorate fellows are: **Dr. Anna Peled**, Chemistry, group of Prof. Fernando Patolsky • **Dr. Anna Scomparin** (Italy), Medicine, group of Prof. Ronit Satchi-Fainaro • **Dr. Filipe Natalio** (Portugal), Life Sciences, group of Prof. Micha Ilan • **Dr. Ksawery Kajetan Kalinowski** (Australia), Engineering, group of Prof. Adi Arie • **Dr. Michal Levy-Sakin**, Chemistry, group of Dr. Yuval Ebenstein • **Dr. Stive Pregent** (England), Physics, group of Dr. Roy Beck-Barkai.

This year’s Nano graduate student fellows are: **Rachel Blau** (M.Sc.), Medicine, group of Prof. Ronit Satchi-Fainaro • **Alon Kosloff** (M.Sc.), Chemistry, group of Prof. Fernando Patolsky • **Alex Henning** (Ph.D.), Engineering, group of Prof. Yossi Rosenwaks • **Aviad Levin** (Ph.D.), Life Sciences, group of Prof. Ehud Gazit • **Eli Wilner** (Ph.D.), Physics, group of Prof. Eran Rabani • **Nimrod Bachar** (Ph.D.), Physics, group of Prof. Guy Deutscher.
New researchers in the Center

Dr. Tal Ellenbogen

Dr. Tal Ellenbogen has recently joined the Department of Physical Electronics after returning from Harvard University where he specialized in nanophotonics and excitonics as an active member of The Harvard University Center for Nanoscale Systems and The MIT Center for Excitonics. Dr. Ellenbogen established a new Laboratory for Nanoscale Electro Optics (NEO Lab) at Tel-Aviv University which studies the fundamentals of the interaction between light and matter at the nanoscale. The NEO Lab aims to gain better understanding of the underlying physical mechanisms of this interaction and to use it to develop the next generation of optical and electro-optical devices. The research at the NEO Lab involves extensive fabrication and design of novel nanostructured materials for a wide range of applications combined with advanced optical and electro-optical characterization of their linear, non-linear and transient dynamics. Specific research interests of the lab include: nonlinear plasmonics, generation and manipulation of hybrid light matter states by strong coupling of excitons and surface plasmons, optical metamaterials, plasmonic beam shaping and control, lasing properties of nanostructures, nanoantennas, manipulation of photophysical phenomena by nano-engineering and localized heat generation and measurements.

Tag based on optical metasurfaces which change their color response with respect to the polarization state of incident light. The metasurface is composed of dense arrays of unique nanoantennas. Response of the tag to (a) unpolarized light, and light polarized at (b) 0°, (c) 90°, and (d) 45°. (e) Scanning electron microscope image of the nanoantennas which compose the metasurface. Areas 1 and 2 define the letter region and the background region respectively.

Dr. Tal Schwartz

Dr. Tal Schwartz received his PhD in 2008 for his research on nonlinear dynamics in stochastic optical systems from the Technion, Israel Institute of Technology. He then moved to France for his postdoctoral studies under a Rothschild Fellowship from the Yad Hanadiv Foundation and Chateaubriand Fellowship from the French Embassy in Israel. He joined the Laboratory for Nanostructures, led by Thomas Ebbesen at Strasbourg University, where he studied the interaction of light with organic molecules in nanostructures, focusing on strong coupling effects in organic cavities and plasmonic hole-arrays. In 2012 he joined Tel Aviv University as a senior lecturer in the School of Chemistry, where he is currently establishing his research group. Dr. Schwartz’s group will study interaction of light with organic dyes and plasmonic nanostructures, concentrating on strong coupling of molecules to photonic devices: when organic molecules are attached to a sub-wavelength device, such as a plasmonic nanostructure or a microcavity, the quantization of the electromagnetic field and its confinement into a small region in space can create new quantum states which are half-light and half-matter. In his research, Dr. Schwartz explores how the creation of these new energy states affect the behavior of materials, and how the ultrafast dynamics in such hybrid systems is altered by the photonic structures. He develops new techniques to use the interaction of the molecules with light in nanostructures in order to manipulate chemical reactions and material properties, such as electronic transport or luminescence properties of organic materials. This may lead to novel types of chemical catalysts which are based on specially designed plasmonic structures, and to the design of new architectures for achieving organic electro-optics devices with superior efficiency.

In a different aspect of this research, Dr. Schwartz is searching for possible ways for using the coupling of molecules to plasmonic structures for inducing phase coherence among the molecules by femtosecond laser pulses. He will use this kind of macroscopic “entanglement” as a framework for generating and studying collective quantum states of matter, known as polariton condensates and polariton lasers.
Alex Epstein

Alex joined the Center as our new equipment engineer, replacing Assaf Hazan and Gregory Avrushenko. Alex brings to the Center many years of outstanding experience in the field of vacuum technology. He has extensive industrial experience acquired from working for several companies, including: Rafael, SCD, CSTI, and the Technion. From 2001 he worked in Trellis Photonics in Jerusalem until 2003, when he moved to Mark Technologies as a service and installation manager supporting vacuum equipment for industry and university centers. From 2006 until 2012 he worked in Sirica Corporation building research designated equipment for special projects. Alex joined the Nano Center in August 2012.

Ronit Timor

Ms. Ronit Timor is the Center’s new Administrative Assistant. In her capacity as an Administrative Assistant, Ronit will be in charge of the smooth operation of our office, taking care of student scholarships, seminars, workshops, PR, visits, social events and much more. With a B.A. in the History of Arts from TAU, Ronit started working at TAU in 1991, at the Faculty of Medicine. She then moved to the Department of Communication Disorders until 2005. Between 2005 and 2012 Ronit was leading the Unit of Special Projects in the Arts at the Faculty of Arts of TAU. She joined the Nano Center in August 2012.

Near-Field Scanning Optical Microscopy (NSOM) System

The system comprises an NSOM tool fully integrated into a dual (upright + inverted) Olympus microscope. The system is manufactured by Nanonics Imaging.

A tiny pulled cantilevered optical fiber, with a sub-wavelength (up to 30 nm) aperture, is brought into a contact with the investigated sample and scanned over it using AFM-based feedback mechanism (the fiber is attached to a tiny tuning fork eliminating any optical background from the feedback laser).

In the illumination mode, a laser light is coupled into the fiber creating a sub-wavelength-sized point of light. During the scanning process, the light transmitted through the sample (transmission mode) or reflected from the sample (reflection mode) is detected, pixel by pixel, by an APD detector, creating an optical image with sub-wavelength resolution, which is defined by the aperture size. Simultaneously, AFM topographical data is registered. In the collection mode, the APD detector is used to register optical signals collected by the aperture being scanned over light-emitting features on a sample surface. The achievable spatial optical resolution is around 50 nm.

The “4π” geometry of the dual microscope allows for clear optical axis for sample visualization and for all NSOM modes.

The system is equipped with a compact green 532 nm laser for illuminating through optical fibers and with the image processing software. The system is located at the Engineering Faculty Building under the supervision of Prof. Ady Arie.
Events

- **Nano-focus**: FIB day, hosting Dr. Andreas Remscheid and Dr. Sven Bauerdick from Raith, as well as Dr. Yigal Lilach, took place on December 4th, 2012. During this high application-oriented day, organized by the Nano Center, the FIB ionLine system was presented, its strengths in various applications, including a special demonstration in the FIB lab in the Nano center.

- **Prof. Jinwoo Cheon** from the Yonsei University in Korea has visited TAU and the Nano center and gave a special seminar on October 21st, 2012, entitled “Rational Design of Nanoparticles for Biomedical and Energy Applications”.

- **The nano socials**, a new tradition, began on 29th November, 2012. On the last Thursday of each month, at 14:30, meet us at the center for networking and socializing, and join us in celebrating the birthdays of the past month.
The Fred Chaoul 8th Annual Workshop, held in Hagoshrim Hotel and Conference Center in June 2012.