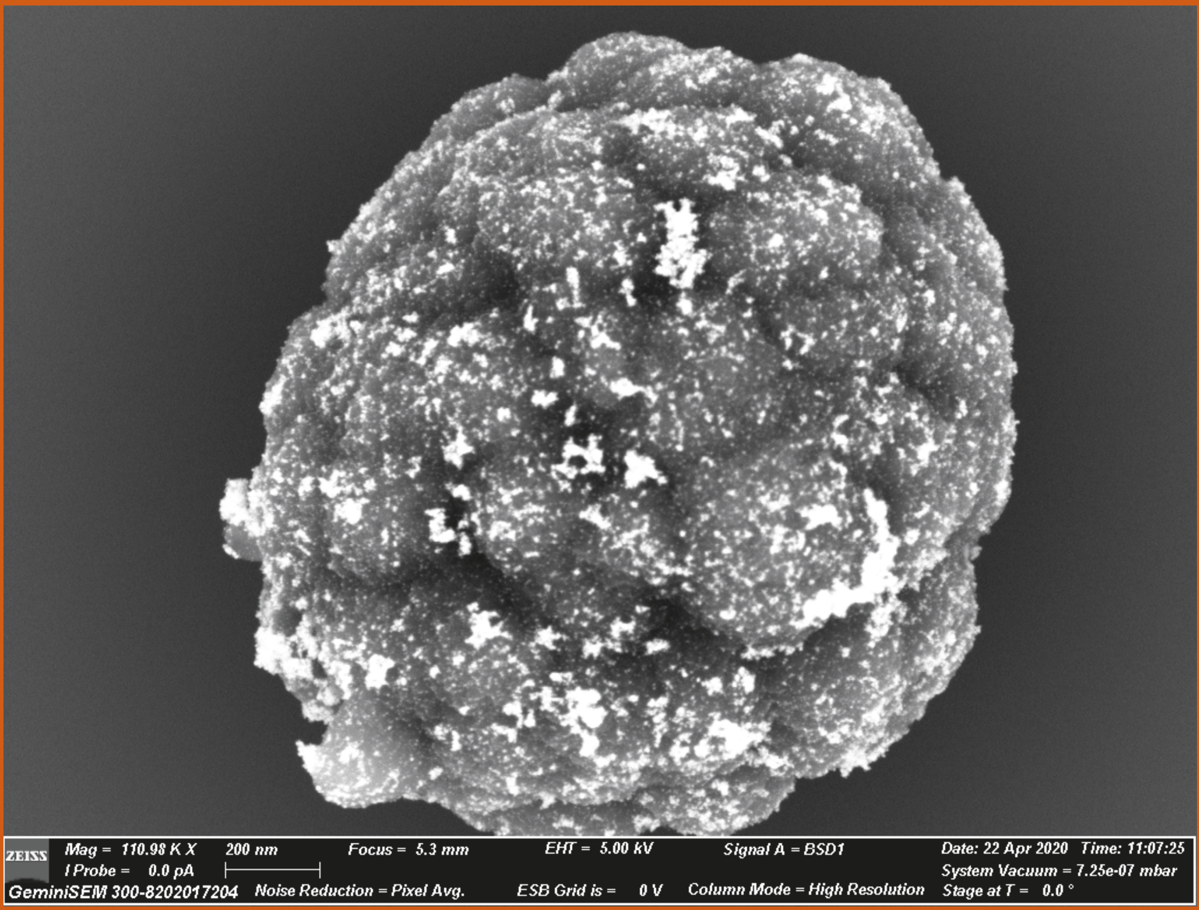
Tel Aviv University Center for Nanoscience & Nanotechnology

SCIENTIFIC REPORT 2019-2020



Tel Aviv University
Center for Nanoscience
& Nanotechnology

Tel Aviv University Center for
Nanoscience & Nanotechnology
Powering Innovation

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SCIENTIFIC REPORT

October 2020

The cover image: A highly porous vaterite microspherulite filled with 3-nm gold seeds using the innovative freezing-induced loading technique. The image was taken by Dr. Gal Radovski of the TAU Center for Nanoscience & Nanotechnology and belongs to Prof. Pavel Ginzburg's group.

Graphic Design: Michal Semo Kovetz, TAU Graphic Design Studio

Contents

PART 1
MAIN ACTIVITIES AND FACILITIES

Overview

The Center for Nanoscience and Nanotechnology, the first Israeli institute of its kind with about 100 affiliated research groups, is the largest and most influential center at Tel Aviv University. The multidisciplinary center houses a variety of laboratories from different domains, all working together under one roof. Over the last 20 years, the Center has organized international collaborations with leading researchers through research, seminars, student exchanges and more. In addition, through strong and longstanding ties with industry, the Center continuously provides extensive services to a growing number of companies - from small startups to large corporations.

After eight years of leading the Center into to a new era, Prof. Yael Hanein completed her term as Director the Center for Nanoscience and Nanotechnology at the end of February 2020.

At the beginning of March 2020, Prof. Tal Dvir, a leading researcher at TAU's George S. Wise Faculty of Life Sciences, was appointed as her successor.

Prof. Dvir has been involved in nanotechnology R&D for over a dozen years. In addition to being the head of the Nano Center, he heads the Sagol Center for Regenerative Biotechnology, a large research laboratory that develops smart bio and nanotechnologies for engineering complex tissues, including cardiac and neural tissues. Several of his innovations are being further developed by Medical Devices/Biotech/Pharma companies

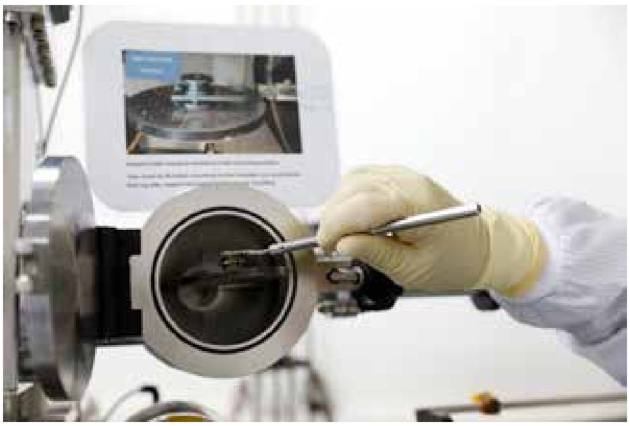
In spite of the COVID-19 pandemic, the Center continued its activities and services under special safety regulations in order to secure the health of its employees and users.

The following report highlights the activities of the Tel Aviv University's Center for Nanoscience and Nanotechnology during the period of January 2019 – September 2020.

We hope you will find the information in this report useful for identifying new partnerships, resources and ideas. Comprehensive and constantly updated information about the Nano Center is available on our website at www.nano.tau.ac.il.

Hubs of innovation

The Chaoul Center for Nanoscale Systems



The Chaoul Center for Nanoscale Systems is Israel's leading facility of its kind. The Center provides the country's micro and nanotechnology community, in both academia and industry, with access to the field's most advanced R&D services, knowledge and equipment. The Roman Abramovich Nanoscience and Nanotechnology Building, presently under construction and scheduled to open in 2022, will have a specially designated and substantial space for the Chaoul Center and its state-of-the-art equipment.

Thanks to the Chaoul family, as well as the Israeli government and TAU, about 80 academic groups and 40 companies – from large Israeli corporations to small startups, currently use the Chaoul Center's laboratories. These laboratories offer researchers and corporations the opportunity to develop prototypes from small-scale predefined runs to large R&D projects as well as full-process development, jointly with the customer. Services - including characterization, device design, and fabrication processes – are continually improved and expanded, as we add standard operating procedures for more systems, and offer them online.

The Chaoul Center's equipment is among the most advanced and comprehensive in Israel, spanning many types of fabrication methods, and enabling the development of full-process prototypes. BookitLab was incorporated in 2018, in order to efficiently manage the scheduling, monitoring and financing of the Chaoul Center's services.

Using significant support from governmental funds, we continue to update our equipment purchasing and installation. During 2019, we purchased and started to operate a new state of the art High Resolution Scanning Electron Microscope (HR-SEM). In 2020-2021, we plan to purchase a state-of-the-art FIB with a dual port to replace the current single port, old, beta-site device, as well as state-of-the-art biological oriented Atomic Force Microscope (AFM).

International Collaborations

XIN Center

Since 2014, the XIN Center has been the flagship partnership between the elite Chinese University Tsinghua (THU) of Beijing and Tel Aviv University. This joint collaboration focuses on high-impact applied research, promoting over a dozen applied research programs at both TAU and THU. A unique mentoring system that includes leading scientists, industrialists and business figures accompany projects throughout all stages of research, combining internal and external resources from both Israel and China. Emphasis is placed on projects conducted jointly by top Chinese and Israeli researchers in the fields of Nanoscience and Nanotechnology.

A new joint ISF-NSFC grant for collaborating TAU and THU researchers, who joined forces through the XIN Center, was approved for a 3-year funding starting at the end of 2019: Prof. Michael Urbakh of TAU and Prof. Quanshui Zheng of THU won the grant for research on Nano Friction.

2019 XIN Innovation Forum,
August 17-21, 2019, Beijing

The 8th International Conference on Nanoscience and Technology, China (China NANO 2019) was chaired by Professor Bai Chunli, President of the Chinese Academy of Sciences, China. More than 500 keynote speakers and guests from all over the world attended the conference, and more than 60 companies/units exhibited at the conference.

Other highlights of the forum include:

- China Israel Nano Workshop at the National Center for Nanoscience and Technology in Beijing
- Visits to Tsinghua University labs, to Tsinghua joint GHDDI (Bill Gate's Drug Discovery Center) and to Boston Scientific T3 Engine and International Medical Robotics Innovation Center (IMC).

INASCON2019 Nano-Science and Nanotechnology Conference, July 15- July 18, 2019, Tsinghua University

Two Ph.D. students from TAU took part in the INASCON2019 Nano-Science and Nanotechnology Conference that was held at Tsinghua University.

The topic for the conference was "Co-develop Nano-X ideas of the future"

The students were:

Ms. Tamara Ehm, (Prof. Roy Beck's lab, Raymond and Beverly Sackler Faculty of Exact Sciences, Tel Aviv University). Research subject: *"Structural Characterization of Self-Assembly Inspired Myelin Sheath Complexes: A Biophysical Perspective on Adrenoleukodystrophy"*

Mr. Ori Mayer, (Prof. Noam Shomron's lab, Sackler Faculty of Medicine, Tel Aviv University). Research subject: *"Delivery of microRNA via Nanoparticals"*

Artificial Intelligence Meetings,
June 12th, 2019, Tel Aviv University

A six-member delegation from Tsinghua University, including Prof. Zhangbo, Dean of the Tsinghua AI Institute, visited XIN and AI researchers from TAU's Department of Electrical Engineering and the Blavatnik School of Computer Science.

XIN Workshop on Medical Innovation,
April 30th and May 6th, 2019, Tel Aviv University

A discussion for collaboration in the medical field of 20 people from Tsinghua University headed by Prof. Cheng Feng, Director of Global Health Program in Tsinghua University with TAU professors from the faculties of Life Sciences and Medicine.

Germany-Israel Academia-Industry Nanotechnology Grants

Since 2017, five TAU researchers affiliated with the Center have been continuing with their research that was part of a three-year €30-million plan for companies and academic institutions from Israel and Germany, to promote joint nanotechnology initiatives.

TAU researchers that won five of the initial 13 grants:

Prof. Yossi Rosenwaks, Iby and Aladar Fleischman Faculty of Engineering, *Novel Gas Sensor*

Prof. Natan Shaked, Iby and Aladar Fleischman Faculty of Engineering, *3D optic Tomography of Cancer Cells*

Prof. Yael Hanein, Iby and Aladar Fleischman Faculty of Engineering, *Wearable Nano-Based Electronics for Mental Disorder Diagnosis and Mental Function Restoration*

Prof. Yuval Ebenstein, George S. Wise Faculty of Life Sciences, *Lab-On-A-Chip Cancer Diagnostics by Quantification of Epigenetic Markers*

Dr. Ariel Ismach, Iby and Aladar Fleischman Faculty of Engineering, *2D Layered Materials*

Tel Aviv University-Northwestern University Nanoscience and Nanotechnology Initiative

In 2018, thanks to the generosity of Mr. Roman Abramovich, the Nano Center launched the Tel Aviv University-Northwestern University Nanoscience and Nanotechnology Initiative.

The initiative aims to bring together scholars, scientists, engineers and students from both universities for exchange and research in the fields of nanoscience and nanotechnology, thereby facilitating a robust synergy and exchange of ideas. Ultimately, the joint venture intends to advance R&D activities, leading to economic growth in both countries. The initiative includes: postdoctoral fellowships, student exchange programs, an annual nanoscience and nanotechnology workshop and joint research grants.

In 2019, the following four joint research projects were initiated under the support of the Initiative:

1. Novel Light Sources Based on Nonlinear Conversion Enhanced by Metasurfaces (Prof. Koby Scheuer)
2. Novel Photo-Active Metal-Protein-Graphene Membranes for Energy, Biomedical and Nano-Electronics Applications (Prof. Shachar Richter)
3. NanoTransformers Based on Intrinsically Disordered Protein Amphiphiles (Prof. Roi Beck and Prof. Roey Amir)
4. Enzyme-Responsive Nanoparticles for Targeted Delivery, Accumulation, and Retention of Drugs to Diseased and Inflamed Oral Tissues (Dr. Lihi Adler + Dr. Eyal Rosen)

Additionally, with the support of the Initiative, TAU M.Sc. student Yael Meir, under the supervision of Prof. Koby Scheuer, initiated research at Northwestern University. The research initiative took place over a period of 9 months.

Educational Activities

Educational Activities

TAU's Center for Nanoscience and Nanotechnology organizes a range of social and scientific activities, including an annual workshop, monthly seminars, a Nano-MBA seminar, student exchange programs and more. Major activities in 2019-2020 included:

Northwestern University–Tel Aviv University International Winter School on Nano Materials for Energy Conversion and Storage

January 2019, Tel Aviv University

Our 2019 Winter School, January 14-17, focused on Nanomaterials for Energy Storage and Conversion. The Winter School was supported by the XIN Center at the TAU Center for Nanoscience and Nanotechnology and by the new TAU-Northwestern Initiative. The main topics were: battery and super capacitors, fuel cells and SOFC, solar fuel/synthetic fuel, and industrial product innovation. The school included lectures by leading researchers and a student poster session

The Winter School's organizers were Dr. Brian Rosen and Prof. Michael Gozin of Tel Aviv University.

The Fred Chaoul 12th Annual Workshop on Nanoscience and Nanotechnology

February 19-21, 2019

The workshop took place on February 19-21, 2019, at the Dead Sea in Israel. Attended by faculty members, technical staff and research students from TAU, the workshop promoted scientific cooperation among TAU scientists, and empowered our young researchers. This get-together continued a long tradition first launched in 2001, which has benefited considerably from the participation of prominent international speakers such as David Weitz, Viola Vogel, Alex Zunger, Kurt Urban, Peter H. Seeberger and others.

Nano-MBA Seminars

Research in the field of nanotechnology has great potential for future applications in a wide range of industries. In order to help our students and researchers realize this potential, we have developed a six-session program on the prospects and challenges of the business/entrepreneurial arena. Lectures, given by experts on each subject, address a variety of topics: assessing the market potential of an innovation and identifying barriers to commercialization; IP strategies and management; regulatory requirements; establishing startup companies and licensing agreements; resources for financing innovations; managing R&D projects – milestones, junctions and case studies of successes and failures.

School Visits

Before COVID, the Nano Center regularly hosted and guided groups from K-12 schools from all over Israel, in order to enrich their knowledge on nanotechnology and promote scientific excellence among the country's younger generation. At TAU's advanced nano facilities, our young guests view cutting-edge experiments from the forefront of modern science.

A New Building – The Roman Abramovich Nanoscience and Nanotechnology Building

Thanks to the magnanimous support of Mr. Abramovich, construction on the building has commenced. The new building will fulfill the growing needs of both the Nano Center and TAU's research community. The detailed design was finished this year and the new design has been approved by the Tel Aviv Authorities.

Since the beginning of 2020, construction has been progressing at a rapid pace. The special pedestals that are required for the stability of the clean rooms were successfully constructed.

As can be seen from the attached picture, the foundation and part of the building has already been completed.

The picture also shows one specialty aspect of a building designed for nanotechnology research. The huge cement blocks that can be seen everywhere are specially designed pedestals used for machines that need extremely stable mechanical surroundings for very high resolution research.

The next step planned is signing contracts for the next phases of the building, which includes metalwork for the outer part of the building and the facilities for the clean rooms and various researchers' laboratories.

Research collaborations with industry in Israel and abroad

New Ventures

New startup companies based on the innovations of researchers from the TAU Nano Center are constantly being established. Following are new ventures of 2019-2020:

- **Matricelf** (Prof. Tal Dvir) - Omentum based scaffold for tissue engineering
- **Starget Pharma** (Prof. Ehud Gazit) – Somatostatin analogs for diagnosing cancer
- **X-Trode** (Prof. Yael Hanein) – Nano electrodes for brain stimulations EEG and DBS
- **MV - APT MultiV**u (Prof. David Mendlovic) – Multiview light field compact camera
- **Lumerra Technologies** (Prof. Jacob Scheuer) – Optical design, optical technology and/or integrated photonics
- **Q-Art Medical** (Prof. Natan Shaked) – Interferometric phase microscopy for label-free morphological evaluation of sperm cells
- **Selene Therapeutics, under FutuRx** (Prof. Inna Slutsky) – Targeting DHODH to treat epilepsy and MCI
- **ImaginDairy Ltd.** (Prof. Tamir Tuller) – In vitro expression of milk proteins for dairy products and dairy product substitutes for the food industry

Agreements with Industry

A considerable number of TAU nanotechnologies have been transferred to industry through license agreements. In 2019-2020 these included:

- **Cambridge Epigenetix Optical** (Prof. Yuval Ebenstein) – Labeling and detection of Hydroxymethylcytosine – a BioMarker for Cancer
- **Neovii Biopharmaceuticals** (Prof. Jonathan Gershoni) – Coronavirus epitope-based vaccine for MERS and other infectious diseases
- **Helios** (Dr. Brian Rosen) – Methods to extract metals from rocks on the Moon and on Mars
- **Anima Biotech** (Prof. Tamir Tuller) – The enhancement and optimization of bioinformatic analyses of di-codon usage in mammalian genomes and its influence on mRNA translation

Recruiting Affiliates and Post Docs

The TAU Nano Center benefits from a vibrant community of nearly one hundred excellent principle investigators and their teams. Over 30 of our affiliates are new recruits who joined Tel Aviv University in the past decade, primarily through the resources put forward by the Israel National Nanotechnology Initiative (INNI). Two post-docs from China were funded during 2019 through the Nano Center's post-doc programs.

PART 2
RESEARCHERS

Dr. Gili Bisker

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Research title:

Single-walled carbon nanotubes as optical sensors

Research Abstract

We develop optical nanosensors based on fluorescent single-walled carbon nanotubes (SWCNTs). SWCNTs fluorescence is in the near-infrared range, which overlaps with the biological transparency window, and does not photobleach nor blink. Tailored surface functionalization can render the nanotube selective to a specific molecular target, where binding of the target analyte to the SWCNT results in a modulation of the emitted light, manifested as either an intensity change or a shift in the peak emission wavelength. These optical nanosensors can detect the molecules of interest with high spatial and temporal resolution, opening new avenues for numerous biomedical applications.

Publications

1. Ignacio A. Martínez, Gili Bisker, Jordan M. Horowitz & Juan M. R. Parrondo, "Inferring broken detailed balance in the absence of observable currents", Nature Communications, 10, 3542, (2019).
2. Gili Bisker, "Dissipate your way to self-assembly", Nature Physics, 16, 707–708, (2020).
3. Adi Hendler-Neumark and Gili Bisker "Fluorescent Single-Walled Carbon Nanotubes for Protein Detection", Sensors 19(24), 5403, (2019).

Dr. Ben Maoz

Faculty/School: Biomedical Engineering
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Research title:

Studying brain physiology in health and disease using Organs-on-a-Chip

Research Abstract

Our lab developed advanced *in vitro* models such as Organs-on-a-Chip and new technologies for interfacing sensors with tissues. In order to create these models and integrate sensors, we design and fabricate nano-devices which allow in situ readouts of the cell functionality. These sensors are made from nano structures, which are extremely sensitive to electric potential, but are also made from biocompatible materials, so that they will be integrated in biological tissues. The work that is carried out in our lab is aimed to expediate drug development, personalized medicine and to study cellular interactions.

Publications

1. P. Nikolakopoulou, R. Rauti, D. Voulgaris, I. Shlomy, Ben M. Maoz, A. Herland;"Recent progress in translational engineered *in vitro* models of the central nervous system"; Brain, (2020).
2. A. Herland*, Ben M. Maoz*, E. A. FitzGerald, T. Grevesse, C. Vidoudez, S. P. Sheehy, N. Budnik, S. Dauth, R. Mannix, B. Budnik, K. K Parker and D. E. Ingber; "Proteomic and metabolomic characterization of human neurovascular unit cells in response to methamphetamine"; Advance Biosystems, 4, 1900230, (2020),
3. A. Herland*, B. M. Maoz*, D. Das*, A. Przekwas*, M. Somayaji*, R. Prantil-Baun*, R. Novak*, M. Cronce, T. Huffstater, S. S. F. Jeanty, M. Ingram, A. Chalkiadaki,D. B. Chou, S. Clauson, A. Delahanty, S.J. Firoozinezhad, Y. Milton, A. Sontheimer-Phelps, B. Swenor, O. Levy, K. K. Parker and D. E. Ingber;"Quantitative prediction of human drug pharmacokinetic responses enabled by fluidically coupled vascularized organ chips", Nature Biomedical Engineering, (2020).
4. R. Novak*, M. Ingram*, S. Clauson*, D. Das*, A. Delahanty*, A. Herland*, B.M. Maoz*, S.S.F Jeanty, M.R. Somayaji, M. Burt, E. Calamari, A. Chalkiadaki, A. Cho, Y. Choe, D.B. Chou, M. Cronce, S. Dauth, T. Divic, J. Fernandez-Alcon, T. Ferrante, J. Ferrier, E.A. FitzGerald, R. Fleming, S. Jalili-Firoozinezhad, T. Grevesse, J.A. Goss, T. Hamkins-Indik, O. Henry, C. Hinojosa, T. Huffstater, K.-J. Jang, V. Kujala, L. Leng, R. Mannix, Y. Milton, J.C. Nawroth, B.A. Nestor, C.F. Ng, B. O'Connor, T.-E. Park, H. Sanchez, J. Sliz, A. Sontheimer-Phelps, B. Swenor, G. Thompson II, G.J. Touloumes, Z. Tranchemontagne, N. Wen, M. Yadid, A. Bahinski, G.A. Hamilton, D. Levner, O. Levy, A. Przekwas, R. Prantil-Baun, K.K. Parker, D.E. Ingber, "Robotic incubator insert platform for human body-on-chips experimentation"; Nature Biomedical Engineering, (2020).
5. R. Rauti, N. Renous, B. M. Maoz;"Mimicking the brain extracellular matrix *in vitro*: A review of current methodologies and challenges"; Isr. J. Chem. 59, 1 – 12, (2019).

Prof. Natan Zvi Shaked

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Research title:

Interferometry, microscopy and nanoscopy in biological cells and tissues

Research Abstract

We are interested in the development of interferometric imaging methods for nano-profiling of thin elements, such as live biological cells in vitro, lithography processes and semiconductor wafers. Specifically, we develop interferometric and tomographic phase microscopy methods that can operate outside of the optical lab, in instable environments. By using compact, low-coherence, common-path, off-axis interferometric modules, we obtain 3-D imaging of live biological cells without external labeling, and record the optical path delay of light passing through the sample with sub-nanometer accuracy. Furthermore, since these interferometric methods are very sensitive to local refractive-index changes, we develop plasmonic nanoparticles, which induce local heat changes due to photothermal excitation, as new contrast agents in live cells.

Publications

1. N. Nissim, M. Dudaie, I. Barnea, and N. T. Shaked, "Real-time stain-free classification of cancer cells and blood cells using inteferometric phase microscopy and machine learning," Accepted to *Cytometry A*, (2020).
2. M. Dudaie, N. Nissim, I. Barnea, T. Gerling, C. Duschl, M. Kirschbaum and N. T. Shaked, "Label-free discrimination and selection of cancer cells from blood during flow using holography-induced dielectrophoresis," Accepted to Journal of Biophotonics, (2020).
3. N. T. Shaked, V. Micó, M. Trusiak, A. Kus, and S. K. Mirsky, "Off-axis digital holographic multiplexing for rapid wave front acquisition and processing," Accepted to Advances in Optics and Photonics, (2020).
4. S. Cohen-Masalton, A. Tayeb, I. Barnea, and N. T. Shaked, "Cell and nucleus refractive-index mapping by interferometric phase microscopy and rapid confocal fluorescence microscopy," Accepted to Journal of Biophotonics, (2020).
5. Y. N. Nygate, M. Levi, S. K. Mirsky, N. A. Turko, M. Rubin, I. Barnea, G. Dardikman-Yoffe, M. Haifler, A. Shalev, and N. T. Shaked, "Holographic virtual staining of individual biological cells," Proceedings of the National Academy of Sciences USA (PNAS), (2020).
6. G. Dardikman-Yoffe, S. K. Mirsky, I. Barnea, and N. T. Shaked, "High-resolution 4-D acquisition of freely swimming human sperm cells without staining," Science Advances, 6, 15, eaay7619, (2020).
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8. G. Dardikman-Yoffe, D. Roitshtain, S. K. Mirsky, N. A. Turko, M. Habaza and N. T. Shaked, "PhUn-Net: ready-to-use neural network for unwrapping quantitative phase images of biological cells," Biomedical Optics Express, 11, 2, 1107-1121, (2020).
9. L. Wolbromsky, M. Dudaie, S. Shinar, M. Dudaie, and N. T. Shaked, "Multiplane imaging with extended field-of-view using a quadratically distorted grating," Optics Communications, 463, 125399, 1-5, (2020).
10. S. K. Mirsky and N. T. Shaked, "First experimental realization of six-pack holography and its application to dynamic synthetic aperture superresolution," Optics Express, 27, 19, 26708-26720, (2019).
11. M. Rubin, O. Stein, N. A. Turko, Y. Nygate, D. Roitshtain, L. Karako, I. Barnea, R. Giryes, and N. T. Shaked, "TOP-GAN: Stain-free cancer cell classification using deep learning with a small training set," Medical Image Analysis, 57, 176-185, (2019).
12. G. Dardlkman and N. T. Shaked, "Is multiplexed off-axis holography for quantitative phase imaging more spatial bandwidth-efficient than on-axis holography?," Journal of Optical Society of America A, 36, 2, (2019).

Prof. Tamir Tuller

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Research title:

Predictive computational modeling, simulation, and systems biology analysis of intracellular biophysical processes.

Research Abstract

We develop generic computational biophysical models for simulating, predicting and engineering gene expression. We use these models for better understanding intracellular processes and their evolution and for solving various biotechnological and medical problems.

Publications

1. Lia Baron*, Shimshi Atar*, Hadas Zur*, Modi Roopin*, Eli Goz and Tamir Tuller, "Computational based design, generation, and tracking of 500 synthetic silent variants of porcine circovirus reveals the relations between silent genomic information and viral fitness", To appear in Scientific Reports, (2020).
2. Lena Danielli, Ximing Li, Tamir Tuller and Ramiz Daniel, "Quantifying distribution of protein oligomerization degree reflects cellular information capacity", To appear in Scientific Reports, (2020).
3. Yonatan Chemla#, Michael Peeri, Mathias Heltberg, Mogens HOgh Jensen, Tamir Tuller* and Lital Alfonta*, "mRNA secondary structure stability regulates bacterial translation insulation and re-initiation", To appear in Nature communication, (2020).
4. Yoram Zarai, Zohar Zafrir, Bunpote Siridechadilok, Amporn Suphatrakul, Modi Ruppin, Justin Julander and Tamir Tuller, "Evolutionary selection against short nucleotide sequences in viruses and their related hosts", DNA Research, 27, 2, (2020).
5. Doron Levin and Tamir Tuller, "Whole cell biophysical modeling of codon-tRNA competition reveals novel insights related to translation dynamics", PLoS Compt. Biol., 16(7), e1008038, (2020).
6. Shir Bahiri-Elitzur and Tamir Tuller, "Computational discovery and modeling of novel gene expression rules encoded in the mRNA", Biochemical Society Transactions, 48, 4, 1519-1528, (2020).
7. Maya Galili, Tamir Tuller, "CSN: Unsupervised approach for inferring biological networks based on the genome alone", BMC Bioinformatics, 21, 190, (2020).
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12. Iddo Weiner#, Yael Feldman, Noam Shahar, Iftach Yacoby and Tamir Tuller, "CSO -- a sequence optimization software for engineering chloroplast expression in Chlamydomonas reinhardtii", Algal Research, 46, 101788, (2019).
13. Renana Sabi and Tamir Tuller, "Novel Insights into gene expression regulation during meiosis revealed by translation elongation dynamics", Nature Systems Biology and Applications, 5, 12, (2019).
14. Noam Shahar#, Iddo Weiner#, Lior Stotsky, Tamir Tuller* and Iftach Yacoby*, "Prediction and large-scale analysis of primary operons in plastids reveals unique genetic features in the evolution of chloroplasts", Nucleic Acids Res., 47,7, (2019).
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16. Alon Diament and TamirTuller, "Modeling three-dimensional genomic organization in evolution and pathogenesis", Seminars in Cell & Developmental Biology, 90, 78-93, (2019).
17. Arup Panda and Tamir Tuller, "Exploring the evidences of local selection in naturally occurring intrinsically disordered proteins", to appear in Genomics Proteomics and Bioinformatics, (2019)
18. Itzik Nanikashvili, Yoram Zarai, Alexander Ovseevich, Tamir Tuller and Michael Margaliot, "Networks of ribosome flow models for

modeling and analyzing intracellular traffic", Scientific Reports, 9, 1703, 2019.

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Prof. Meital Zilberman

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Research title:

Polymeric biomaterials and implants, controlled drug release, tissue engineering

Research Abstract

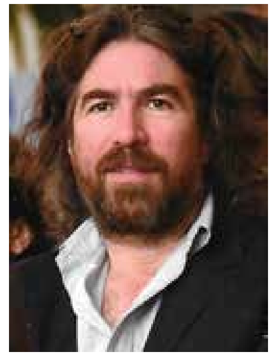
Our lab works in the new, emerging field of 'active implants' - implantable medical devices made of biodegradable polymers. Remaining intact in the body for a predictable period of time - from weeks to years – these devices degrade with time into non-toxic products, without the need for surgical removal. The new field involves a thorough understanding of polymer physics, materials science, bioengineering, chemistry and biology.

Our research combines biodegradable polymers, tissue engineering and drug delivery systems, to develop active (drug-eluting) implants and scaffolds for tissue regeneration. We investigate the effects of kinetic and thermodynamic parameters in the preparation process, on the microstructure and resulting properties (drug release profile, mechanical and physical properties, biocompatibility etc.). The results of our studies have great medical relevance, aiming to provide new solutions to basic needs in the fields of medical implants and tissue regeneration.

Publications

1. Dafna Knani, Maytal Foox and Meital Zilberman, "Simulation of the Bioadhesive Gelatin-Alginate Conjugate Loaded with Antibiotic Drugs", Polym Adv Technol. 2019, 30, 519–528.
2. Daniella Goder, Lior Matsliah, Shir Giladi, Liron Reshef-Steinberger, Idan Zin, Alon Shaul and Meital Zilberman, "Mechanical, Physical and Biological Characterization of Soy Protein Films Loaded with Bupivacaine for Wound Healing Applications", International Journal of Polymeric Materials and Polymeric Biomaterials, 2020.
3. Maya Baranes-Zeevi, Daniella Goder and Meital Zilberman, "Novel Drug-Eluting Soy-Protein Structures for Wound Healing Applications", Polym Adv Technol., 2019, 30, 2523–2538.
4. Lia Ofek, Daniella Goder, and Meital Zilberman, "Formulation – Properties of Novel Ibuprofen-Loaded Soy Protein Wound Dressings ", Recent Progress in Materials (a special issue: "Applications and Development of Biomaterials in Medicine", 1(4), 1-19, 2019.
5. Meital Zilberman, Elad Koren, Helen Guez and Lior Matsliah, "Controlled Release of Antimicrobial Small Molecules" Chapter 3, Antimicrobial Materials for Biomedical Applications, Editors: Abraham J Domb, Konda Reddy Kunduru, Shady Fara, 2019.

Prof. Roey Amir



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Research title:

Design and fabrication of enzyme-responsive polymeric amphiphiles and their assembly into functional materials

Research Abstract

Stimuli-responsive nanocarriers that can disassemble to release their encapsulated cargo upon external stimuli have gained increasing attention due to their possible utilization as smart drug delivery systems. Among the various types of stimuli, enzymes offer great potential for the activation of biomedical carriers, due to their overexpression in various diseases. The design of enzyme-responsive block copolymers is highly challenging, as the enzyme must reach the enzyme-sensitive moieties - which are spread along the backbone of the polymer, and might be hidden inside the hydrophobic cores of the self-assembled structures. The polydispersity of the stimuli-responsive block raises another significant challenge for the kinetic analysis and mechanistic study of the enzymatic response, as the enzyme's access to the enzymatically activated moieties can vary greatly - depending on their location along the polymer backbone, the length of the polymer chain, and its solubility. To address these challenges, we are developing highly modular polymeric platforms based on dendritic amphiphiles. These amphiphiles can self-assemble in water into micellar nanocontainers that disassemble and release encapsulated molecular cargo upon enzymatic activation. The modularity of these dendrons containing amphiphiles offers great control and tuning of the disassembly rate of the formed micelles, through simple adjustment of their molecular structures. Such smart enzymatically responsive amphiphiles can open the way for the fabrication of nanocarriers with tunable release rates for drug delivery applications.

Publications

1. Leigh Peles-Strahl, Revital Sasson, Gadi Slor, Nicole Edelstein-Pardo, Adi Dahan and Roey J. Amir, "Utilizing self-immolative ATRP initiators to prepare stimuli-responsive polymeric films from nonresponsive polymers", Macromolecules, 52, 9, 3268–3277, (2019).
2. Merav Segal,Lihi Ozery, Gadi Slor, Shreyas S. Wagle, Tamara Ehm, Roy Beck and Roey J. Amir, "The architectural change of the shell forming block from linear to V-shaped accelerates micellar disassembly but slows the complete enzymatic degradation of the amphiphiles", Biomacromolecules, 21, 10, 4076–4086, (2020).

Prof. Ori Cheshnovsky

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Research title:

Super resolution microscopy; Optical properties of nano-structure

Research Abstract

We have developed far field extinction microcopy which enables sensitive CD measurement on individual nano-objects, encompassing dramatic suppression of linear optical activity artifacts. We report on CD of both chiral-shaped plasmonic nanostructures (gold Gammadions) and achiral-shaped inorganic nanocrystals having a chiral crystal lattice (HgS). This work extends the single-particle-spectroscopy toolbox to include CD spectroscopy.
We have developed a new super resolution methodology, in which the nonlinear response of the optical system to modulated stimulated emission depletion is used to get three-fold improvement in diffraction limited resolution.
We use core Ge/Shell Si nanowires to induce direct bandgap transitions. We can correlate the absorption spectra, the high resolution TEM images and the elemental analysis on the same individual nanowire, while the group of Alex Zunger lays theoretical foundations to these findings.
Together with the group of Prof. Haim Suchowski, we study the ultrafast optical response of nano-objects, utilizing also the nonlinear response as a tool to better understand the dynamics.

Publications

1. Tzang O., Hershkovitz D., Cheshnovsky O., “Label-Free Super-Resolution Microscopy by Nonlinear Photo-modulated Reflectivity”, Label-Free Super-Resolution Microscopy, Biological and Medical Physics, Biomedical Engineering, 2019, 261-287.
2. A Shaus, B Sober, O Tzang, Z Ioffe, O Cheshnovsky, I Finkelstein, E Piasetzky "Raman Binary Mapping of Iron Age Ostracon in an Unknown Material Composition and High-Fluorescence Setting—A Proof of Concept", Archaeometry 61 (2), 459-469, 2020.

Dr. Guy Cohen

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Research title:

Nonequilibrium phenomena in chemical and condensed matter physics

Research Abstract

Our group investigates nonequilibrium phenomena in chemical and condensed matter physics. We try to understand how strongly correlated quantum systems react to dissipative environments and to external perturbations, particularly in the context of the transport properties of nanosystems. This is a deeply challenging and fundamental problem, and we therefore work to improve state-of-the-art computational methods, such as real-time quantum Monte Carlo algorithms. Our recently developed Inchworm Monte Carlo methods circumvent the dynamical sign problem—the primary bottleneck which prevented the application of previous-generation Monte Carlo methods to nonequilibrium systems and dynamics.

Publications

1. Eitan Eidelstein, Emanuel Gull and Guy Cohen, "Multiorbital quantum impurity solver for general interactions and hybridizations", Phy. Rev. Lett. 124 (20), 206405, (2019).
2. Hristiana Atanasova, Alexander I. Lichtenstein and Guy Cohen, "Correlated nonequilibrium steady states without energy flux", Phys. Rev. B 101 (17), 174316, (2019).
3. Guy Cohen and Michael Galperin, "Green's function methods for single molecule junctions", J. Chem. Phys. 152 (9), 090901, (2020).
4. Michael Ridley, Michael Galperin, Emanuel Gull and Guy Cohen, "Numerically exact full counting statistics of the energy current in the Kondo regime", Phys. Rev. B 100 (16), 165127, (2020).
5. Igor Krivenko, Joseph Kleinhenz, Guy Cohen and Emanuel Gull, "Dynamics of Kondo voltage splitting after a quantum quench", Phys. Rev. B 100 (20), 201104, (2019).
6. Michael Ridley, Emanuel Gull and Guy Cohen, "Lead geometry and transport statistics in molecular junctions", J. Chem. Phys. 150, 244107, (2019).
7. Feng Chen, Guy Cohen and Michael Galperin, "Auxiliary master equation for nonequilibrium dual-fermion approach", Phys. Rev. Lett. 122, 186803, (2019).

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Research title:

NMR diffusion measurements in supramolecular chemistry, antibiofilm agents, pillararenes, molecular capsules and self-assembly, and diffusion MRI of the CNS

Research Abstract

Our group research is focused on two fields:

1. Supramolecular Chemistry

- NMR Diffusion Measurements in Supramolecular Chemistry
- Large Hydrogen Bond Molecular Capsules or Molecules Within Molecules
- Pillar[n]arenes

2. MRS and MRI of the CNS

- From DWI and DTI to High-b-values q-Space Diffusion-Weighted MRI (QSI) in White Matter Associated Disorders
- Applications of clinical High-b-values q-Space Diffusion-Weighted MRI (QSI) in White Matter Associated Disorders
- Compartment Size and Shape by Double-Pulsed-Field-Gradient (d-PFG) spectroscopy and imaging
- Cellular MRI of Stem Cells' Migration

Publications

1. Yoram Cohen and Sarit Slovak, "Diffusion NMR for the Characterization, in Solution, of Supramolecular Systems Based on Calixarenes, Resorcinarenes, and other Macrocyclic Arenes", Org. Chem. Front., 2019, 6, 1705-1718.
2. Matthias. Schnurr, Roymon Joseph, Aalissa Naugolny-Keisar, Dana Kaizerman, Nils Bogdanoff, Patrick Schünke, Yoram Cohen and Leif Schröder, "High Exchange Rate Complexes of ^{129}Xe with Water-Soluble Pillar[5]arenes for Adjustable Magnetization Transfer MRI", ChemPhysChem., 2019, 20, 246-251.
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4. Dana Kaizerman-Kané, Maya Hadar, Noam Tal, Roman Dobrovetsky, Yossi Zafrani and Yoram Cohen, "pH-Responsive Pillar[6]arene-based Water-Soluble Supramolecular Hexagonal Boxes", Angew. Chem. Int. Ed., 2019, 58, 5302-5306. (Hot paper).
5. Yong-Sheng Li, Luis Escobar, Yu-Jie Zhu, Yoram Cohen, Pabio Ballester, Julius Rebek, Jr., Yang Yu," Relative Hydrophobicity of cis and trans Formamides", Proc. Natl. Acad. Sci. USA., 2019, 116, 19815-19820.
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7. Dana Kaizerman-Kane, Maya Hadar, Eran Granot, Fernando Patolsky, Yossi Zafrani and Yoram Cohen, "Shape Induced Sorting via Rim-to-Rim Complementarity in the Formation of Pillar[5, 6]Arene-Based Supramolecular Organogels", Org. Chem. Front., 2019, 6, 3348-3354.
8. Y. Scher, S. Reuveni and Yoram Cohen, "Constant Gradient FEXSY: A Time-Efficient Method for Measuring Exchange", J. Magn. Reson., 2020, 311, 106667.
9. Pabio Ballester, Luis Escobar, Yong-Shen. Li, Yoram Cohen, Yang Yu, and Julius Rebek Jr., "Kinetic Stabilities and Exchange Dynamics of Water-Soluble Bis-Formamide Caviplexes Studied Using Diffusion Ordered NMR Spectroscopy (DOSY)", *Chem. Eur. J.*, 26, 8220-8225, (2020). *Hot paper*
10. Maya Hadar, Dana Kaizerman-Kane, Yossi Zafrani and Yoram Cohen, "Temperature-Dependent and pH-Responsive Pillar[5]Arene-Based Complexes and Hydrogen-Bond-Based Supramolecular Pentagonal Boxes in Water", Chem. Eur. J., 2020, 26, 11250-11255.

Prof. Haim Diamant

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Research title:

Theory of complex fluid

Research Abstract

Our research group attempts to understand the structure and dynamic response of soft materials and complex fluids using analytical models. Recent projects have included: dynamics of driven colloidal suspensions, in-plane dynamics of heterogeneous membranes and instabilities in thin sheets.

Publications

1. Yulia Sokolov and Haim Diamant, "Permeability of immobile rings of membrane inclusions to in-plane flow", J. Chem. Phys., 2019, 150, 154901.
2. Uri Hanael, Assaf Ben-Moshe, Haim Diamant, and Gil Markovich, "Spontaneous and directed symmetry breaking in the formation of chiral nanocrystals", Proc. Natl. Acad. Sci. USA, 2019, 116, 11159–11164.
3. Ella Borberg, Marina Zverzhinetsky, Adva Krivitsky, Alon Kosloff, Omri Heifler, Gal Degabli, Hagit Peretz Soroka, Ronit Satchi Fainaro, Larisa Burstein, Shlomi Reuveni, Haim Diamant, Vadim Krivitsky, and Fernando Patolsky, "Light-controlled selective collection-and-release of biomolecules by an on-chip nanostructured device", Nano Lett., 2019, 19, 9, 5868–5878.
4. Ram M. Adar, Samuel A. Safran, Haim Diamant, and David Andelman, "Screening length for finite-size ions in concentrated electrolytes", Phys. Rev. E, 2019, 100, 042615.
5. Chen Bar-Haim and Haim Diamant, "Surface response of a polymer network: Semi-infinite network", Langmuir, 2020, 36, 14, 3981–3987.
6. Guy Jacoby, Irina Portnaya, Dganit Danino, Haim Diamant and Roy Beck, "Delayed nucleation in lipid particles", Soft Matter, 2020, 16, 247.
7. Gil Ariel and Haim Diamant, "Inferring entropy from structure", Phys. Rev. E, 2020, 022110.
8. Thomas A. Witten and Haim Diamant, "A review of shaped colloidal particles in fluids: anisotropy and chirality", Rep. Progr. Phys., 2020, https://doi.org/10.1088/1361-6633/abb5c4

Prof. Yuval Ebenstein

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Research title:

Nano-bio-photonics

Research Abstract

Our lab specializes in many areas of optical imaging and spectroscopy, with emphasis on single-molecule detection and the development of imaging-based techniques. Our research focuses on the application of novel imaging and optical detection approaches to genomic studies and biomarker detection. We develop new spectroscopy and microscopy methodologies that combine advanced optics with tools and reagents from the realm of nanotechnology. In addition, we have great interest in developing unique biochemistries for genomic analysis, based on chemo-enzymatic reactions.

Publications

1. Sapir Margalit, Sigal Avraham, Tamar Shahal, Yael Michaeli, Noa Gilat, Prerna Magod, Michal Caspi, Shelly Loewenstein, Guy Lahat, Dinorah Friedmann-Morvinski, Revital Kariv, Rina Rosin-Arbesfeld, Shahar Zirkin and Yuval Ebenstein, "5-Hydroxymethylcytosine as a clinical biomarker:Fluorescence-based assay for high-throughput epigeneticquantification in human tissues", Int. J. Cancer, 146, 2020, 115–122.
2. Dmitry Torchinsky, Yael Michaeli, Natalie R. Gassman and Yuval Ebenstein, "Simultaneous detection of multiple DNA damage types by multi-colour fluorescent labelling", Chem. Commun., 2019, 55, 11414-11417.
3. Nikhil Jain, Tamar Shahal, Tslil Gabrieli, Noa Gilat, Dmitry Torchinsky, Yael Michaeli, Viola Vogel and Yuval Ebenstein, "Global modulation in DNA epigenetics during pro-inflammatory macrophage activation", Epigenetics, 14:12, 2019, 1183-1193.
4. Noa Gilat, Dmitry Torchinsky, Sapir Margalit, Yael Michaeli, Sigal Avraham, Hila Sharim, Nadav Elkoshi, Carmit Levy, Shahar Zirkin and Yuval Ebenstein, "Rapid quantification of oxidation and UV induced DNA damage by repair assisted damage detection-(Rapid RADD)", Anal. Chem., 2020, 92, 14, 9887–9894.
5. Vilhelm Muller, Albertas Dvirnas, John Andersson, Vandana Singh, Sriram KK, Pegah Johansson, Yuval Ebenstein, Tobias Ambjornsson and Fredrik Westerlund, "Enzyme-free optical DNA mapping of the human genome using competitive binding", Nucleic Acids Research, 2019, 47, 15.
6. Hila Sharim, Assaf Grunwald, Tslil Gabrieli,Yael Michaeli, Sapir Margalit, Dmitry Torchinsky, Rani Arielly, Gil Nifker, Matyas Juhasz, Felix Gularek, Miguel Almalvez, Brandon Dufault, Sreetama Sen Chandra, Alexander Liu, Surajit Bhattacharya, Yi-Wen Chen, Eric Vilain, Kathryn R. Wagner, Jonathan Pevsner, Jeff Reifenberger, Ernest T. Lam, Alex R. Hastie, Han Cao, Hayk Barseghyan, Elmar Weinhold and Yuval Ebenstein, "Long-read single-molecule maps of the functional methylome", Genome Research, 2020, 29:646–656.
7. Nadezda Lapshina, Jonathan Jeffet, Gil Rosenman, Yuval Ebenstein and Tal Ellenbogen, "Single fluorescent peptide nanodots", ACS Photonics, 2019, 6, 7, 1626–1631.
8. Vandana Singha, Pegah Johansson, DmitryTorchinsky, Yii-Lih Lin, Robin Öz, Yuval Ebenstein, Ola Hammarsten and Fredrik Westerlund, "Quantifying DNA damage induced by ionizing radiation and hyperthermia using single DNA molecule imaging", Translational Oncology, 13, 2020, 10, 100822.
9. Christian Heck, Yael Michaeli, Ilko Bald and Yuval Ebenstein, "Analytical epigenetics: single-molecule optical detection of DNA and histone modifications", Current Opinion in Biotechnology, 55, 2019, 151-158.
10. Gabi Shefer, Yonit Marcus-Perlman, Tamar Shahal, Elad Segev, Yuval Ebenstein and Naftali Stern, "SUN-LB009 epigenetic changes in response to metabolic modifiers in late life: exercise, high fat diet, and angiotenin1-7 effects on metabolic health and DNA methylation in frail old mice", Journal of the Endocrine Society, 3,2019,1.

Prof. Sharly Fleischer

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Research title:

Ultrafast molecular dynamics and coherent control using ultrashort optical and terahertz fields

Research Abstract

Our research involves ultrashort and intense laser pulses in the visible/near-IR range (10^14 ~ 10^15 Hz) and in the terahertz (THz) range (10^11 – 10^12 Hz) for various time-resolved spectroscopic measurements and coherent control of matter.
Ongoing projects include:
Methodology development for controlling the rotational dynamics of gas phase molecules.
Study of novel decay/decoherence processes in gas phase rotors.
In Operando THz spectroscopy of Li-Ion batteries.
Generation and shaping of THz fields.
Spatio-temporal characterization of laser-induced air plasma.

Publications

1. Ran Damari, Omri Weinberg, Daniel Krotkov, Natalia Demina, Katherine Akulov, Adina Golombek, Tal Schwartz and Sharly Fleischer, "Strong coupling of collective intermolecular vibrations in organic materials at terahertz frequencies", Nature Communications, 2019, 10, 3248.
2. Dina Rosenberg and Sharly Fleischer, "Intrinsic calibration of laser-induced molecular alignment using rotational echoes", Phys. Rev. Research 2, 2020, 023351.
3. Asya Svirinovsky- Arbeli, Dina Rosenberg, Daniel Krotkov, Ran Damari, Krishnendu Kundu, Akiva Feintuchc, Lothar Houben, Sharly Fleischer and Michal Leskesa, "The effects of sample conductivity on the efficacy of dynamic nuclear polarization for sensitivity enhancement in solid state NMR spectroscopy", Solid State Nuclear Magnetic Resonance, 99, 2019, 7-14.
4. Shay Keren-Zur, Mai Tal, Sharly Fleischer, Daniel M. Mittleman and Tal Ellenbogen, "Generation of spatiotemporally tailored terahertz wavepackets by nonlinear metasurfaces", Nature Communications, 2019, 10, 1778.
5. Muriel E Layani-Tzadka, Daniel Krotkov, Einat Tirosh, Gil Markovich and Sharly Fleischer, "Contact-free conductivity probing of metal nanowire films using THz reflection spectroscopy", Nanotechnology, 30, 2019, 21.
6. Eli Flaxer and Sharly Fleischer, "Differential chopping controller with high-resolution and accuracy using digital signal processor", Review of Scientific Instruments, 90, 2019, 076106.
7. Amit Beer, Dror Hershkovitz and Sharly Fleischer, "Iris-assisted terahertz field-induced second-harmonic generation in air", Optics Letters, 44, 2019, 21, 5190-5193.

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Research title:

NMR-based structural chemistry, biology, and virology

Magic Angle Spinning (MAS) solid state NMR for structural virology; Development and theory of MAS NMR for the study of diamagnetic metal-ion-containing compounds ("quadrupolar NMR"); Structure and dynamics of macromolecular assemblies by NMR.

Research Abstract

Research in our group focuses on developing and applying magic-angle spinning solid state NMR for the study of complex systems, with a particular emphasis on structural virology.
One example is bacteriophages – these are nano-scale bacteria-infecting viruses that contain a genome (RNA or DNA) wrapped by many similar copies of a major coat protein that caps the genomic material, with one or several different functional minor coat proteins. Our group prepares, purifies and uses magic-angle spinning NMR techniques to characterize the structure and dynamics of various phages in atomic-detailed resolution.
Another area of interest is the NMR of metal ions, which play a critical role in many materials including enzymes, catalysis and more. Low occupancies, dynamics and other obstacles often hinder the detailed characterization of such sites, and our group addresses this challenge. We develop and apply techniques for characterizing the structural environment of metal ions such as 11B, 51V, 7Li, 23Na. 209Bi and other similar nuclei exhibiting a large anisotropic interaction in the magnetic field.
For example: lithium salts have been known as mood stabilizing drugs for bipolar disorder patients for over 50 years. It has been hypothesized that lithium exerts its therapeutic effect by binding with the enzyme myo-inositol monophosphatase (IMPase), thereby reducing inositol levels in the blood and diminishing the hyperactive phosphatidyl-inositol cell signaling pathway. Other targets of lithium have also been proposed. Since lithium is mostly spectroscopically silent, we use magic-angle spinning NMR techniques to directly observe and characterize lithium's binding sites in its drug targets.

Publications

1. Jonathan Tzadikov, Natasha Ronith Levy, Liel Abisdris, Reut Cohen, Michal Weitman, Ilia Kaminker, Amir Goldbourt, Yair Ein-Eli and Menny Shalom, "Bottom-up synthesis of advanced carbonaceous anode materials containing sulfur for na-ion batteries", Adv. Funct. Mater. 2020, 30, 592.
2. Porat G., Lusky OS., Dayan N. and Goldbourt A, "Nonuniformly sampled exclusively-13C/15N 4D solid-state NMR experiments: Assignment and characterization of IKe phage capsid", Magn Reson Chem. 2020. Accepted on line doi:10.1002/mrc.5072.
3. M. Makrinich, M. Sambol, A. Goldbourt "Distance measurements between carbon and bromine using a split-pulse PM-RESPDOR solid-state NMR experiment", Phys. Chem. Chem. Phys. Accepted. doi:10.1039/D0CP01162B
4. A. Goldbourt (2020) "Magic-angle spinning NMR of bacteriophage viruses", eMagRes, Vol. 9, Iss. 2. doi:10.1002/9780470034590.emrstm1600.
5. Gal Porat and Amir Goldbourt, "Assessment of non-uniform sampling schemes in solidstate NMR of bacteriophage viruses", Isr. J. Chem. 2019, 59, 1027 – 1038.
6. Nghia Tuan Duonga, Federica Rossi, Maria Makrinich, Amir Goldbourt, Michele R. Chierotti, Roberto Gobetto and Yusuke Nishiyama, "Accurate 1H-14N distance measurements by phase-modulated RESPDOR at ultra-fast MAS", J. Magn. Reson. 2019, 308, 106559.
7. Amir Goldbourt, "Structural characterization of bacteriophage viruses by NMR", Prog. Nucl. Magn. Reson. Spect. 114–115 (2019) 192–210.
8. A. Haimovich, A. Goldbourt "How does the mood stabilizer lithium bind ATP, the energy currency of the cell", BBA - general subjects. 2020, 864, 129456.
9. Gregor Žerjav ,Albin Pintar, Michael Ferentz, Miron Landau, Anat Haimovich, Amir Goldbourt and Moti Hersko, "Effect of surface chemistry and crystallographic parameters of TiO2 anatase nanocrystals on photocatalytic degradation of bisphenol A", Catalysts 2019, 9(5), 447.
10. Maria Makrinich and Amir Goldbourt, "1H-Detected quadrupolar spin–lattice relaxation measurements under magic-angle spinning solid-state NMR", Chem. Commun., 2019, 55, 5643-5646.
11. S. Menkin, M. Lifshitz, A. Haimovich, M. Goor, R. Blanga, S. G. Greenbaum, A. Goldbourt and D. Golodnitsky, "Evaluation of ion-Transport in composite electrolytes comprising active

or inert ceramics. Case Study of active and inert ceramics", Electrochimica Acta. 2019, 34, 447-455.

12. Jingwei Xu, Nir Dayan, Amir Goldbourt and Ye Xiang, "Cryo-electron microscopy structure of the filamentous bacteriophage Ike", PNAS, 2019, 116, 5493–5498.

Prof. Diana Golodnitsky

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Research title:

Synthesis, characterization of materials and study of ion-transport phenomena in new nanostructured electrodes and solid electrolytes for energy storage devices

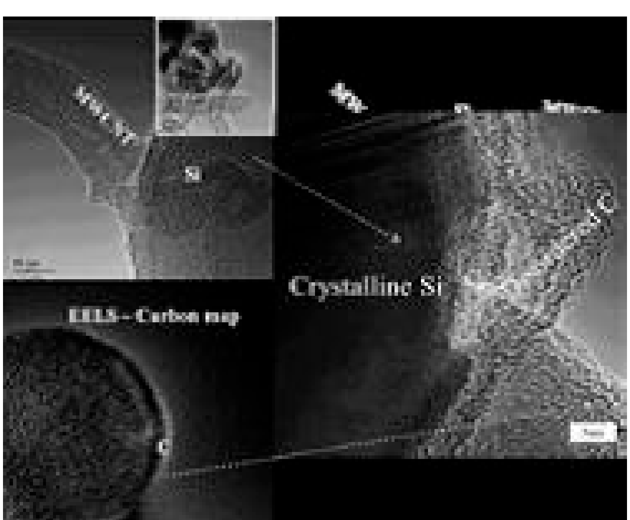
Research Abstract

My major research activities include synthesis and characterization of materials and study of ion-transport phenomena in new nanostructured electrodes and solid electrolytes for energy-storage devices, elucidation of mechanism of simultaneous electrophoretic deposition on nanoporous membranes, and development of free form-factor printed batteries.

The focus of the first project is on reducing energy barriers for the interfacial ion transport and improving the cation transference number in composite electrolyte by tuning the polymer chemistry combined with functionalization of the surface of ceramic.

In the second project, concurrent electrophoretic deposition (EPD) of positive and negative battery electrodes on opposite sides of nanoporous polymer- and ceramic membranes for the formation of a three-layer-battery structure is studied.

In the third project, we suggest a novel coaxial cable flexible-battery design and develop novel 3D printed all solid-state electrolytes prepared by fused-filament fabrication (FFF).



Publications

1. S. Menkin, M. Lifshits, A. Haimovich, M. Goor, R. Blanga, S. G. Greenbaum, A. Goldbourt and D. Golodnitsky, Evaluation of Ion-Transport in Composite Polymer-in-Ceramic Electrolytes. Case Study of Active and Inert Ceramics. Electrochimica Acta, 304, 2019, 447-455
2. Ido Ben-Barak, Yosef Kamir, Svetlana Menkin, Meital Goor, Inna Shekhtman, Tania Ripenbein, Diana Golodnitsky and Emanuel Peled Drop-on-Demand 3D Printing of Lithium Iron Phosphate Cathodes, J. Electrochem. Soc. 2019, 166, 3, A5059-A5064
3. Yonatan Horowitz, Ido Ben-Barak, Dan Schneier, Meital Goor-Dar, Johannes Kasnatscheew, Paul Meister, Mariano Grünebaum, Martin Winter, Hans-Dieter Wiemhöfer, Diana Golodnitsky, and Emanuel Peled, Study of the Formation of a Solid Electrolyte Interphase (SEI) on a Silicon Nanowire Anode in Liquid Disiloxane Electrolyte with Nitrile End Groups for Lithium-Ion Batteries, Batteries & Supercaps, 2019 , 2, 213–222, DOI: 10.1002/batt.201800123
4. Fernando Patolsky, Nimrod Harpak , Mr. Guy Davidi , Mr. Dan Schneier , Dr. Svetlana Menkin, Edna Mados, Diana Golodnitsky, Emanuel Peled, Large Scale Self-Catalyzed Sponge-Like Silicon Nanonetwork-based 3D-Anodes for High-Capacity Lithium-Ion Batteries, Nano Lett. 2019, 19, 1944−1954
5. D. Schneier, Y. Shacham, K.Goldshtein1, M. Goor, D. Golodnitsky, E. Peled, Comparative Characterization of Silicon Alloy Anodes, Containing Single-Wall or Multi-Wall Carbon Nanotubes, Journal of The Electrochemical Society, 166 (4) A740-A746 (2019)
6. Tzach Mukra, Yonatan Horowitz, Meital Goor-Dar, Johannes Kasnatscheew, Paul Meister, Mariano Grünebaum, Martin Winter, Hans-Dieter Wiemhöfer, Diana Golodnitsky, and Emanuel Peled. Disiloxane with Nitrile End Groups as Co-solvent to Replace LiNO3 Additive in Lithium-Sulfur Batteries, Electrochimica Acta, 307 (2019) 76-82
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Kamir, Moty Marcos Dorfman, Alexander Gladkikh, and Diana Golodnitsky, On the Road to a Multi-Coaxial-Cable Battery: Development of a Novel 3D-Printed Composite Solid Electrolyte, Journal of The Electrochemical Society, 2020 167 070503

9. Shay Tirosh, Niv Aloni, Simcha Meir, David Cahen, and Diana Golodnitsky. FTO Darkening Rate as a Qualitative, High-throughput Mapping Method for Screening Li-Ionic Conduction in Thin Solid Electrolytes, DOI: 10.1021/acscombsci.9b00099 ACS Comb. Sci. 2020, 22, 1, 18-24
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11. Elazar Cohen, Moran Lifshitz, Alexander Gladkikh, Yossi Kamir, Ido Ben-Barak and Diana Golodnitsky, Novel One-Step Electrophoretic Deposition of Membrane-Electrode Assembly for Flexible-Batteries Application J. Mater. Chem. A, 2020, DOI: 10.1039/D0TA02328K.
12. Yonatan Horowitz, Christina Schmidt, Dong-Hwang Yoon, Luise Mathilda Riegger, Leon Katzenmeier, Georg Maximillian Bosch, Malachi Noked, Yair Ein-Eli, Jürgen Janek, Wolfgang G. Zeier, Charles Eliezer Diesendruck, and Diana Golodnitsky "Between Liquid and All Solid - a Prospect on Electrolyte Future in Lithium-Ion Batteries for Electric Vehicles" Journal of Energy Technology, 2020 EMID:d6c3dcea98f3e3e8

Prof. Michael Gozin

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Research title:

Development of new energetic materials, catalysts and biopolymers.

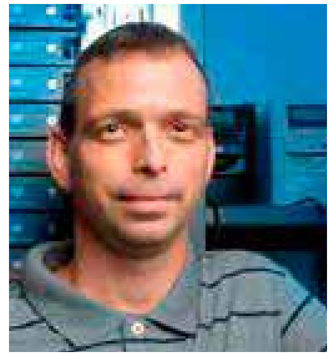
Research Abstract

My group focuses on the development of novel energetic compounds and nanomaterials for various applications, including gas generators, propellants and materials for deep-well oil and gas extraction. We work on synthesis and comprehensive characterization of various nitrogen-rich heterocycles, related metal complexes, energetic nanomaterials based on graphene oxide derivatives and energetic three-dimensional metal organic frameworks.

Publications

1. "Methane Dry Reforming Catalyst Prepared by the Co-deflagration of High-nitrogen Energetic Complexes", Dahan, M.; Komarala, E. P.; Fadeev, L.; Chinnam, A. K.; Shlomovich, A.; Lipstman, S.; Padi, S. P.; Haustein, H. ; Gozin, M.; Rosen, B. A.; J. Mater. Chem. A 2019, 7(1), 141-149. [IF 11.301, Q1].
2. "Macroalgal Biomass Subcritical Hydrolysates for the Production of Polyhydroxyalkanoate (PHA) by Haloferax mediterranei", Ghosh, S.; Gnaim, R.; Greiserman, S.; Fadeev, L.; Gozin, M.; Golberg, A.; Bioresource Technol. 2019, 271, 166-173. [IF 7.539, Q1].
3. "Starch from the Sea: the Green Macroalga Ulva sp. as a Potential Source for Sustainable Starch Production from the Sea in Marine Bio-refineries"; Prabhu, M.; Chemodanov, A.; Gottlieb, R.; Katzir, M.; Nahor, O.; Gozin, M.; Alvaro, I.; Livney, Y.; Golberg, A.; Algal Res. 2019, 37, 215-227. [IF 4.008, Q1].
4. "Tuning the Crystal Morphology and Catalytic Behavior of Graphene-templated Energetic Bis-tetrazole Copper Coordination Polymers", Zhang, X-X. ; He, W.; Chen, S-W. ; Lyu, J-Y. ; Guo, Z.; Gozin, M. ; Yan, Q-L. ; Adv. Compos. Hybrid Mater. 2019, 2, 289-300.
5. "Jellyfish-based Biodegradable Plastic", Reshef-Steinberg, L.; Nudelman, R.; Gulakhmedova, T.; Barkay, Z.; Gozin, M.; Richter, S.; Adv. Sustainable Sys. 2019, 1900016.
6. "Jellyfish-Based Smart Wound Dressings Devices Containing Antibacterial Nanoparticles", Nudel-man, R.; Gulakhmedova, T.; Gozin, M.; Richter, S.; Adv. Func. Mater. 2019, 1902783. [IF 15.621, Q1].
7. "Energetic Butterfly: Heat-Resistant Diaminodinitro trans-Bimane", Zhang, P.; Kumar, D.; Zhang, L.; Shem-Tov, D.; Petrutik, N.; Chinnam, A. K.; Yao, C.; Pang, S.; Gozin, M.; Molecules, 2019, 24, 4324. [IF 3.267, Q2].
8. "Co-Production of Monosaccharides and Hydrochar From Green Macroalgae Ulva (Chlorophyta) sp. With Sub-Critical Hydrolysis and Carbonization", Greiserman, S. ; Epstein, M. ; Chemodanov, A.; Prabhu, M.; Guttman, L.; Jinjikhashvily, G.; Shamis, O.; Gozin, M.; Kribus, A.; Golberg, A. ; BioEnergy Res. 2019, 12(4), 1090-1103. [IF 2.195, Q2].
9. "Molecular and Crystal Features of Thermostable Energetic Materials, Guidelines for Architecture of "Bridged" Compounds", Li, H.; Zhang, L.; Petrutik, N.; Wang, K.; Ma, Q.; Shem-Tov, D.; Zhao, F. ; Gozin, M., ACS Cent. Sci. 2020, 6(1), 54-75. [IF 12.685, Q1].
10. "Controlled Reactivity of Metastable n-Al@Bi$(IO_3)_3$ by Employment of Tea Polyphenols as an Inter-facial Layer"; Tang, D.; Chen, S.; He, W.; Yang, G.; Liu, P-J.; Gozin, M.; Yan, Q-L.; Chem. Eng. J. 2020, 381, 122747. [IF 10.652, Q1, 11/108].
11. "Strategies for Achieving Balance Between Performance and Crystal Stability of High Energy Density Materials", Li, C. ; Li, H. ; Huang, Y. ; Gozin, M. ; Sun, C. Q. ; Zhang, L.; iScience 2020, 23(3), 100944. [IF 4.447, Q1].
12. "Tandem-action" Ferrocenyl Iodocuprates Promoting Low Temperature Hypergolic Ignitions of Green EILs-H_2O_2 Bipropellants", Wang, K.; Liu, T.; Jin, Y.; Shi, H.; Petrutik, N.; Shem-Tov, D.; Yan, Q-L.; Gozin, M.; Zhang, Q.; J. Mater. Chem. A 2020, 8, 14661-14670. [IF 11.301, Q1].
13. "Energetic Materials: Novel Syntheses and Diagnostics", Luo, S.-N.; Gozin, M.; Engineering 2020, doi.org/10.1016/j.eng.2020.07.002. [IF 6.495, Q1].
14. "Nanomaterials in Rocket Propulsion Systems", Elsevier 2019; Eds. Guo-Qiang He, Qi-Long Yan, Pei-Jin Liu and Michael Gozin, ISBN: 9780128139080.
15. "Insensitive Energetic Materials Containing Two-Dimensional Nanostructures as Building Blocks", Yan, Q-L.; Gozin, M.; Pei-Jin Liu, P-J.; He, G-Q.; Chapter 3 in "Nanomaterials in Rocket Propulsion Systems", Elsevier 2019; pg. 81-111; ISBN: 9780128139080.

Prof. Oded Hod



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Research title:

Theoretical and computational nanomaterials science

Research Abstract

Nanoscience and nanotechnology open a unique opportunity for applying highly accurate theories to realistic material science problems. Research in my group focuses on the theoretical study of the mechanical, electronic, magnetic and transport properties of systems at the nanoscale. Using first-principles computational methods, we aim to characterize both the ground state and dynamical properties of such systems.

A combination of codes developed within our group, along with commercial computational chemistry packages, operating on a highly parallelizable high-performance computer cluster, allows us to address the properties and functionality of a variety of systems, ranging from carefully tailored molecular structures all the way to bulk systems.

In addition to questions of basic science, we pursue the design of technologically applicable nanoscale material properties, for future applications in fields such as nano-electronics, nano-spintronics, nanotribology, accurate and sensitive chemical sensing and nano-mechanical devices.

Publications

1. Wengen Ouyang, Huasong Qin, Michael Urbakh, and Oded Hod, "Controllable Thermal Conductivity in Twisted Homogeneous Interfaces of Graphene and Hexagonal Boron Nitride", Nano Lett., in press (2020).
2. D. Dutta, A. Oz, O. Hod, and E. Koren, "The Scaling Laws of Edge vs. Bulk Interlayer Conduction in Mesoscale Twisted Graphitic Interfaces", Nat. Commun., in press (2020).
3. A. Oz, O. Hod, and A. Nitzan, "Numerical Approach to Nonequilibrium Quantum Thermodynamics: Nonperturbative Treatment of the Driven Resonant Level Model Based on the Driven Liouville von-Neumann Formalism", J. Chem. Theory Comput. 16, 1232-1248 (2020).
4. W. Ouyang, I. Azuri, D. Mandelli, A. Tkatchenko, L. Kronik, M. Urbakh, and O. Hod, "Mechanical and Tribological Properties of Layered Materials Under High Pressure: Assessing the Importance of Many-Body Dispersion Effects", J. Chem. Theory Comput. 16, 666-676 (2020).
5. T. Maaravi and O. Hod, "Simulating Electron Dynamics in Open Quantum Systems under Magnetic Fields", J. Phys. Chem. C 124, 8652-8662 (2020).
6. D. Mandelli, W. Ouyang, M. Urbakh, and O. Hod, "The Princess and the Nanoscale Pea: Long-Range Penetration of Surface Distortions into Layered Materials Stacks", ACS Nano 13, 7603-7609 (2019).
7. I. Oz, O. Hod, and A. Nitzan, "Evaluation of Dynamical Properties of Open Quantum Systems Using the Driven Liouville-von Neumann Approach: Methodological Considerations", Mol. Phys. 117, 2083-2096 (2019).
8. D. Mandelli, W. Ouyang, O. Hod, and M. Urbakh, "Negative Friction Coefficient in Superlubric Graphite-Hexagonal Boron Nitride Heterojunctions", Phys. Rev. Lett. 122, 076102 (2019).

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Research title:

Synthesis and physical studies of colloidal nanoparticles and their assemblies

Research Abstract

The colloidal nanomaterial research group creates nanostructures from various inorganic materials using wet chemical techniques, and investigates their unique physical properties—magnetic, electrical, and optical. The group was among the pioneers of a new field called nano-chirality. In this field we study the interaction of the chiral molecule with achiral metal and semiconductor nanocrystals, through measurements of optical activity. Another aspect of this work is enantio-selective synthesis of inorganic nanocrystals that crystallize in chiral crystallographic space groups (similar to quartz, for example). In addition, we have an on-going applied science project for preparing transparent electrode films made of metal nanowire networks grown directly on various types of substrates, for flexible electronics.

Publications

1. Daniel Vestler, Assaf Ben-Moshe, and Gil Markovich, “Enhancement of Circular Dichroism of a Chiral Material by Dielectric Nanospheres”, J. Phys. Chem. C 2019, 123, 8, 5017–5022.
2. Uri Hananel, Assaf Ben-Moshe, Daniel Tal, and Gil Markovich, “Enantiomeric Control of Intrinsically Chiral Nanocrystals”, Adv. Mater. 2019, 1905594.
3. Uri Hananel, Assaf Ben-Moshe, Haim Diamant, and Gil Markovich, “Spontaneous and Directed Symmetry Breaking in the Formation of Chiral Nanocrystals”, PNAS, 2019, 116 (23), 11159-11164.
4. Muriel E Layani-Tzadka, Daniel Krotkov, Einat Tirosh, Gil Markovich and Sharly Fleischer, “Contact-Free Conductivity Probing of Metal Nanowire Films Using THz Reflection Spectroscopy”, Nanotechnology, 2019, 30, 21.
5. Muriel E. Layani-Tzadka, Lee-Or Barouch, Daniel Vestler, Ilana Aksenfeld, Daniel Azulai, Einat Tirosh, and Gil Markovich, “Flow-Directed Growth of Aligned Metal Nanowire Films: Toward Light-Polarizing Transparent Conductors”, ACS Appl. Nano Mater. 2019, 2, 5, 3073–3080.
6. Uri Hananel, Assaf Ben-Moshe, Daniel Tal, Gil Markovich, "Enantiomeric Control of Intrinsically Chiral Nanocrystals", Advanced Materials, in press (2020).

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Research title:

Electronic processes at molecular interfaces (theory)

Research Abstract

AN's research focuses on the interaction of light with molecular systems, chemical reactions in condensed phases and interfaces and charge transfer processes in such environments

Publications

1. Na Xin, Jianxin Guan, Chenguang Zhou, Xinjiani Chen, Chunhui Gu, Yu Li, Mark A. Ratner, Abraham Nitzan, J. Fraser Stoddart & Xuefeng Guo, "Concepts in the Design and Engineering of Single-Molecule Electronic Devices", Nature Reviews Physics, 1, 211–230, (2019).
2. Zeyu Zhou, Hsing-Ta Chen, Abraham Nitzan, and Joseph Eli Subotnik, "Nonadiabatic Dynamics in a Laser Field: Using Floquet Fewest Switches Surface Hopping To Calculate Electronic Populations for Slow Nuclear Velocities", J. Chem. Theory Compt., 16, 2, 821–834 (2020).
3. Tao E. Li, Joseph E. Subotnik, and Abraham Nitzan, "Cavity Molecular Dynamics Simulations of Liquid Water under Vibrational Ultrastrong Coupling", PNAS, 117 (31), 18324-18331, (2020).
4. Annabelle Oz, Oded Hod, and Abraham Nitzan, "Numerical Approach to Nonequilibrium Quantum Thermodynamics: Nonperturbative Treatment of the Driven Resonant Level Model Based on the Driven Liouville von-Neumann Formalism", J. Chem. Theory Comput., 16, 2, 1232–1248, (2020).
5. Alexander Semenov and Abraham Nitzan, "Electron Transfer in Confined Electromagnetic Fields Featured", J. Chem. Phys., 150, 174122 (2019).
6. Hsing-Ta Chen, Tao E. Li, Abraham Nitzan, and Joseph E. Subotnik, "Predictive Semiclassical Model for Coherent and Incoherent Emission in the Strong Field Regime: The Mollow Triplet Revisited", J. Phys. Chem. Lett., 10, 6, 1331–1336, (2019).
7. Galen T. Craven and Abraham Nitzan, "Wiedemann–Franz Law for Molecular Hopping Transport", Nano Lett., 20, 2, 989–993, (2020).
8. Hsing-Ta Chen, Tao E. Li, Maxim Sukharev, Abraham Nitzan, and Joseph E. Subotnik, "Ehrenfest+R Dynamics. II. A Semiclassical QED Framework for Raman Scattering", J. Chem. Phys., 150, 044103, (2019).
9. Renai Chen, Inon Sharony, and Abraham Nitzan, "Local Atomic Heat Currents and Classical Interference in Single-Molecule Heat Conduction", J. Phys. Chem. Lett., 11, 4261–4268, (2020).
10. Alexander Semenov and Abraham Nitzan, "Transport and Thermodynamics in Quantum Junctions: A Scattering Approach", J. Chem. Phys. 152, 244126, (2020).
11. Inbal Oz, Oded Hod &Abraham Nitzan, "Evaluation of Dynamical Properties of Open Quantum Systems Using the Driven Liouville-von Neumann Approach: Methodological Considerations", Journal Molecular Physics, 117, 15-16, (2019).
12. Henning Kirchberg, Michael Thorwart, and Abraham Nitzan, "Charge Transfer through Redox Molecular Junctions in Nonequilibrated Solvents", J. Phys. Chem. Lett., 11, 5, 1729–1737, (2020).
13. Mayte Gómez-Castaño, Andrés Redondo-Cubero, Lionel Buisson, Jose Luis Pau, Agustin Mihi, Serge Ravaine, Renaud A. L. Vallée, Abraham Nitzan, and Maxim Sukharev, "Energy Transfer and Interference by Collective Electromagnetic Coupling-, Nano Lett., 19, 8, 5790–5795, (2019).
14. Natalya A. Zimbovskaya and Abraham Nitzan, "Energy, Work, Entropy, and Heat Balance in Marcus Molecular Junctions", J. Phys. Chem., B, 124, 13, 2632–2642, (2020).
15. Tao E. Li, Hsing-Ta Chen, Abraham Nitzan, and Joseph E. Subotnik, "Understanding the Nature of Mean-Field Semiclassical Light-Matter Dynamics: An Investigation of Energy Transfer, Electron-Electron Correlations, External Driving, and Long-Time Detailed Balance", Phys. Rev. A 100, 062509, (2019).
16. Hsing-Ta Chen, Tao E. Li, Maxim Sukharev, Abraham Nitzan, and Joseph E. Subotnik, "Ehrenfest+R Dynamics. I. A Mixed Quantum–Classical Electrodynamics Simulation of Spontaneous Emission", J. Chem. Phys., 150, 044102 (2019).

Prof. Fernando Patolsky

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Research title:

Synthesis and characterization of new nanoscale materials for the development of nano-electronic, electro-optic and electro-magneto optical devices, and their applications in biology, chemistry and technology

Research Abstract

Prof. Fernando Patolsky's research group in the School of Chemistry is a young, dynamic scientific team, always seeking excellence and challenging research.

Nanoscience and Nano-biotechnology are our main fields of interest and specialization. Our work focuses on applied research for the development of novel applications and technologies. We cover the entire spectrum, from the basics of nanoscience and nanostructure synthesis, to the development of ultrasensitive sensors and biosensors for detecting molecular and biomolecular footprints. In particular, we are interested in coupling biological phenomena with chemical reactions to develop new sensing and diagnostic tools.

Another area of interest is 'energy-related' research, especially the development of novel, cost-effective and efficient fuel cell devices. Our group's facilities, located in several rooms within the TAU campus, and covering most of our research needs, include: our own clean-room, with all the equipment required for fabrication of nanodevices; probe stations; several sensing stations; AFM for the broad characterization of nanodevices; wet chemical labs; electrochemistry labs; biosensing labs; and a cell culture lab for growing and evaluating neural systems.

Publications

1. Vadim Krivitsky, Marina Zverzhinetsky, and Fernando Patolsky, "Redox-Reactive Field-Effect Transistor Nanodevices for the Direct Monitoring of Small Metabolites in Biofluids toward Implantable Nanosensors Arrays", ACS Nano 2020, 14, 3, 3587–3594.
2. Ella Borberg, Marina Zverzhinetsky, Adva Krivitsky, Alon Kosloff, Omri Heifler, Gal Degabli, Hagit Peretz Soroka, Ronit Satchi Fainaro, Larisa Burstein, Shlomi Reuveni, Haim Diamant, Vadim Krivitsky, and Fernando Patolsky, "Light-Controlled Selective Collection-and-Release of Biomolecules by an On-Chip Nanostructured Device", Nano Lett., 2019, 19, 9, 5868–5878.
3. Nimrod Harpak, Guy Davidi, Dan Schneier, Svetlana Menkin, Edna Mados, Diana Golodnitsky, Emanuel Peled, and Fernando Patolsky, "Large-Scale Self-Catalyzed Spongelike Silicon Nano-Network-Based 3D Anodes for High-Capacity Lithium-Ion Batteries", Nano Lett., 2019, 19, 3, 1944–1954.
4. Esther Lestrell, Fernando Patolsky, Nicolas H.Voelcker, and Roey Elnathan,"Engineered Nano-Bio Interfaces for Intracellular Delivery and Sampling: Applications, Agency and Artefacts", Materials Today, 33, 2020, 87-104.
5. Dana Kaizerman-Kane, Maya Hadar, Eran Granot, Fernando Patolsky, Yossi Zafrani and Yoram Cohen, "Shape Induced Sorting via Rim-to-Rim Complementarity in the Formation of Pillar[5, 6]Arene-Based Supramolecular Organogels", Org. Chem. Front., 2019, 6, 3348-3354.
6. Nimrod Harpak, Guy Davidi, Yarden Melamed, Adam Cohen, and Fernando Patolsky, "Self-Catalyzed Vertically Aligned Carbon Nanotube–Silicon Core–Shell Array for Highly Stable, High-Capacity Lithium-Ion Batteries", Langmuir, 2020, 36, 4, 889–896.
7. Nimrod Harpak, Guy Davidi, Adam Cohen, Adva Raz, Fernando Patolsky, "Thermally-Treated Nanowire-Structured Stainless-Steel as an Attractive Cathode Material for Lithium-Ion Batteries", Nano Energy, 76, 2020, 105054.
8. Vadim Krivitsky, Boris Filanovsky, Vladimir Naddaka, and Fernando Patolsky, "Direct and Selective Electrochemical Vapor Trace Detection of Organic Peroxide Explosives via Surface Decoration", Anal. Chem. 2019, 91, 8, 5323–5330.
9. Ella Yeor-Davidi, Marina Zverzhinetsky, Vadim Krivitsky and Fernando Patolsky, "Real-Time Monitoring of Bacterial Biofilms Metabolic Activity by a Redox-Reactive Nanosensors Array", Nanobiotechnol., 2020, 18:81.
10. Dan Schneier, Nimrod Harpak, Svetlana Menkin, Guy Davidi, Meital Goor, Edna Mados, Gilat Ardel, Fernando Patolsky, Diana Golodnitsky and Emanuel Peled, "Analysis of Scale-up Parameters in 3D Silicon-Nanowire Lithium-Battery Anodes", Journal of The Electrochemical Society, 2020, 167, 5.
11. Vadim Krivitsky, Boris Filanovsky, Tatiana Bourenko, Eran Granot, Anna Praiz, and Fernando Patolsky, "Vapor Trace Collection and Direct Ultrasensitive Detection of Nitro-Explosives by 3D Microstructured Electrodes", Anal. Chem., 2019, 91, 22, 14375–14382.

Prof. Emanuel Peled

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Research title:

Synthesis, characterization of nano materials and study of electrochemical phenomena in new nanostructured electrodes and electrolytes for energy storage devices

Research Abstract

Nano Pt based catalysts for PEM fuel cells and direct methanol fuel cells.
Silicon nano particles and nano structures as anode for lithium ion batteries.
Study the deposition and dissolution of lithium nano structures in lithium metal batteries.
Study interface phenomena between lithium and electrolytes.
3D jet printer for lithium ion batteries.

Publications

1. Ido Ben-Barak, Yosef Kamir, Svetlana Menkin, Meital Goor, Inna Shekhtman, Tania Ripenbein, Diana Golodnitsky and Emanuel Peled Drop-on-Demand 3D Printing of Lithium Iron Phosphate Cathodes, J. Electrochem. Soc. 2019, 166, 3, A5059-A5064.
2. Yonatan Horowitz, Ido Ben-Barak, Dan Schneier, Meital Goor-Dar, Johannes Kasnatscheew, Paul Meister, Mariano Grünebaum, Martin Winter, Hans-Dieter Wiemhöfer, Diana Golodnitsky, and Emanuel Peled, Study of the Formation of a Solid Electrolyte Interphase (SEI) on a Silicon Nanowire Anode in Liquid Disiloxane Electrolyte with Nitrile End Groups for Lithium-Ion Batteries, Batteries & Supercaps, 2019, 2, 213–222, DOI: 10.1002/batt.201800123.
3. Fernando Patolsky, Nimrod Harpak , Mr. Guy Davidi , Mr. Dan Schneier , Dr. Svetlana Menkin, Edna Mados, Diana Golodnitsky, Emanuel Peled, Large Scale Self-Catalyzed Sponge-Like Silicon Nanonetwork-based 3D-Anodes for High-Capacity Lithium-Ion Batteries, Nano Lett. 2019, 19, 1944−1954.
4. D. Schneier, Y. Shacham, K.Goldshtein1, M. Goor, D. Golodnitsky, E. Peled, Comparative Characterization of Silicon Alloy Anodes, Containing Single-Wall or Multi-Wall Carbon Nanotubes, Journal of The Electrochemical Society, 166 (4) A740-A746 (2019).
5. Tzach Mukra, Yonatan Horowitz, Meital Goor-Dar, Johannes Kasnatscheew, Paul Meister, Mariano Grünebaum, Martin Winter, Hans-Dieter Wiemhöfer, Diana Golodnitsky, and Emanuel Peled. Disiloxane with Nitrile End Groups as Co-solvent to Replace LiNO3 Additive in Lithium-Sulfur Batteries, Electrochimica Acta, 307 (2019) 76-82.
6. Evelina Faktorovich-Simon, Amir Natan, Emanuel Peled, and Diana Golodnitsky, Comparison of the Catalytic Activity of Carbon, Spinel-based, and Carbide Materials in the Na-Air Battery, Frontiers, 10, 2019 doi: 10.3389/fmats.2019.00249doi: 10.3389/fmats.2019.00249.
7. M. Goor, S. Menkin and E. Peled, High power Direct Methanol Fuel Cell for Mobility and Portable Applications, International Journal of Hydrogen Energy 44, 3138- 3143 (2019).
8. E. Peled, D. Schneier, Y. Shaham, G. Ardel, L. Burstein, and Y. Kamir, Understanding the Spontaneous Reactions between Oxide-Free Silicon and Lithium-Battery Electrolytes, JECS 166 (10) A2091-A2095 (2019).
9. E. Peled, D. Schneier, Y. Shaham, G. Ardel and L. Burstein; Elucidation of the Reaction of Si Anode with Li Battery Electrolyte, accepted
10. T. Mukra and E. Peled: Elucidation of the Losses in Cycling Lithium-Metal Anodes in Carbonate-Based Electrolytes, JECS (in press 2020)

Prof. Doron Shabat

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Research title:

Self-immolative molecular systems for drug delivery; Optical properties of organic molecules coupled to optical devices

Research Abstract

Chemiluminescence modality is among the most sensitive methods known to achieve high signal-to-noise ratio for diagnostic applications. We have recently developed a new molecular methodology to design and predict light-emission properties of phenoxy-dioxetane luminophors suitable for use under physiological conditions. The methodology is based on incorporation of a substituent on the benzoate species that is obtained during the chemiexcitation pathway of the Schaap's adamantylidene-dioxetane probe. The substituent effect was initially evaluated on the fluorescence emission generated by the benzoate species and then on the chemiluminescence of the dioxetane luminophores. A striking substituent effect on the chemiluminescence efficiency of the probes was obtained when acrylate and acrylonitrile electron-withdrawing groups were installed. The chemiluminescence quantum yield of the best probe was more than three orders of magnitude higher than that of a standard, commercially available adamantylidene-dioxetane probe. These are the most powerful chemiluminescence-dioxetane luminophores synthesized to date that are suitable for use under aqueous conditions. We also demonstrated that such probes are capable of providing high-quality chemiluminescence cell images based on endogenous activity of native enzymes. This is the first demonstration of cell imaging achieved by a non-luciferin small-molecule probe with direct chemiluminescence mode of emission. We anticipate that the strategy presented here will lead to development of efficient chemiluminescence probes for various applications in the field of sensing and imaging.

Publications

1. Samer Gnaim and Doron Shabat, "Activity-Based Optical Sensing Enabled by Self-Immolative Scaffolds: Monitoring of Release Events by Fluorescence or Chemiluminescence Output", Acc. Chem. Res., 2019, 52, 10, 2806–2817.
2. Reuven Edri, Idan Gal, Nadav Noor, Tom Harel, Sharon Fleischer, Nofar Adadi, Ori Green, Doron Shabat, Lior Heller, Assaf Shapira, Irit Gat-Viks, Dan Peer and Tal Dvir, "Personalized Hydrogels for Engineering Diverse Fully Autologous Tissue Implants", Adv. Mater., 2019, 31, 1803895.
3. Subin Son, Miae Won, Ori Green, Nir Hananya, Amit Sharma, Yukyoung Jeon, Jong Hwan Kwak, Jonathan L. Sessler, Doron Shabat, Jong Seung Kim, " Chemiluminescent Probe for the In Vitro and In Vivo Imaging of Cancers Over-Expressing NQO1", Angew.Chem. Int.Ed. 2019, 58, 1739 –1743.
4. Nir Hananya and Doron Shabat, "Recent Advances and Challenges in Luminescent Imaging: Bright Outlook for Chemiluminescence of Dioxetanes in Water", ACS Cent. Sci. 2019, 5, 6, 949–959.
5. Samer Gnaim, Anna Scomparin, Anat Eldar-Boock, Christoph R. Bauer, Ronit Satchi-Fainaro and Doron Shabat, "Light Emission Enhancement by Supramolecular Complexation of Chemiluminescence Probes Designed for Bioimaging", Chem. Sci., 2019, 10, 2945–2955.
6. Nir Hananya, Jolene P. Reid, Ori Green, Matthew S. Sigman and Doron Shabat, "Rapid Chemiexcitation of Phenoxy-Dioxetane Luminophores Yields Ultrasensitive Chemiluminescence Assays", Chem. Sci., 2019, 10, 1380-1385.
7. Sayantan Das, Julian Ihssen, Lukas Wick, Urs Spitz and Doron Shabat, "Chemiluminescent Carbapenem-Based Molecular Probe for Detection of Carbapenemase Activity in Live Bacteria", Chem. Eur.J.2020, 26,3647 –3652.
8. Nir Hananya, Ofir Press, Alakesh Das, Anna Scomparin, Ronit Satchi-Fainaro, Irit Sagi and Doron Shabat, "Persistent Chemiluminescent Glow of Phenoxy-dioxetane Luminophore Enables Unique CRET-Based Detection of Proteases", Chem. Eur.J.2019, 25,14679 –14687.
9. Sen Ye, Nir Hananya, Ori Green, Hansen Chen, Angela Qian Zhao, Dr. Jiangang Shen, Doron Shabat and Dan Yang, "A Highly Selective and Sensitive Chemiluminescent Probe for Real-Time

Monitoring of Hydrogen Peroxide in Cells and Animals", Angew. Chem. Int. Ed. 2020, 59, 14326 –14330.

10. Samer Gnaim and Doron Shabat, "Chemiluminescence Molecular Probe with a Linear Chain Reaction Amplification Mechanism", Org. Biomol. Chem., 2019, 17, 1389-1394.
11. Jon Miranda-Apodaca, Nir Hananya, Adrián Velázquez-Campoy, Doron Shabat and Juan B. Arellano, "Emissive Enhancement of the Singlet Oxygen Chemiluminescence Probe after Binding to Bovine Serum Albumin", Molecules 2019, 24(13), 2422.
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Research title:

Interactions of light with molecules at the nano-scale

Research Abstract

In nature, light and matter interact constantly, with photons absorbed or emitted, inducing chemical reactions and driving the transport of charges. When such interactions occur inside a wavelength-scale region, confined by a photonic nanostructure, they can change dramatically, giving rise to new and exciting effects.

In our research, we explore artificial structures with which we may create complex materials with new properties, and control the interaction of light and matter. We focus on several aspects of this theme, which lies at the meeting point of Chemistry, Quantum Physics, Optics and Material Science:

- Strong interaction of molecules with light - We investigate the optical properties of organic molecules (dyes) coupled with optical devices, aiming to understand photophysical and quantum processes in such hybrid systems, and to control these interactions. Gaining such control is important for photochemistry applications, light-harvesting and organic light-emitting devices.
- Optical properties of metallic nanoparticle clusters - A nanometer-size gold particle has a very distinct color, completely different from the color of bulk gold. The reason is that when we shape a metal at the nanometric scale, it supports localized plasmon modes that depend on features like geometry and size. In our research we explore how such nanoparticles assemble into well-defined clusters in order to produce composite materials with new optical properties.

Publications

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2. Somen Mondal, Anna Yucknovsky, Katherine Akulov, Nandan Ghorai, Tal Schwartz, Hirendra N Ghosh, and Nadav Amdursky "Efficient Photosensitizing Capabilities and Ultrafast Carrier Dynamics of Doped Carbon Dots", J. Am. Chem. Soc. 141, 15413 (2019).
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Research title:

Programmable and interactive materials

Research Abstract

Programmable materials are materials whose properties, behavior, and functionality are directly dictated by the chemical information written and programmed within them. The prime example of such materials are proteins, in which the programming of the amino acid sequence (the primary structure) directly determines the three-dimensional structure (the tertiary structure).

Our group studies chemically programmable materials that contain a sequence of commands (information) for performing a specific task or function coded in their chemical structure. In particular, we are interested in synthesis and fabrication of polymer fibers that can hold chemical and physical information, and study how this information can be used for folding these one-dimensional fibers into three-dimensional structures, and how a specific design can lead to selective binding and to self-assembly. Using tools from Thermodynamics and from Information Theory, we explore the underlying principles that determine the behavior of programmable materials. We also study the use of such materials for fabrication of microelectromechanical systems (MEMs) and for medical applications, including tissue engineering and smart drug release mechanisms.

In our lab, we employ a variety of fabrication techniques, including lithography, electro-hydrodynamic co-jetting and deposition methods. In addition, we make use of an array of microscopy and spectroscopy techniques for characterization and manipulation of these systems, and utilize a variety of computational and theoretical tools for modeling, analyzing and understanding the characteristics of such materials.

Publications

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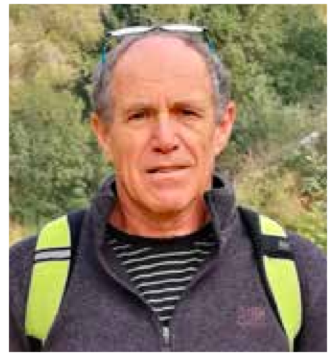
Prof. Michael Urbakh



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Research title:
Nanotribology (theory)

Research Abstract

Since 1995, Michael Urbakh has been working on the theory of friction at the nano and mesoscales. Frictional motion plays a central role in diverse systems and phenomena that span vast ranges of scales, from the nanometer contacts inherent in micro- and nano-machines and biological molecular motors, to the geophysical scales of earthquakes. The focus of the research in the Michael Urbakh group is on a molecular level description of processes occurring between interacting surfaces in relative motion, which is needed to first understand, and later to manipulate friction.

Important new results obtained by Michael Urbakh in this field include:

- Understanding the mechanism of transition from stick-slip motion to sliding
- Prediction and characterization of new regimes of frictional motion, in particular chaotic stick-slip and inverted stick-slip motion
- Understanding the origin of a finite lifetime of superlubricity between incommensurate surfaces, and suggestion of novel ways to stabilize the low-friction superlubric state
- Description of friction in terms of rupture and formation of surface junctions
- Description of thermal effects on nanoscale friction, and understanding the origin of unexpected nonmonotonic dependence of nanoscale friction on temperature
- Understanding the mechanism of wear and ripple formation in nanoscale friction
- Understanding the mechanism of onset of sliding motion for elastic sliders with extended rough interfaces
- Bridging a gap between descriptions of friction at the nano and macroscales
- Development of novel methods for controlling friction using mechanical vibration, electric field and chemistry
- Understanding mechanisms of electrotunable friction in ionic liquids
- Understanding mechanisms of friction in junctions of layered materials
- Upscaling superlubricity to microscale

A distinctive feature of research in the Michael Urbakh group is the development of minimal models which focus on a small number of the most relevant degrees of freedom of dynamical systems, but can nevertheless explain phenomena of high complexity. Moreover, the proposed minimal models have enabled predictions that were later verified experimentally. A special highlight was the remarkable prediction of the possibility to control friction mechanically via vibrations of small amplitude and energy. Michael Urbakh demonstrated that manipulation by mechanical excitations, when applied at the right frequency, amplitude and direction, pulls the molecules out of their potential energy minima and thereby reduces friction (at other frequencies or amplitudes the friction can be increased). This work stimulated experimental studies that confirmed the theoretical prediction, and recently this idea has been used by IBM in the development of the ultrahigh-density data storage device Millipede.

The theoretical approaches developed in the field of nanoscale friction led to breakthroughs in other fields, such as single molecule force spectrosopy and molecular motors. In particular, Michael Urbakh developed a novel method for revealing molecular scale energy landscapes from the results of force unfolding experiments, which is now widely used in many experimental laboratories. Another development was a new approach to building microscopic engines on the nano and microscales, allowing efficient transformation of the fed energy into directed motion. These engines can move translationally or rotationally on surfaces, and perform useful functions such as pulling a nanoscale cargo.

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1. Guang Feng, Ming Chen, Sheng Bi, Zachary A. H. Goodwin, Eugene B. Postnikov, Nikolai Brilliantov, Michael Urbakh, and Alexei A. Kornyshev, "Free and Bound States of Ions in Ionic Liquids, Conductivity, and Underscreening Paradox", Phys. Rev., 2019, X 9, 021024, 2160-3308.
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Research title:

Nonlinear photonic crystals; Plasmonics; Electron optics

Research Abstract

Our group is active in several areas of research: nonlinear optics, plasmonics and electron beam shaping.

In nonlinear optics, we mainly concentrate on quadratic nonlinear processes in ferroelectric crystals. The ability to modulate the quadratic nonlinear coefficient is used by us for shaping the spatial and spectral response of the nonlinear crystal.

In plasmonics, our efforts in recent years have focused on generating special types of plasmonic beams. To this end, we have developed special types of couplers between free-space light beams and plasmonic beams, applying concepts and coding schemes developed in the field of holography.

In electron beam shaping, we utilize a recent technological breakthrough, enabling us to shape the phase and amplitude of electron beams by passing them through a thin SiN membrane, patterned by focused ion beam milling.

Publications

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15. Dror Weisman and Ady Arie, "Dynamic Control of Plasmonic Beams", Optics Letters, 44, 15, 2019, 3689-3692.

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Research title:

Physical optics

Research Abstract

In the Physical Optics group we conduct research in diverse areas of optics - ranging from ultrafast and nonlinear optics, through extreme nonlinear optics to nano-photonics.
Specific subjects include: macroscopic control of high harmonic generation, optical super-oscillations, Fano resonance shaping in optical devices and use of accelerating optical fields to control nonlinear interactions.

Publications

1. Yaniv Eliezer, Thomas Zacharias and Alon Bahabad "Observation of optical backflow", Optica, 7, 1, 2020, 72-76.
2. Thomas Zacharias and Alon Bahabad, "Light beams with volume superoscillations", Optics Letters, 45, 13, 2020, 3482-3485.
3. Georgiy Shoulga and Alon Bahabad, "Simultaneous ultrabroadband quasi-phase-matching for high-order harmonic generation", Phys. Rev., A 99, 2019, 043813.
4. Amit Bekerman, Sahar Froim, Barak Hadad and Alon Bahabad, "Beam profiler network (BPNet): a deep learning approach to mode demultiplexing of Laguerre–Gaussian optical beams", Optics Letters, 44, 15, 2019, 3629-3632.
5. Ben Slavin and Alon Bahabad, "Evolution of guided modes under spatiotemporal perturbations", Journal of Optics, 21, 4, 2019.

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Research title:

Nano-antennas

Research Abstract

The dramatic increase in a worldwide demand for electrical power makes it clear that the development of clean, renewable alternative energy sources is essential, with solar power harvesting as the leading direction. The basic properties of conventional photovoltaic solar cells are determined by their materials' chemistry and the corresponding electronic properties. As a result, such solar cells have inherent and fundamental limitations in terms of optical bandwidth, efficiency and cost. On the other hand, power harvesting utilizing RF approaches has demonstrated high efficiency (exceeding 85%) in the radio-frequency spectral range, as well as low fabrication costs. The objective of our research is to develop new detection and power conversion schemes for optical frequencies, based on metallic rectifying nano-antennas (rectennas). A nano-rectenna includes two fundamental elements: an antenna and a rectifier. The antenna receives the EM wave and converts it into an alternating electric current (AC). The rectifier converts the AC current into a direct current (DC). We have demonstrated the ability to design, optimize and fabricate ultra-wideband nano-antenna arrays. We have measured the spectral properties of the scattered field from these antennas, and shown very good agreement with numerical simulations. We have also demonstrated preliminary success in integrating the nano-antennas with the rectifiers. We now intend to utilize these abilities to develop a new concept for solar-power harvesting, which can revolutionize the field by providing an inexpensive and efficient approach for direct EM to DC power conversion.

Publications

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5. Arkadi Sharshevsky, Yaniv Brick and Amir Boag, "Direct solution of scattering problems using generalized source integral equations", IEEE Transactions on Antennas and Propagation, 68, 7, 2020, 5512.
6. Y. Blau, O. Bar-On, Y. Hanein, A. Boag, and J. Scheuer, "Meta-hologram-based authentication scheme employing a speckle pattern fingerprint," Optics Express, vol. 28, no. 6, pp. 8924-8936, 16 March 2020.

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Research title:

Nanoscale electro-optics

Research Abstract

We study the fundamentals of the interaction between light and matter at the nanoscale, in order to gain a better understanding of the underlying physical mechanisms of this interaction, and use it to develop the next generation of optical and electro-optical devices. Our research involves: extensive fabrication and design of novel nanostructured materials for optical and electro-optical applications; characterization of the interaction of these materials with laser beams and incoherent light; and the development of relevant analytical or numerical models and simulations.
The lab's active lines of research and development currently include: stimulated emission effects in nano-complexes, and emission control and synchronization for optical computing and lab-on-a-chip applications; nonlinear plasmonic metamaterials for optical wave mixing applications; hybrid light-matter excitations based on strongly coupled exciton-plasmon-polaritons and waveguide-exciton-polaritons, as a means for developing all-optical and electro-optical switches, coherent light sources and optical amplifiers; optical elements based on metamaterials and nano-antennas for consumer electronics and imaging devices; and new structured surfaces for interferometric microscopy.

Publications

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2. Shay Keren-Zur, Mai Tal, Sharly Fleischer, Daniel M. Mittleman and Tal Ellenbogen, “Generation of Spatiotemporally Tailored Terahertz Wavepackets by Nonlinear Metasurfaces”, Nature Communications, 10, 2019, 1778.
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14. Symeon Sideris and Tal Ellenbogen, “Terahertz Generation in Parallel Plate Waveguides Activated by Nonlinear Metasurfaces”, Optics Letters, 44, 14, 2019, 3590-3593.

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Research title:

Theory of light-matter interactions, tailored by nanostructured environment

Research Abstract

The main research effort is concentrated around studies of light-matter interactions with bio-inspired structures, such as nanoparticles and their arrays. Those were recently found in several types of marine organisms and plants. Theoretical and numerical models are supported with comprehensive material characterizations and followed by spectroscopic studies.

Publications

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8. H. Barhom, A. Machnev, R. E Noskov, A. A Goncharenko, E. Gurvitz, A. S Timin, V. A Shkoldin, S. V Koniakhin, O. Yu Koval, M. Zyuzin, A. S. Shalin, I. Shishkin, and P. Ginzburg, "Biological kerker effect boosts light collection efficiency in plants", Nano letters, 19 (10), 7062-7071 (2019).
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Research title:

Microfluidics for self-assembly; nanotubes-neuron interfaces

Research Abstract

The lab specializes in micro and nano systems. In particular, we are interested in neuronal interfaces and wearable electrophysiology. In the last several years we have developed a novel class of micro electrodes for neuronal recording and stimulation. The electrodes are fabricated by synthesizing high density carbon nanotube islands on lithographically defined, passivated titanium nitride conductors on a silicon dioxide substrate. More recently, we have also developed a flexible version of these electrodes. The enhanced electrochemical properties of the electrodes, their flexible and simple micro-fabrication preparation procedure, as well as their bio-compatibility and durability, suggest that carbon nanotube electrodes are a promising platform for high resolution neuronal coupling. These electrodes are currently explored primarily for surface EMG and EEG applications.

The main focus of the lab is the development and characterization of highly efficient nanomaterial based platforms suited for future wire-free, light induced retina implants. Our envisioned implants are soft, wireless stand-alone polymeric films embedded with photosensitive pixels. After exploring different materials, different characterization and optimization methodologies, we have been able to realize films that can indeed stimulate blind retinas. Presently we work towards the implementation of these technologies as viable retinal implants.

Finally, we work on electronic skin for electrophysiological evaluation. We recently developed novel dry electrodes, exhibiting outstanding electromyography recording along with excellent user comfort. The electrodes are realized using screen-printing of silver and carbon inks on a soft support. The conformity of the electrodes helps establish direct contact with the skin, making the use of a gel superfluous, supporting long term recordings.

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Research title:
Nanoprobing, scanning probe microscopy

Research Abstract
Prof. Rosenwaks leads a research group of 10 graduate students and scientists, and his current research interests include: nanoscale electrical measurements using mainly Kelvin probe force microscopy, nanowire transistors and sensors, charge carrier dynamics and transport in semiconductors, and Kelvin probe microscopy of 2D materials.

Publications
1. Shimanovich, K.; Mutsafi, Z.; Shach-Caplan, M.; Pikhay, E.; Roizin, Y.; Rosenwaks, Y., "Efficient temperature sensor based on SOI gate-all-around electrostatically formed nanowire transistor", piIEEE Transactions on Electron Devices, 66, 3549-3553, 2019
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Research title:

Solid-state detectors and devices

Research Abstract

Our research is focused on the following detectors:

Compound II-VI semiconductor detectors for X- and Gamma-rays – The wide band-gap Cd1-xZnxTe semiconductors have very beneficial properties for Gamma-ray detector application. The forbidden band gap of the ternary compound semiconductor depends on the Zn content. We study macroscopic as well as microscopic properties of these semiconductors and related devices. We use device characterization such as I-V(T), Noise PSD, TCT (Transient Current Technique), X-ray spectroscopy, etc., to evaluate the overall properties and performance of the resulting device. We use a TSC (Thermally Stimulated Current) and Laplace-DLTS setup combined with optical injection (PITS) to characterize the deep levels in the band-gap, and AFM based measurements to study local electrical activity.

Silicon detectors for MIPs (Minimum Ionizing Particles), X- and Gamma-rays – We study some aspects of the dependence of device technology and geometry on performance and yield.

Radiation hardness of semiconductor detectors and VLSI electronics – We study radiation-induced damage in semiconductors and semiconductor devices. Our group participates in the RD-50 Collaboration at CERN (European center for nuclear and particle physics). The aim of the collaboration is to advance the understanding of the nature of the defects introduced by various particles to detectors, and to find ways to improve the radiations hardness (tolerance) of the detectors.

Silicon-germanium detectors – We study the electrical properties of currently available SiGe bulk semiconductors (with and without lithium diffusion) and devices by means of "dark" properties characterization, as well as by Laplace DLTS and other techniques.

Indium-Antimonite detectors – Indium-Antimonite semiconductor has high carrier mobility and bandgap suitable for infrared absorption. The binary semiconductor is often used for IR detectors. We investigate the bulk material and passivation layer for this semiconductor.

Publications

1. Sushrut Modak, Leonid Chernyak, Minghan Xian, Fan Ren, Stephen J. Pearton, Sergey Khodorov, Igor Lubomirsky, Arie Ruzin and Zinovi Dashevsky, "Impact of electron injection on carrier transport and recombination in unintentionally doped GaN", Journal of Applied Physics 128, 2020, 085702.
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Research title:

Integrated nanophotonics, slow light and polymer optics

Research abstract

We study fundamental concepts and technologies involving the interaction of light with nano-structures. We focus on metasurfaces and their applications. Our recent achievements include the development of new applications for metasurfaces: Anti-Counterfeiting measures, particle acceleration, beam characterization. We are also developing novel approaches for tunable metasurfaces for dynamic holography and LiDAR applications, utilizing phase change materials and flexible substrates. We also develop novel light sources and lasers by patterning nanostructures on soluble active materials such as dyes doped Sol-Gels and UV curable epoxies and lead-halide perovskite. Our recent achievement in this area is the demonstration of ultra-high-Q resonators based on Sol-Gel, micro DFB lasers employing perovskites and an active hyperbolic metamaterial based on lead-halide perovskite with unique properties in the visible band.

Publications

1. Philipp Brenner, Ofer Bar-On, Marius Jakoby, Isabel Allegro, Bryce S. Richards, Ulrich W. Paetzold, Ian A. Howard, Jacob Scheuer and Uli Lemmer, "Continuous wave amplified spontaneous emission in phase-stable lead halide perovskites", Nature Communications,10, 988, 2019.
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Research title:

Nano-chemical processes for microelectronics; Integration of biological materials on chips for acute toxicity detection

Research Abstract

The main goal of our research is to study functional biochips with new concepts of integration of whole cells with electronically interfacing biosensors. The coupling of living cells, serving as sensor elements with microelectronic devices, provides novel opportunities for biosensors performing as stable, sensitive, specific and accurate electronic devices. Electroless deposition methods, in which metal cations are chemically reduced by a reducing agent into a deposited metallic film, may provide a new and effective tool for the coupling of biological activities and electronic circuits. Electrical characteristics (conductivity) and structure preservation are achieved by coating the structure with a thin metal film. In order to miniaturize the biosensors, we: a) integrate a single cell or a small number of cells located within a small area on a chip, or: b) integrate our biochips with systems with cell lines or directly on the tissue (i.e. plant or animal). To achieve this, we control the location of the cell on the electrode, as well as to provide electrical contact between the cell and electrode. We develop various strategies of interfacing, such as a functionalized nano metal particle on semiconductor nanostructures, metal/elastomer composites, conjugate polymers with nano particles, and integrate them on both rigid and flexible substrates. Our group develop basic technologies for biochip/biosensors and their interface to the networks and to the cloud supporting data driven agriculture, food and biomedicine.

Publications

1. Dmitry Filonov, Sergey Kolen, Andrey Shmidt, Yosi Shacham-Diamand, Amir Boag and Pavel Ginzburg, "Volumetric 3D-printed antennas, manufactured via selective polymer metallization", PSS Rapid Research Letter, 13, 6, 2019.
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9. Eran Mishuk, Andrei Ushakov, Jenny Shklovsky, Slava Krylov, Yosi Shacham-Diamand, Vladimir Ya. Shur, Andrei Kholkin and Igor Lubomirskya, "Fracture strength and fatigue endurance in Gd-doped ceria thermal actuators", Sensors and Actuators A: Physical, 304, 2020, 111885.
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Research title:

Renewable energy and Bio-MEMs

Research Abstract

Global population growth and a rising quality of life in the era of climate change are expected to increase the demand for food, chemicals and fuels. A possible, sustainable direction for addressing this challenge is the production of biomass and the conversion of this biomass into the required products through a complex system known as a biorefinery. However, concerns over net energy balance, potable water use, environmental hazards and uncertainty with regard to processing technologies — mostly problems with lignin—raise questions regarding the actual potential of terrestrial biomass to meet the anticipated food, feed and energy challenges in a sustainable way.

An alternative source of biomass for biorefineries is offshore-grown macroalgae. Macroalgae have been harvested throughout the world for centuries, both as a food source and as a commodity for the production of hydrocolloids. However, to date, macroalgae still represent only a tiny percentage of the global biomass supply: ~17·106 tons fresh weight (FW) of macroalgae compared to 16·1011 tons of terrestrial crops, grasses and forests. A presently expanding body of evidence suggests that offshore-cultivated macroalgae, which contain very little lignin, and do not compete with food crops for arable land or potable water, can provide an alternative source of biomass for the sustainable production of food, chemicals, and fuels. The goal of our laboratory is to develop a fundamental understanding of energy flows in offshore marine biorefineries, to boost the net energy return on investment, and to develop new technologies at the nano, micro and macro levels for implementing marine biorefineries for the benefit of humanity and society. To this end we are currently developing: 1) in silica metabolic model of multiorganism fermentation for biofuels production; 2) technologies for algae breeding from "spore to sea", microdevices for studying seaweed-bacteria interactions; 3) a portfolio of computational and experimental tools for biomass deconstruction and fermentation.

Publications

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2. Polikovsy,M, Califano G, Dunger N, Wichard T, Golberg A. Engineering bacteria-seaweed symbioses for modulating the photosynthate content of Ulva (Chlorophyta): Significant for the feedstock of bioethanol production. Algal Research. 2020. 49:101945.
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macroalgal biomass production in Indian coastal waters", Botanica MarinaDOI: https://doi.org/10.1515/bot-2018-0099, 2020.

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19. Greiserman S, Epstein M, Chemodanov A, Steinbruch E, Prabhu M, Guttman L, Jinjikhashvily G, Shamis O, Gozin M, Kribus A and Golberg A., "Co-production of monosaccharides and hydrochar from green macroalgae Ulva (Chlorophyta) sp. with subcritical hydrolysis and carbonization. Bioenergy Research, 2019.
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Research title:

Molecular mechanisms of synaptic plasticity in health and disease

Research Abstract

Our laboratory investigates the functions of key synaptic proteins in synaptic transmission and plasticity, both in health and in neurodegenerative diseases. The lab applies a multidisciplinary approach, pooling expertise in molecular biology, electrophysiology, biochemistry, optogenetics, high-end imaging and computer-simulation techniques, to understand how neurons communicate at the cellular and molecular levels to influence animal behavior. Recently, we integrated a novel method, termed super-resolution microscopy, enabling the detection of protein distribution at single-molecule, 20-nm resolution. Using several super-resolution methods (dSTORM, STED), and combining experimental and computational capabilities, our group described how the spatial distribution of synaptic proteins from the SNARE and active zone families influences synaptic transmission. We are now using this system to investigate how the alpha synuclein protein forms aggregates, and to discover the mode of action of specific inhibitors, such as chemical chaperones and aromatic small molecules. Work is performed on brain slices, induced pluripotent stem cells and cell lines. Recently, we have started to implement these tools to study protein aggregation in neurodegenerative diseases. We are developing tools for characterization of alpha synuclein aggregation in a Parkinson's disease mouse model, skin biopsies from Parkinson's disease patients and human induced pluripotent stem cells and human body fluids from tears and saliva. These tools can be used both for early diagnosis and for tracking disease progression and efficacy of treatment.

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Research title:

Application of antibodies in tissue engineering

Research Abstract

In collaboration with the group of Prof. Tal Dvir, we have been implementing antibodies to improve features of biomaterials used as scaffold for tissue engineering.
Recently we published: "Universal Biofactor-Releasing Scaffold Enabling in Vivo Reloading". We described a new reloadable system in which 3D fibrous scaffolds conjugated with an anti His-tag antibody enable the retention and controlled release of any His-tag-modified growth factor. The scaffolds can be reloaded in vitro or in vivo with any His-tagged biomolecule at any time according to the physiological need. We demonstrated the potential of the system to be sequentially reloaded in vivo, and as a proof of concept, we provide evidence for the efficient in vivo vascularization of scaffolds after reloading with tagged VEGF.

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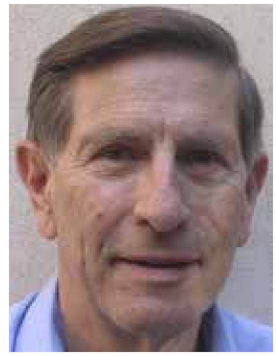
Prof. Chanoch Carmeli



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Research title:

Application of photosynthetic reaction center proteins PSI in the fabrication of novel nano-bio-solid state devices

Research Abstract

Fabrication of photoactive cysteine mutants of the protein chlorophyll complex photosystem I (PSI) mono and multilayers to solid state nanostructures such as nano-roads, nano-slits, slits arrays, microelectrodes and highly transparent 2D plats are used to evaluate the alteration of mutual properties of the metamaterials and the proteins. The hybrid structures enhance the absorption of PSI and alter the spin of electrons, enhance photovoltage and modulate the light transmission and scattering in far- and near field respective.

Publications

1. Omri Heifler, Chanoch Carmeli and Itai Carmeli, "Chemical Tagging of Membrane Proteins Enables Oriented Binding on Solid Surfaces", Langmuir 2020, 36, 16, 4556–4562.

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Research title:

Tissue engineering and regenerative medicine

Research Abstract

Our lab develops smart bio- and nanotechnologies for engineering complex tissues. Our work focuses on engineering hearts, the brain, spinal cord, retina and intestine.

Our research interests include:

- Engineering personalized tissue implants
- 4D printing of tissues and organs
- Engineering tissues and organs with built-in electronics
- Developing smart biomaterials for tissue regeneration
- Smart delivery systems

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Research title:

Self-assembly of short aromatic peptides: from amyloid diseases to nanotechnology

Research Abstract

The work in our group focuses on the molecular self-assembly of biological, bio-inspired and other organic building blocks, a key process in chemistry and biochemistry. We apply a minimalistic approach to define the smallest molecular recognition and assembly modules, and to understand the physicochemical basis for their association. We study the organization of biological systems in diverse fields, including amyloid diseases such as Alzheimer's disease and Parkinson's disease, diabetes, virology and metabolic disorders. We have identified the ability of very short peptides, as well as metabolites, to form typical amyloidal nano-fibrils. Our study of minimal recognition modules has led to the discovery of a family of dipeptide nanostructures of various architectures, including nanotubes, nanospheres, nanoplates and hydrogel, with nanoscale order and unique mechanical, optical, piezoelectric and semiconductive properties. These various assemblies form from remarkably simple building blocks that can potentially be synthesized in large amounts at a low cost. We demonstrated how these peptide nanostructures can be used as casting molds for the fabrication of metallic nano-wires and coaxial nano-cables. We used inkjet technology, as well as vapor deposition methods to coat surfaces and form peptide "nano-forests" in a highly controlled manner. We are currently employing microfluidic techniques to enable the formation of assembled products with specific size distribution, while controlling the assembly kinetics. We recently extended our studies to peptide nucleic acids (PNA), thereby converging the fields of peptide nanotechnology and DNA nanotechnology.

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Research title:

Molecular and cellular mechanisms of tumor reprogramming

Research Abstract

Tumor-selective drug conjugates can potentially improve the prognosis for patients affected by glioblastoma (GBM) – the most common and malignant type of brain cancer with no effective cure. We have previously generated a lentiviral induced immunocompetent mouse model of GBM that closely recapitulates the human disease. Using this preclinical model, we evaluate different nanoparticle platforms for both systemic and intratumoral delivery. We have recently evaluated a novel tumor penetrating peptide that targets cell surface p32, LinTT1 (AKRGARSTA), as a GBM targeting ligand for systemically-administered nanoparticles. LinTT1-functionalization increased tumor homing of iron oxide nanoworms (NWs) to brain tumors. LinTT1-guided proapoptotic NWs exerted strong anti-glioma activity in two models of GBM, including doubling the lifespan of the mice in an aggressive orthotopic stem cell-like GBM that recapitulates the histological hallmarks of human GBM.

Publications

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Research title:

Structural biology of cellular signaling

Research Abstract

We focus on several molecular systems that play key roles in signal transduction. Our goal is to obtain a mechanistic understanding of: how the molecules interact, transmit and respond to various cues on the most basic level of physics and chemistry; and how this understanding can forge greater progress in comprehending the general biology to which they are pivotal.

Publications

1. Gomez-Llorente, Y., Jebara, F., Patra, M., Malik, R., Nisemblat, S., Chomsky-Hecht, O., Parnas, A., Azem, A., Hirsch, J. A., and I. Ubarretxena-Belandia, "Structural basis for active single and double ring complexes in human mitochondrial Hsp60-Hsp10 chaperonin." Nature Communications, 11, 2020, 1916.
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Research title:

Marine invertebrates – biomineralization and skeletal properties

Research Abstract

Most of the studies in my laboratory focus on Sponges (phylum Porifera) - the oldest multicellular organisms in existence, together with the natural substances they produce, and their symbiosis with other marine organisms. Over the years we have studied many sponge species and their associates: from microorganisms (cyanobacteria, heterotrophic bacteria and fungi) through algae and invertebrates (e.g., scyphozoans, barnacles and polychaetes) to vertebrates (fish and hawksbill turtles).

As filter-feeding sessile organisms, frequently non-cryptic sponges have developed a wide array of natural products (metabolites) that assist them in dealing with their surroundings. In our laboratory, we study such marine-derived natural products through two different disciplines. The first, Marine Biotechnology, investigates how the sponge produces such metabolites. The second, Chemical Ecology, examines how the sponge utilizes these compounds. Subsequently, we evaluate the potential of exploiting these metabolites for human benefit, mostly as lead compounds for the development of pharmaceutical drugs.

In another line of research, Biomineralization and Biomimetic, we investigate how organisms deposit various minerals and collagen, their ecological/physiological function, and how we may utilize this understanding for the production of biomimetic materials.

Research in my laboratory is thus highly multidisciplinary, utilizing knowledge from fields as diverse as ecology, organic chemistry, microbiology, biochemistry, molecular biology and geochemistry. Our studies also relate to different levels of organization, from the population level through the physiological and cellular, to the molecular and chemical levels.

Publications

1. Dimitry Kovalerchik, Ravindra Pal Singh, Pnina Schlesinger, Aseel Mahajni, Sigal Shefer, Micha Fridman, Micha Ilan and Shmuel Carmeli "Bromopyrrole Alkaloids of the Sponge Agelas oroides Collected Near the Israeli Mediterranean Coastline", J. Nat. Prod. 2020, 83, 2, 374–384.
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Research title:

DNA-based organic nanowires; Biomedical applications of plasmonic nanoparticle structures

Research Abstract

DNA-BASED NANOTECHNOLOGY

The DNA molecule, well known from biology for containing the genetic code of all living species, has caught the attention of chemists and physicists as a possible candidate for wiring electronic materials in a programmable way. Self-assembled DNA-based conductive architectures can reduce the size of current electronic devices by ~1000 times, while shifting the production process from complicated and defect-rich lithography, to processes based on self-assembly and self-organization. However, the double stranded (ds) random sequenced DNA lacks the desirable feature of conductivity. To meet this challenge, we develop new conductive molecular nanowires based on G4-DNA, E-DNA (a hybrid of DNA strands and silver atoms) and thin gold-coated DNA nanowires. All of these can be assembled into complex 2D and 3D DNA architectures, forming a foundation for DNA-based nano-circuits and nano-devices.

BIOMEDICAL APPLICATIONS OF PLASMONIC NANOPARTICLE STRUCTURES

Noble metal nanoparticles attract huge scientific interest due to their attractive electronic, optical, chemical and thermal properties. In particular, these particles have been successfully used in therapy and diagnostics of cancer. Our research focuses specifically on gold nanoparticles coated with DARPin _9-29, an ankyril repeat protein specifically designed to target human epidermal growth factor receptor 2 (HER2), which is overexpressed in breast cancer. We have demonstrated that the interaction of spherical gold nanoparticles (GNPs) and gold nanorods (GNRs) with DARPin _9-29 yields very stable conjugates that do not aggregate at physiological salt concentrations, bind specifically with the surface of SK-BR-3 cells that overexpress receptor HER2, and are internalized into them by endocytosis. Moreover, we have demonstrated that illumination of the DARPin-GNR-treated SK-BR-3 cells with near infrared light leads to significant cell death. Specific eradication of cancer cells using GNR-DARPin conjugates paves the way to novel photodynamic approaches for specific treatment of cancer.

Publications

1. Galina Proshkina, Sergey Deyev, Anastasiya Ryabova, Francesco Tavanti, Maria Cristina Menziani, Roy Cohen, Liat Katrivas and Alexander Kotlyar, "DARPin_9-29-Targeted Mini Gold Nanorods Specifically Eliminate HER2-Overexpressing Cancer Cells", ACS Appl. Mater. Interfaces 2019, 11, 38, 34645–34651.
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Research title:

Biomaterial-based targeted carriers for theranostics of cancer and inflammations

Research Abstract

Our group applies three lipid-based particulate drug carriers for theranostics of major pathology classes - all invented and developed 'in-house'. Two such projects are currently being executed at the lab, and each project includes three stages: (i) Formulation studies – making the drug-carrier systems and characterizing them through structural and physicochemical studies; (ii) In vitro studies in cultures of the relevant target and control cell lines, pursuing safety and retention of therapeutic activity of the carrier-encapsulated drug; and (iii) In vivo studies in appropriate animal models, pursuing safety, pharmacokinetics and efficacy.

The current projects are: (1) Inhalational treatment of respiratory damage by aerosols of hyaluronan-liposomes encapsulating anti-inflammatory and anti-oxidant drugs - a single drug or both in the same liposome. This is currently at the in-vivo stage, evaluating safety and efficacy in a mouse model for acute lung inflammation. (2) carrier-formulated antidotes against opiates. This is currently at the formulation studies, soon to go into in vivo studies in mice, in which comparisons between IV and IM injections will be carried out.

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Research title:

Design functional materials that are inspired by biology

Research Abstract

Peptides are promising building blocks of supramolecular materials for biotechnological applications as they are much simpler structurally than proteins, relatively easy to synthesize, and can be scaled up. The side chain groups of the 20 gene-encoded amino acids provide diverse chemical functionalities including aromatic, basic/acidic, polar, and aliphatic that can interact through various noncovalent intra- and inter-molecular interactions. These interactions result in supramolecular structures that can be designed for a specific functionality. Our objective is to design peptide materials with properties that are similar to those of biological materials including materials for cell support, conductive and photoprotective materials. We strive to establish the sequence-structure relationships underlying these materials to get a molecular level understanding of how they are built.

Publications

1. Rein V. Ulijn and Ayala Lampel, "Order/Disorder in Protein and Peptide-Based Biomaterials", Isr. J. Chem. 2019, 59, 1 –13.
2. Ayala Lampel, "Biology-Inspired Supramolecular Peptide Systems", Chem 6, 6, 2020, 1222-1236.
3. Charalampos G. Pappas, Nadeesha Wijerathne, Jugal Kishore Sahoo, Ankit Jain, Daniela Kroiss, Ivan R. Sasselli, Ana Sofia Pina, Ayala Lampel and Rein V. Ulijn, "Spontaneous Aminolytic Cyclization and Self-Assembly of Dipeptide Methyl Esters in Water", ChemsystemsChem, 2, 5, 2020.
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Research title:

Micropatterning approaches to the study of cells' developmental decisions

Research Abstract

Our goal is to understand how cells within a population reach developmental decisions at the phenotypic and mechanistic level. How do cells "decide" to change their state? Why do similar cells respond differently to the same signal? What properties of the cell internal state affect its decision? How do mechanical and biochemical signals, in the context of a 3D tissue, drive this decision? Our lab studies these fundamental questions in in-vitro 3D mammalian model systems of early development, using methods from stem cell biology, live cell fluorescent imaging, microfluidics/micropatterning, statistical and computational analysis.

Publications

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Research title:

Glycans in immune recognition and response

Research Abstract

Our lab studies the mechanisms that govern glycan immune recognition and responses in animal models and humans, both in vitro and in vivo. We combine glycobiology, immunology, biotechnology and cancer research, and use cutting-edge technologies within these disciplines, including glycan microarray and glyco-nanotechnology.
Current interests include:

- Immunological mechanisms of unique anti-carbohydrate antibodies
- Glyco-immunology in xenotransplantation, which we investigate as members of the EU TRANSLINK Consortium
- Anti-carbohydrate antibodies in mucosal secretions and sera
- Developing novel diagnostics and therapeutics for chronic inflammation-mediated diseases
- Developing bio-nanotechnology tools based on glycan recognition
- Identifying and characterizing Tumor-Associated Carbohydrate Antigens (TACA), as members of the Cancer Biology Research Center (CBRC)

Publications

1. Soulillou JP, Padler-Karavani V., "Editorial: Human Antibodies Against the Dietary Non-human Neu5Gc-Carrying Glycans in Normal and Pathologic States", Front Immunol., 2020, eCollection.
2. Yehuda S, Padler-Karavani V., "Glycosylated Biotherapeutics: Immunological Effects of N-Glycolylneuraminic Acid", Front Immunol. 11:21, 2020.
3. Cohen-Dvashi H, Amon R, Agans KN, Cross RW, Borenstein-Katz A, Mateo M, Baize S, Padler-Karavani V, Geisbert TW, Diskin R., "Rational Design of Universal Immunotherapy for TfR1-Tropic Arenaviruses", Nat Commun. 11(1), 2020, 67.
4. Paul A, Bachar Abramovitch S, Padler-Karavani V., "Specific Detection of Neu5Gc in Animal Tissues by Immunohistochemistry", Methods Mol Biol., 2020, 59-72.
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7. Leviatan Ben-Arye S, Schneider C, Yu H, Bashir S, Chen X, von Gunten S, Padler-Karavani V., "Differential Recognition of Diet-Derived Neu5Gc-Neoantigens on Glycan Microarrays by Carbohydrate-Specific Pooled Human IgG and IgA Antibodies", Bioconjug Chem., 2019, 1565-1574.
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9. Rousse J, Salama A, Leviatan Ben-Arye S, Hruba P, Slatinska J, Evanno G, Duvaux O, Blanchard D, Yu H, Chen X, Bach JM, Padler-Karavani V, Viklicky O, Soulillou JP., "Quantitative and Qualitative Changes in Anti-Neu5Gc Antibody Response Following Rabbit Anti-thymocyte IgG Induction in Kidney Allograft Recipients", Eur J Clin Invest., 2019, 2936-2947.
10. Reuven EM, Leviatan Ben-Arye S, Yu H, Duchi R, Perota A, Conchon S, Bachar Abramovitch S, Soulillou JP, Galli C, Chen X, Padler-Karavani V., "Biomimetic Glyconanoparticle Vaccine for Cancer Immunotherapy", ACS Nano, 2019, [Epub ahead of print].

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Research title:

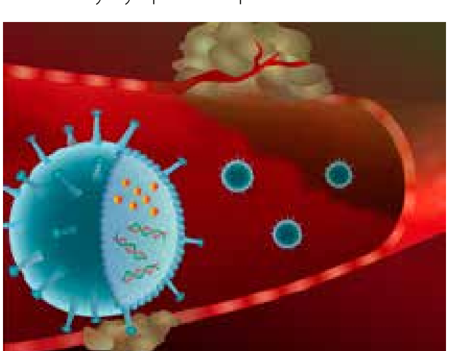
Targeted nanomedicines as carriers for molecular medicines.

Research Abstract

The Peer's lab works at the interface of materials science, chemistry, molecular biology, and immunology, to discover and validate novel therapeutic targets at the molecular level, and to develop specific molecular medicines for therapeutics and disease management. The lab is highly dynamic, multidisciplinary, and focuses on developing targeted fully degradable nano-vehicles for cell-specific delivery of molecular medicines using RNA interference, mRNA, self-amplified RNA, DNA, and genome editing strategies. The lab goal is to translate academic discoveries into innovative therapeutic modalities.

We are particularly interested in:

- Probing and manipulating the immune cells with nanomaterials.
- Developing novel strategies for targeting drug delivery nanoparticles to the specific cell population.
- Developing novel lipid nanomedicine using RNA interference, mRNA, self-amplified RNA, DNA, and novel genome editing strategies, for therapeutic of inflammatory bowel diseases, solid tumors, and blood cancer.
- Harnessing RNAi as a tool for drug discovery and therapeutic applications.
- Designing new ionizable lipids nanoparticles for nucleic-acids delivery.
- Breaching the blood-brain barrier to deliver therapies into the CNS.
- Developing strategies to improve the efficacy of nucleic-acids delivery by lipid nanoparticles.



Publications

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2. Kon E, Hazan-Halevy I, Rosenblum D, Cohen N, Chatterjee S, Veiga N, Raanani P, Bairey O, Benjamini O, Nagler A, Peer D. (2020) Resveratrol Enhances mRNA and siRNA Lipid Nanoparticles Primary CLL Cell Transfection. Pharmaceutics 12(6): E520.
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4. Veiga N, Diesendruck Y, and Peer D (2020) Targeted Lipid Nanoparticles for RNA Therapeutics and Immunomodulation in Leukocytes. Adv Drug Deliv Rev.
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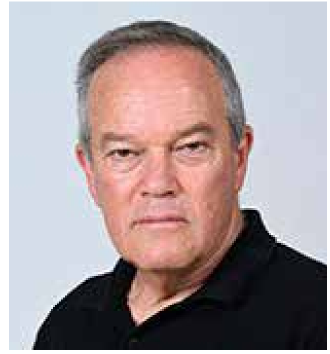
17. Mizrahy S, Gutkin A, Decuzzi P, Peer D. (2019) Targeting Central Nervous System Pathologies with Nanomedicines. J Drug Target. 27(5-6):542-554.

Prof. Daniel Segal



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Research title:

Determinants of protein misfolding and self-assembly in amyloid diseases and development of novel inhibitors as therapeutics

Research Abstract

'Conformational diseases' are diseases caused by misfolding of a protein, often as a result of a missense mutation that does not necessarily disrupt the active site of the protein. As a result, the protein may lose its function, and often the misfolded monomers self-assemble to form cytotoxic aggregates. In some cases, such misfolding can be reversible under experimental conditions. Thus, drugs that cause refolding of the misfolded protein may restore its function and prevent its harmful aggregation.

We study the structural causes of protein misfolding in conditions ranging from neurodegenerative diseases to certain cancers, and search for ways to refold them. Our research methods include: In-vitro and bacterial assays of protein folding and aggregation (in collaboration with Prof. Ehud Gazit, Biotechnology Dept.), cytotoxicity assays in cell culture, genetics and molecular biology of transgenics (drosophila, mice), immunohistochemistry, behavioral and cognitive assays (mouse work - in collaboration with Dr. Dan Frenkel, Neurobiology Dept.).

Main projects in the lab include:

- In-vivo development and screening of novel small molecules to address a range of diseases: amyloid-beta and tau inhibitors for Alzheimer's disease; alpha-synuclein inhibitors for Parkinson's disease; and TDP-43 inhibitors for ALS
- Developing and screening natural plant compounds, as amyloid-beta and tau inhibitors for Alzheimer's disease
- Examining the mechanism of TDP-43 spreading in ALS
- Examining the role of protein glycosylation in the aging and neurodegenerative brain
- Studying the misfolding of the tumor suppressor proteins p53 and VHL, and developing small molecules for restoring their folding and function.

Publications

1. Guru Krishnakumar Viswanathan, Dana Shwartz, Yelena Losev, Elad Arad, Chen Shemesh, Edward Pichinuk, Hamutal Engel, Avi Raveh, Raz Jelinek, Itzik Cooper, Fabien Gosselet, Ehud Gazit and Daniel Segal, "Purpurin Modulates Tau-derived VQIVYK Fibrillization and Ameliorates Alzheimer's Disease-like Symptoms in Animal Model", Cellular and Molecular Life Sciences, 77, 2020, 2795–2813.
2. Ashim Paul, Bo-Dou Zhang, Satabdee Mohapatra, Gao Li, Yan-Mei Li, Ehud Gazit and Daniel Segal, "Novel Mannitol-Based Small Molecules for Inhibiting Aggregation of α-Synuclein Amyloids in Parkinson's Disease", Front. Mol. Biosci., 2019, 6, 16.
3. Ashim Paul, Guru Krishnakumar Viswanathan, Satabdee Mahapatra, Gianfranco Balboni, Salvatore Pacifico, Ehud Gazit and Daniel Segal, "Antagonistic Activity of Naphthoquinone-Based Hybrids toward Amyloids Associated with Alzheimer's Disease and Type-2 Diabetes", ACS Chem. Neurosci., 2019, 10, 8, 3510–3520.
4. Guru Krishna Kumar Viswanathan, Ashim Paul, Ehud Gazit and Daniel Segal, "Naphthoquinone Tryptophan Hybrids: A Promising Small Molecule Scaffold for Mitigating Aggregation of Amyloidogenic Proteins and Peptides", Front. Cell Dev. Biol., 2019, 7, 242.
5. Ashim Paul, Wen-Hao Li, Guru Krishna Kumar Viswanatha, Elad Arad, Satabdee Mohapatra, Gao Li, Raz Jelinek, Ehud Gazit, Yan-Mei Li and Daniel Segal, "Tryptophan–Glucosamine Conjugates Modulate Tau-Derived PHF6 Aggregation at Low Concentrations", Chem. Commun., 2019, 55, 14621-14624.
6. Yelena Losev, Ashim Paul, Moran Frenkel-Pinter, Malak Abu-Hussein, Isam Khalaila, Ehud Gazit and Daniel Segal, "Novel Model of Secreted Human Tau Protein Reveals the Impact of the Abnormal N-Glycosylation of Tau on its Aggregation Propensity", Scientific Reports, 9, 2019, 2254.
7. Malak Abu-Hussien, Guru Krishna Kumar Viswanathana, Esraa Haj, Ashim Paul, Ehud Gazit and Daniel Segal, "An Amyloidogenic Hexapeptide from the Cataract-Associated γD-Crystallin is a Model for the Full-Length Protein and is Inhibited by Naphthoquinone-Tryptophan Hybrids", International Journal of Biological Macromolecules, 157, 2020, 424-433.

8. Gao Li, Wu-Yue Yang, Wen-Hao Li, Yun-Yi Luo, Yeh-Jun Lim, Yang Li, Ashim Paul, Daniel Segal, Liu Hong and Yan-Mei Li, "Rational Design of a Cocktail of Inhibitors Against Aβ Aggregation", Chem. Eur.J., 2020, 26,3499 –3503.
9. Merav D. Shmueli, Limor Levy-Kanfo, Esraa Haj, Alan R. Schoenfeld, Ehud Gazit and Daniel Segal, "Arginine Refolds, Stabilizes, and Restores Function of Mutant pVHL Proteins in Animal Model of the VHL Cancer $syndrome", Oncogene, 38, 2019, 1038–1049.

Prof. David Sprinzak

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Research title:

Probing intercellular signaling and cellular mechanics at the nanoscale level

Research Abstract

The development of a multicellular organism is a truly fantastic process. How genetically identical cells differentiate into distinct cell types in an accurate and reproducible manner remains one of the most important questions in biology.

The long-term goal of the lab is to elucidate the design principles of complex developmental programs underlying organized differentiation patterns. In particular, we are interested in:

(1) How the properties of intercellular signaling pathways contribute to the development of tissues and organs.

(2) How cellular mechanics and cellular morphology affect, and are affected by, regulatory processes within cells and signaling between cells.

To address these questions we use an interdisciplinary approach combining synthetic biology, quantitative imaging techniques, micropatterning technology and mathematical models.

Publications

1. Cristina Porcheri, Ohad Golan, Fernando J Calero-Nieto, Roshana Thambyrajah, Cristina Ruiz-Herguido, Xiaonan Wang, Francesca Catto, Yolanda Guillén, Roshani Sinha, Jessica González, Sarah J Kinston, Samanta A Mariani, Antonio Maglitto, Chris S Vink, Elaine Dzierzak, Pierre Charbord, Bertie Göttgens, Lluis Espinosa, David Sprinzak and Anna Bigas, "Notch Ligand Dll4 Impairs Cell Recruitment to Aortic Clusters and Limits Blood Stem Cell Generation", EMBO J., 2020, 39, 8, e104270.
2. Yulia Liubomirski, Shalom Lerrer, Tsipi Meshel, Dina Morein, Linor Rubinstein-Achiasaf, David Sprinzak, Stefan Wiemann, Cindy Körner, Marcelo Ehrlich and Adit Ben-Baruch, "Notch-Mediated Tumor-Stroma-Inflammation Networks Promote Invasive Properties and CXCL8 Expression in Triple-Negative Breast Cancer", Front. Immunol., 10, 84, 2019.
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4. Yi Kuang, Ohad Golan, Kristina Preusse, Brittany Cain, Collin J Christensen, Joseph Salomone, Ian Campbell, FearGod V Okwubido-Williams, Matthew R Hass, Zhenyu Yuan, Nathanel Eafergan, Kenneth H Moberg, Rhett A Kovall, Raphael Kopan and David Sprinzak, "Enhancer Architecture Sensitizes Cell Specific Responses to Notch Gene Dose via a Bind and Discard Mechanism", eLife 2020, 9, e53659.
5. Asaf Liberman, Matan Mussel, Danny Kario, David Sprinzak and Uri Nevo, "Modelling Cell Surface Dynamics and Cell–Cell Interactions Using Cell Studio: A Three-Dimensional Visualization Tool Based on Gaming Technology", J. R. Soc. Interface, 16, 2019, 0264.

Dr. Yariv Wine

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Research title:

Systems Immunology and Immunotechnology

Research Abstract

The Wine research group focuses on discovering and developing monoclonal antibodies to be used in therapeutic and diagnostic applications. Monoclonal antibodies exhibit extraordinary properties reflected in their high specificity and affinity towards various targets. In our group, we leverage these properties to develop integrative diagnostic point-of-care platforms for the rapid and accurate detection of pathogens. The platform is based on integrating the discovered monoclonal antibodies into an electrochemical immunosensor that will exhibit high sensitivity and accuracy. As a model system, we chose to develop an immunosensor for the detection of pathogenic *E.Coli* in its intact configuration (while cell detection). Our vision is to develop a point-of-care immunosensor that will be used by healthcare providers to detect an array of pathogens in one assay, thus, facilitating the intervention strategies used for the patient treatment plan.

Publications

1. Diana Rasoulouniriana, Nadine Santana-Magal, Amit Gutwillig, Leen Farhat-Younis, Yariv Wine, Corey Saperia, et al., "A Distinct Subset of FcγRI-Expressing Th1 Cells Exert Antibody-Mediated Cytotoxic Activity", J Clin Invest., 2019, 129(10), 4151–4164.
2. Anna Vaisman-Mentesh, Shai Rosenstein, Miri Yavzori, Yael Dror, Ella Fudim, Bella Ungar, Uri Kopylov, Orit Picard, Aya Kigel, Shomron Ben-Horin, Itai Benhar and Yariv Wine, "Molecular Landscape of Anti-Drug Antibodies Reveals the Mechanism of the Immune Response Following Treatment With TNFα Antagonists", Frontiers in Immunology, 2019, 10, 2921.
3. Yaron Hillman, Dan Lustiger and Yariv Wine, "Antibody-Based Nanotechnology", Nanotechnology, 30, 28, 2019.
4. Anna Vaisman-Mentesh, Matias Gutierrez-Gonzalez, Brandon J. DeKosky and Yariv Wine, "The Molecular Mechanisms that Underlie the Immune Biology of Anti-Drug Antibody Formation Following Treatment with Monoclonal Antibodies", Frontiers in Immunology, 2020, 11, 1951.
5. Shai Rosenstein, Anna Vaisman-Mentesh, Limor Levy, Aya Kigel, Yael Dror and Yariv Wine, "Production of F(ab')2 from Monoclonal and Polyclonal Antibodies", Current Protocols, 131, 1, 2020, e119.
6. Hillman, Y., Gershberg, J., Lustiger, D., Even, D., Brverman, D., Dror, Y., Ashur, I., Vernick, S., Sal-Man, N.*, Wine, Y.* A Monoclonal Antibody that Targets Pathogenic Bacteria Expressing the Type 3 Secretion System – Characterization and Practicable Applications. 2020. Under revision. Analytical Chemistry

Prof. Oswaldo Dieguez

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Research title:

Atomistic simulation of materials, with emphasis on ferroelectric and multiferroic materials

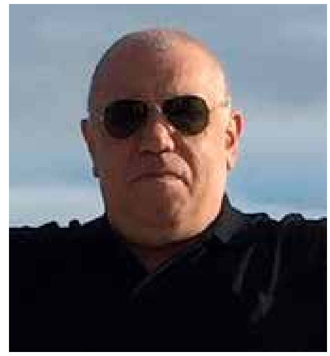
Research Abstract

All matter is made of atoms. By building on this basic assumption and using computers to solve equations that describe the interaction between atoms, I model the behavior of materials.
My main lines of research are:
(1) Design and study of multifunctional oxides, with emphasis on ferroelectric and multiferroic materials
(2) Application of computational methods to the study of materials in general, and materials for energy in particular
(3) Development of computational methods for materials science

Publications

1. N. Cohen and O. Diéguez, "Supertetragonal Phases of Perovskite Oxides: Insights from Electronic Structure Calculations", Israel Journal of Chemistry 60, 2020.
2. M. Dascalu, O. Diéguez, L.D. Geng, R. Pati, Y.M. Jin and I. Goldfarb, "Tomographic Layer-by-Layer Analysis of Epitaxial Iron-Silicide Nanostructures by DFT-Assisted STS", Applied Surface Science, 496, 143583, 2019.
3. M. Dascalu, R. Levi, F. Cesura, O. Diéguez and I. Goldfarb, "Interface Effects on Epilayer Surface Density of States by Scanning Tunneling Spectroscopy and Density Functional Theory", Advanced Theory and Simulations, 1900140, 2019.
4. M. Asher and O. Diéguez, "A Computational Study of Gadolinium-Doped Ceria: Relationship between Atomic Arrangement and Electrostriction", Apl Materials, 7, 041109, 2019.
5. M. Dascalu, F. Cesura, G. Levi, O. Diéguez, A. Kohn and I. Goldfarb, "Controlling the Supermagnetic Response of Tetragonal α-FeSi2 Nanoislands", Applied Surface Science, 476, 189, 2019.
6. A. Auslender, M. Halabi, G. Levi, O. Diéguez and A. Kohn, "Measuring the Mean Inner Potential of Al2O3 Sapphire Using Off-Axis Electron Holography", Ultramicroscopy, 198, 18, 2019.

Prof. Ilan Goldfarb



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Research title:

Growth of epitaxial nanostructures, magnetic properties of nanostructure arrays, STM

Research Abstract

We explore new forms of magnetism on the nanoscale, born out of the size, shape and interactions between the nanometric islands in self-organized epitaxial arrays.

Publications

1. Matan Dascalu, Federico Cesura, George Levi, Oswaldo Diéguez, Amit Kohn and Ilan Goldfarb, "Controlling the supermagnetic response of tetragonal α-FeSi2 nanoislands", Applied Surface Science, 476, 2019, 189-197.
2. Matan Dascalu, Oswaldo Diéguez, Liwei D.Geng, Ranjit Pati, Yongmei M. Jin and Ilan Goldfarb, "Tomographic layer-by-layer analysis of epitaxial iron-silicide nanostructures by DFT-assisted STS", Applied Surface Science, 496, 2019, 143583.
3. Matan Dascalu, Rachel Levi, Federico Cesura, Oswaldo Diéguez and Ilan Goldfarb, "Interface effects on epilayer surface density of states by scanning tunneling spectroscopy and density functional theory", Advanced Theory and Simulations, 2, 12, 2019, 1900140.

Dr. Ariel Ismach

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Research title:

Growth of nanomaterials and structure-property correlations

Research Abstract

"The future looks flat…"

Growth mechanism studies

The formation of 2D materials at the single- and few-layer level is very challenging, and requires basic knowledge of the processes taking place during growth. Moreover, controlled formation of 2D materials on large scales is a prerequisite for their successful integration in new and existing technologies.

To address this important issue, we use Chemical Vapor Deposition (CVD) methodologies for growing Transition Metal Dichalcogenides (TMDs), mainly of the Mo and W families (MoX_2 and WX_2; X = S, Se and Te). Some basic questions we try to address: How does the surface influence growth? How does the precursor type (solid, liquid and gas – volatile or not, etc.) influence growth? What are the requirements for growing a single layer over large areas (surface-mediated growth, layer-by-layer, 3D islands growth, etc.)? Furthermore, we aim to grow more exotic layered materials, unachieved so far.

In-situ and ex-situ doping and alloying of 2D materials

The chemical composition of materials in general greatly affects their electronic and optical properties. Here we aim to control the chemical composition of layered materials during or after their formation. We use various techniques to characterize the doping and alloying processes: Raman Spectroscopy and mapping, Photoluminescence Spectroscopy, XPS, EDS, TOF-SIMS, etc.

Controlled formation of vertical and horizontal heterostructures

Heterostructures made of single- or few- atom-thick materials have attracted a wide interest in the scientific community, due to their potential in nanoelectronics and optoelectronics. Here we employ the lessons learned from the previous tasks to create novel vertical and horizontal heterostructures. This is followed by a full structural, chemical, electrical and optoelectrical characterization.

How do mechanical strains, temperature and the chemical environment affect intrinsic properties?

Commercial and home-made cells are used to address the above questions with regard to synthesized materials. These questions are crucial for the integration of such materials into different technologies, as well as for the development of new devices (such as sensors, electrical switches, etc.).

Publications

1. Keren M. Freedy, Maria Gabriela Sales, Peter M. Litwin, Sergiy Krylyuk, Pranab Mohapatra, Ariel Ismach, Albert V. Davydov and Stephen J. McDonnell, "MoS2 Cleaning by Acetone and UV-Ozone: Geological and Synthetic Material", Applied Surface science, 2019, 478, 183-188.
2. G. Radovsky, T. Shalev and A. Ismach, "Tuning the Morphology and Chemical Composition of MoS2", Nanostructures Journal of Materials Science, 2019, 54, 7768-7779.
3. A. Patsha, V. Sheff and A. Ismach, "Seeded-Growth of WS2 Atomic layers: The Effect on Chemical and Optical Properties", Nanoscale, 2019,11, 22493-22503.
4. Jonah Teich, Ravit Dvir, Alex Henning, Eliran Hemo, Michael J. Moody, Titel Jurca, Hagai Cohen, Tobin Marks, Brian Rosen, Lincoln Lauhon and Ariel Ismach, "Light and Complex 3D MoS2/graphene Heterostructures as an Efficient Catalyst for the Hydrogen Evolution Reaction", Nanoscale, 2020, 12, 2715-2725.
5. O. Luria, P. Mohapatra, A. Kribus and A. Ismach, "Large-Scale Characterization of Two-Dimensional Monolayer MoS2 Island Domains using Spectroscopic Ellipsometry and Reflectometry", Applied Surface Science, 2020, 524, 146418.
6. P. Mohapatra, L. Denzenshvilli, K. Ranganathan, L. Houben and A. Ismach, "Epitaxial Growth of In2Se3 on Monolayer MoS2 Single Crystals for High Performance Photodetectors", Applied Materials Today, 2020, 100734.
7. K Ranganathan, M Fiegenbaum-Raz, A Ismach
8. Large-Scale and Robust Multifunctional Vertically Aligned MoS2 Photo-Memristors, Advanced Functional Materials, 2020, 2005718.

Prof. Amit Kohn

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Research title:

Magnetic and electronic materials for information storage devices

Research Abstract

Prof. Kohn's research projects are in the field of magnetic and electronic materials used for information storage devices. The contribution of the research is to relate between structure and composition of these materials to the magneto-transport properties of the devices. The objective is therefore to improve on, or design new so-called 'spin-electronic' devices. Structural and chemical characterization is mostly achieved by analytical transmission electron microscopy, which probes the properties of the materials at the nanoscale and up to the atomic level. In addition, Amit applies and develops Lorentz electron microscopy and electron holography in order to map magnetic and electrostatic fields in materials and devices at the nanometer scale.

Publications

1. Matan Dascalu, Federico Cesura, George Levi, Oswaldo Diéguez, Amit Kohn and Ilan Goldfarb, "Controlling the supermagnetic response of tetragonal α-FeSi2 nanoislands", Applied Surface Science, 476, 2019, 189-197.
2. Adham Basha, Huarui Fu, George Levi, Gregory Leitus, Andras Kovács, Caiyin You and Amit Kohn, "Interface alloying of ultra-thin sputter-deposited Co2MnSi films as a source of perpendicular magnetic anisotropy", Journal of Magnetism and Magnetic Materials, 489, 2019, 165367.
3. Jingyan Zhang, Pengwei Dou, Wenlin Peng, Yuan Zhuang, Jialong Liu, Amit Kohn, Eran Amsellem, Caiyin You, Jiaqiang Liu, Xinqi Zheng, Guanghua Yu, Yong Jiang and Shouguo Wang, "Multi-resistance state tuned by interfacial active Pt layer in a perpendicular Hall balance", Applied Surface Science, 521, 15, 2020, 146475.
4. Avi Auslender, Mahdi Halabi, George Levi, Oswaldo Diéguez and Amit Kohn, "Measuring the mean inner potential of Al2O3 sapphire using off-axis electron holography", Ultramicroscopy, 198, 2019, 18-25.

Prof. Shachar Richter

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Research title:

Molecular electronics of self-assembly layers

Research Abstract

In our group we adopt a bottoms-up approach to develop and explore various properties of nanomaterials, self-assembled monolayers and thin films. We start from the molecular level, and use molecular synthesis to form the desired basic structures which, in the next stage, are incorporated into our novel devices. Examples include doped proteins, chiral nanostructures and plasmonic materials.

Our compounds can be formed in self-assembly fashion (the self-assembled monolayers of doped proteins), as thin films (white-emitting coating for white LEDs) or as standalone materials (biodegradable plastics and hydrogels made from renewable materials).

In order to explore the properties of these materials we have developed new types of nano-devices, including nano-vertical transistors and circuits, solar cells and light emitting materials. We have also developed novel nanolithography techniques, some of which are currently undergoing commercialization processes.

Our group includes students, postdocs and engineers from various disciplines - including chemistry, physics, biology and engineering.

Publications

1. Roman Nudelman, Hashim Alhmoud, Bahman Delalat, Sharon Fleicher, Eran Fine, Tammila Guliakhmedova, Roey Elnathan, Abraham Nyska, Nicolas H. Voelcker, Michael Gozin and Shachar Richter, "Jellyfish-Based Smart Wound Dressing Devices Containing In Situ Synthesized Antibacterial Nanoparticles", Advanced Functional Materials, 29, 38, 1902783, (2019).
2. Liron Reshef Steinberger, Tamilla Gulakhmedova, Zahava Barkay, Michael Gozin and Shachar Richter, "Jellyfish-Based Plastic", Advanced Sustainable Systems, 3, 7, 1900016, (2019).
3. Einat Hauzer, Rotem Sapir, Yuri Flitsanov, Abraham Kribus, Ariel Ismach and Shachar Richter. Thermally Stable, Three-Dimensional Membrane Composed of Graphene-Nanoparticle-Biocomposite for Photothermal Applications. Submitted (2020)
4. Itai Carmelil, Celine M. Bounioux, Mark B. Richardson, Yael Templeman, Joel M.P. Scofield, Greg G. Qiao, Brian Ashley Rosen, Lenna Yusupov, Louisa Meshi, Nicolas H. Voelcker, Oswaldo Diéguez , Hagai Cohen and Shachar E. Richter. Chiral Self-Motion of Metal-Organic Motors at the Water-Air Interface. Submitted (2020).
5. Edith Beilis, Daniel Beitner and Shachar Richter. The Effect of a Top-Contact Electrode on the Quality of Molecular Junction Measured by Polarization Modulation Infra-Red Reflectance Absorption Spectroscopy. Submitted (2020).
6. Roman Nudelman, Hashim Alhmoud, Bahman Delalat, Ishdeep Kaur, Laure Bourgeois, Roey Elnathan, Nicolas H. Voelcker*, Shachar Richter*, Anna Cifuentes-Rius. Programing the Size, Shape, and Aggregation of Metal Nanoparticles Using Bio-Templated Synthesis. Submitted (2020).

Dr. Brian Rosen

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Research title:

Energy materials laboratory

Research Abstract

Dr. Brian Rosen is a faculty member in the Department of Materials Science and Engineering and founder of the department's Energy Materials Laboratory. The laboratory focuses on improving the activity and durability of catalytic materials for energy storage and conversion applications through tuning crystallography, defect-structure, and leveraging phase separation processes. To this end, the Rosen lab has built electrochemical and high-temperature reactor systems, gas adsorption manifolds, fuel cell testing stations, and in-situ electrochemical and high temperature cells for use in X-ray diffraction studies. Additionally, the Rosen lab routinely runs in-situ synchrotron and TEM experiments.

Publications

1. Nissim Navi, Jonathan Tenenbaum, Eyal Sabatani, Giora Kimmel, Roey Ben David, Brian A. Rosen, Zahava Barkay, Vladimir Ezersky, Eitan Tiferet, Yaron I. Ganor, and Noam Eliaz, "Hydrogen effects on electrochemically charged additive manufactured by electron beam melting (EBM) and wrought Ti-6Al-4V alloys", International Journal of Hydrogen Energy, 2020, 45, 25523-25540.
2. Brian A. Rosen, "Progress and opportunities for exsolution in electrochemistry", Electrochem, 2020, 1, 32-43.
3. Jonah Teich, Ravit Dvir, Alex Henning, Eliran R. Hamo, Michael J. Moody, Titel Jurca, Hagai Cohen, Tobin J. Marks, Brian A. Rosen, Lincoln J. Lauhon and Ariel Ismach, "Light and complex 3D MoS2/graphene heterostructures as efficient catalysts for the hydrogen evolution reaction", Nanoscale, 2020, 12, 2715-2725.
4. Reut Bornovski, Liang-Feng Huang, Eswaravara Prasadarao Komarala, James M. Rondinelli and Brian A. Rosen, "Catalytic enhancement of CO oxidation on LaFeO3 regulated by ruddlesden–popper stacking faults", ACS Appl. Mater. Interfaces,2019, 11, 37, 33850–33858.
5. Moran Dahan, Eswaravara Komarala, Ludmila Fadeev, Ajay K. Chinnam, Avital Shlomovich, Sophia Lipstman , Siva P. Padi, Herman Haustein, Michael Gozin and Brian A. Rosen, "Methane dry reforming catalyst prepared by the co-deflagration of high-nitrogen energetic complexes, J. Mater. Chem. A, 2019, 7, 141-149.
6. Siva P.Padia, Lee Shelly, Eswaravara P. Komarala, Danielle Schweke, Shmuel Hayun and Brian A. Rosen, "Coke-free methane dry reforming over nano-sized NiO-CeO2 solid solution after exsolution", Catalysis Communications, 138, 2020, 105951.
7. Eswaravara Prasadarao Komarala, Ilia Komissarov and Brian A. Rosen, "Effect of Fe and Mn substitution in LaNiO3 on exsolution, activity, and stability for methane dry reforming", Catalysts 2020, 10(1), 27.
8. Roberto Bergamaschini, Brian A. Rosen, Francesco Montalenti and Jérôme Colin, "Motion of crystalline inclusions by interface diffusion in the proximity of free surfaces", Journal of Nanoparticle Research, 21, 271, 2019.
9. Eliran Hamo, Avichay Raviv and Brian A. Rosen, "Influence of nanocrystalline palladium morphology on alkaline oxygen reduction kinetics", Catalysts, 9(7), 2019, 566.
10. Eliran Hamo, Polina Tereshchuk, Melina Zysler, David Zitoun, Amir Natan and Brian A. Rosen, "Corrosion resistance and acidic ORR activity of Pt-based catalysts supported on nanocrystalline alloys of molybdenum and tantalum carbide", Journal of The Electrochemical Society, 166, 2019, 16.

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Research title:

Biomechanics and tissue engineering

Research Abstract

The Lesman lab research is at the interface of mechanics and biology (**http://www.lesmanlab.com/**). We strive to understand the effect of mechanical cues (e.g., forces, stiffness) on biological processes at the cell and tissue level with applications in tissue engineering and regenerative medicine. Within this scope, several directions are currently in focus, including mechanical communication between cells through fibrous extracellular environments, and the effect of external force and force gradients on complex tissue formation. The group uses computer finite element simulations and biological experiments using advanced imaging (confocal microscopy+Airy Scan unit), and mechanical tools (stretching devices, rheometer, nanoindentation). The group has vast expertise with 3D hydrogels for cell culture and bioengineering techniques to control and manipulate cells.

Publications

1. A. Kolel, A. Roitblat Riba, S. Natan, O. Tchaicheeyan, E. Saias, A. Lesman. "Controlled Strain of 3D Hydrogels under Live Microscopy Imaging. Journal of Visual Experiments", Accepted for publication, September 2020.
2. Oren Shabi, Sari Natan, Avraham Kolel, Abhishek Mukherjee, Oren Tchaicheeyan, Haguy Wolfenson, Nahum Kiryati, Ayelet Lesman. "Motion Magnification Analysis of Microscopy Videos of Biological Cells", Plos One, Accepted for publication, Sep 2020.
3. David Gomez, Eial Teomy, Ayelet Lesman, Yair Shokef. "Target Finding in Fibrous Biological Environments", New J. Phys. Sep 2020, in press. https://doi.org/10.1088/1367-2630/abb64b
4. Ortal Shelah, Shir Wertheimer, Rami Haj-Ali and Ayelet Lesman, "Coral-Derived Collagen Fibers for Engineering Aligned Tissues", Tissue Eng Part A., 2020.
5. Sari Natan, Yoni Koren, Ortal Shelah, Shahar Goren and Ayelet Lesman, "Long-Range Mechanical Coupling of Cells in 3D Fibrin Gels", Mol Biol Cell. 2020;31(14):1474-1485. This article appears on the cover
6. Shahar Goren, Yoni Koren, Xinpeng Xu and Ayelet Lesman, "Elastic Anisotropy Governs the Range of Cell-Induced Displacements", Biophysical Journal. March 2020.
7. Avishy Roitblat Riba, Sari Natan, Avraham Kolel, Hila Rushkin, Oren Tchaicheey and Ayelet Lesman, "Straining 3D Hydrogels with Uniform Z-Axis Strains While Enabling Live Microscopy Imaging", Annals of Biomedical Engineering, Volume 48, pages 868–880, Dec 2019.
8. David Gomez, Sari Natan, Yair Shokef and Ayelet Lesman, "Mechanical Interaction between Cells Facilitates Molecular Transport", Advanced Biosystems, Nov 2019, 3(12).

Prof. Touvia Miloh

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Research title:

Nanomechanics; Fluid dynamics in nanochannels; Elastic nanofibers (theory)

Research Abstract

Prof. Touvia Miloh's current research interest is studying symmetry breaking effects of dipolophoresis (combination of dielectrophoresis and induced- charge electrophoresis) on metallo-dielectric Janus nanoparticles (spherical & ellipsoidal), as well as Joule-heating thermophoresis (light induced) of conducting nano/micro particles.

Publications

1. Touvia Miloh, "Thermoosmosis about conducting ellipsoidal nanoparticles", Light-induced. Proc. R. Soc. A, 475, 2019, 20180040.
2. Jacob Nagler and Touvia Miloh, "Electro-rheological effects of polarizable nano spherical particles", Physica Scripta, 95, 2020, 5.
3. Touvia Miloh, "AC Electrokinetics of Polarizable Tri-Axial Ellipsoidal Nano-Antennas and Quantum Dot Manipulation", Micromachines, 10(2), 2019, 83.
4. Touvia Miloh and Jacob Nagler, "Electrorotation of leaky-dielectric and conducting microspheres in asymmetric electrolytes and angular velocity reversal", Electrophoresis, 41, 15, 2020, 1296-1307.

Prof. Slava Krylov

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Research title:

Micro- and nano-electromechanical systems (MEMS/NEMS); micro and nano-sensors and actuators

Research Abstract

Prof. Slava Krylov's research in the area of design and modeling of micro- and nanoelectromechanical systems (MEMS/NEMS) combines theoretical and applied aspects. The overall scope of the work encompasses the development of new approaches to actuation and sensing, and their implementation in micro and nano devices such as: electrostatically, magnetically and thermally actuated, parametrically excited resonators, inertial, mass, bio and chemical sensors, flow sensors, tilting mirrors, bistable and multistable devices and polymeric MEMS.

Publications

1. Marine Veits, Itzhak Khait, Uri Obolski, Eyal Zinger, Arjan Boonman, Aya Goldshtein, Kfir Saban, Rya Seltzer, Udi Ben-Dor, Paz Estlein, Areej Kabat, Dor Peretz, Ittai Ratzersdorfer, Slava Krylov, Daniel Chamovitz, Yuval Sapir, Yossi Yovel and Lilach Hadan, "Flowers respond to pollinator sound within minutes by increasing nectar sugar concentration", Ecology Letters, 22, 9, 2019, 1483-1492.
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3. Ben Torteman, Yoav Kessler, Alexander Liberzon and Slava Krylov, "Micro-beam resonator parametrically excited by electro-thermal Joule's heating and its use as a flow sensor", Nonlinear Dynamics, 98, 2019, 3051–3065.
4. Ben Torteman, Yoav Kessler, Alexander Liberzon and Slava Krylov, "Electro-thermal excitation of parametric resonances in double-clamped micro beams", Applied Physics Letters 115 (19), 2019, 194102.
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7. Lior Medina, Rivka Gilat and Slava Krylov, "Enhanced efficiency of electrostatically actuated bistable micro switches using bow-like operation", IEEE/ASME Transactions on Mechatronics, 1083, 2019, 4435.
8. Omer HaLevy, Naftaly Krakover and Slava Krylov, "Feasibility study of a resonant accelerometer with bistable electrostatically actuated cantilever as a sensing element", International Journal of Non-Linear Mechanics, 118, 2020, 103255.
9. Rivka Gilat and Slava Krylov, "Array of nanostrings electromagnetically interacting through repelling Lorentz forces", International Journal of Non-Linear Mechanics, 119, 2020, 103320.

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12. Peleg Levin, Eli Ashkenazy, Ariel Raz, Miriam Hershcovitz, Siebe Bouwstra, David Mendlovic and Slava Krylov, "Wafer Level Packaged Fully Integrated Tunable Fabry-Pérot Filter with Extended Optical Range for Multispectral and Hyperspectral Imaging", Journal of Microelectromechanical Systems 29 (3), 2020, 357-369.
13. Asaf Asher, Erez Benjamin, Lior Medina, Rivka Gilat, Slava Krylov, "Bistable Micro Caps Fabricated by Sheet Metal Forming", Journal of Micromechanics and Microengineering 30 (6), 2020, 065002.
14. Yoav Kessler, Alexander Liberzon and Slava Krylov, "Flow Velocity Gradient Sensing Using a Single Curved Bistable Microbeam", Journal of Microelectromechanical Systems, 2020, In Press.

Prof. Hadas Mamane

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Research title:

Reactive species for water treatment and biofuels

Research Abstract

Prof. Mamane's research focuses on development of novel technologies for treatment of contaminated water and wastewater and for generating renewable energy and nano-cellulose from waste, by integrating natural and induced photons, radicals, oxidants, nanoparticles and nanomaterials as a treatment technology. She is also involved in developing sustainable tools and point-of-use (POU) technologies for providing safe drinking water in rural communities, and she was appointed as a visiting faculty at IIT Madras, India. Her current nano-related activities include (a) development of novel materials as aerogels, metal organic framework (MOFs), and light enhanced photocatalysts using light emitting diodes and solar irradiation, and (b) electrophoretic deposition coating processes on metal foams for purifying water.

Publications

1. Horovitz, I*, Gitis, V., Avisar, D. and Mamane, H. (2019). Ceramic-based photocatalytic membrane reactors for water treatment–where to next?. Reviews in Chemical Engineering. https://doi.org/10.1515/revce-2018-0036
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4. Rosen, Y*, Mamane, H., and Gerchman, Y. (2019). Short ozonation of lignocellulosic waste as energetically favorable pretreatment. BioEnergy Research, 1-10.
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E., Cohen-Yaniv, V. and Mamane, H., 2020. LP-UV-Nano MgO2 pretreated catalysis followed by small bioreactor platform capsules Treatment for Superior Kinetic Degradation Performance of 17α-Ethynylestradiol. Materials, 13(1), 83.

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18. Akao, P.K., Mamane, H., Kaplan, A., Gozlan, I., Yehoshua, Y., Kinel-Tahan, Y. and Avisar, D., 2020. Lohexol removal and degradation-product formation via biodegradation by the microalga chlorella vulgaris. Algal Research, 51, 102050.
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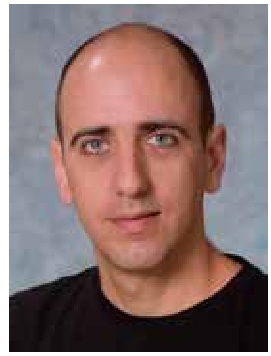
Prof. Yair Shokef



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Research title:

Nonequilibrium statistical mechanics of soft matter

Research Abstract

Our current research efforts focus on two main issues: jammed matter and active matter. The first involves using lattice-based models to study disordered soft materials, such as powders, foams, colloids, and glasses - the dynamics of which are all extremely slow and cooperative. Some of these models jam and remain disordered, due to geometric frustration - namely the inability of a system to simultaneously satisfy all of its local constraints, thus making it difficult for it to reach a global optimum which minimizes the relevant free energy. Other models, studied both analytically and numerically, display kinetically constrained dynamics. Here the geometry is implemented effectively by directly defining which dynamical moves are allowed, and which are forbidden - in ways that may generate jamming similar to that found in more complicated models.

Our second line of research involves the study of fluctuations generated in biological systems due to the presence of molecular motors within them. These motors consume chemical energy and generate mechanical forces that drive the system out of thermodynamic equilibrium. Moreover, biological materials have a very nonlinear mechanical response, and therefore the macroscopic mechanical properties of biological systems are very different from those of passive materials. Our activity along this avenue includes the use of stochastic models for the dynamics, in conjunction with geometrical descriptions of the nonlinear, finite-deformation elasticity of biological materials.

Publications

1. D. Gomez, E. Teomy, A. Lesman, and Y. Shokef, "Target finding in fibrous biological environments", New Journal of Physics, in press, 2020
2. E. C. Oğuz, A. Ortiz-Ambriz, H. Shem-Tov, E. Babià-Soler, P. Tierno, and Y. Shokef, "Topology restricts quasidegeneracy in sheared square colloidal ice", Physical Review Letters 124, 238003, 2020.
3. C. Merrigan, K. Ramola, R. Chatterjee, N. Segall, Y. Shokef, and B. Chakraborty, "Arrested states in persistent active matter: gelation without attraction", Physical Review Research 2, 013260, 2020.
4. A. S. Meeussen, E. C. Oğuz, M. van Hecke and Y. Shokef, "Response evolution of mechanical metamaterials under architectural transformations", New Journal of Physics 22, 023030, 2020.
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7. D. Gomez, S. Natan, Y. Shokef and A. Lesman, "Mechanical interaction between cells facilitates molecular transport", Advanced Biosystems 3, 1900192, 2019.
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10. R. Golkov and Y. Shokef, "Elastic interactions between anisotropically contracting circular cells", Physical Review E 99, 032418, 2019.

Dr. Ines Zucker

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Research title:

Nanomaterials for water treatment, nontoxicity and advanced oxidation

Research Abstract

Dr. Zucker's research activities are centered on environmental materials and processes. Environmental nanotechnology is a developing research topic, where applications and implications of nanomaterials on the environment are assessed. Dr. Zucker works on the development of selective, efficient, and applicable nanomaterials that can enhance or replace traditional technologies for water decontamination. For example, they develop multifunctional nanocomposite capable of removing organic and inorganic contaminants from water. Additionally, the Zucker lab focuses on quantification of the risk of nanomaterials (both engineered and incidental) on the environment through the development of a nanotoxicity screening tool. Specifically, they study the effect of cell-membrane composition on potential interactions with nanomaterials. Transformation and toxicity phenomena of micro- and nanoplastics (i.e., incidental nanomaterials) in the aquatic environment are also part of the ZuckerLab activities.

Publications

1. E. Shaulsky, V. Karanikola, A.P. Straub, A. Deshmukh, I. Zucker, and M. Elimelech, Asymmetric membranes for membrane distillation and thermo-osmotic energy conversion, Desalination 452, 141–148 (2019).
2. I. Zucker, N. Dizge, C.L. Fausey, E. Shaulsky, M. Sun, M. Elimelech, Electrospun silica nanofiber mats functionalized with ceria nanoparticles for water decontamination, RSC Advances 9, 19408–19417 (2019).
3. C.L. Fausey, I. Zucker, E. Shaulsky, J.B. Zimmerman, M. Elimelech, Removal of arsenic with reduced graphene oxide-TiO2-enabled nanofibrous mats, Chemical Engineering Journal 375, 122040 (2019).
4. I. Zucker, S.M. Hashmi, J. Yang, Y. He, L.D. Pfefferle, M. Elimelech, Shape-dependent interactions of manganese oxide nanomaterials with lipid bilayer vesicles, langmuir 35, 13958–13966 (2019).
5. Y. Lester, E. Shaulsky, R. Epsztein, I. Zucker, Capacitive deionization for simultaneous removal of salt and uncharged organic contaminants from water, Separation and Purification Technology 237, 116388 (2020).
6. C.L. Fausey, I. Zucker, D.E. Lee, E. Shaulsky, J.B. Zimmerman, M. Elimelech, Tunable molybdenum disulfide-enabled fiber mats for high-efficiency removal of mercury from water, ACS Applied Materials and Interfaces 12, 18446–18456 (2020).
7. K.J.G. Pollitt, J.H. Kim, J. Peccia, M. Elimelech, Y. Zhang, G. Charkoftaki, B. Hodges, I. Zucker, H. Huang, N.C. Deizel, K. Murphy, M. Ishii, C.H. Johnson, A. Boissevain, E. O'Keefe, P. Anastas, D. Orlicky, D.C. Thompson, Vasilis Vasiliou, 1,4-Dioxane as an emerging water contaminant – State of the science and evaluation of research needs, Science of The Total Environment 690, 853-866 (2019).
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Research title:

Laboratory of bioinspired materials and nanotechnology

Research Abstract

The Bioinspired Materials Laboratory is a material science lab, focusing on mimicking self-assembly processes that occur in nature. The group develop new organic materials for various applications, such as 3D-printed personalized hydrogels for bone tissue regeneration, exhibiting extraordinary mechanical properties and durability, along with biocompatibility and controlled drug release. A central technique is the formation of hybrid hydrogels, using two or more different building blocks, resulting in a 3D hydrogel with novel and diverse properties that can be easily fine-tuned. In addition, the laboratory is interested in antimicrobial activity of nanostructures for surface coatings, and incorporation into composite materials for medical applications.

Publications

1. Moumita Ghosh, Santu Bera, Sarah Schiffmann, Linda J.W. Shimon, and Lihi Adler-Abramovich, "Collagen-Inspired Helical Peptide Co-Assembly Forms a Rigid Hydrogel with Twisted Polyproline II Architecture", ACS Nano, 2020, 14, 8, 9990–10000.
2. Dana Cohen-Gerassi, Zohar A. Arnon, Tom Guterman, Aviad Levin, Moumita Ghosh, Moran Aviv, Davide Levy, Tuomas P.J. Knowles, Yosi Shacham-Diamand, and Lihi Adler-Abramovich, "Phase Transition and Crystallization Kinetics of a Supramolecular System in a Microfluidic Platform", Chem. Mater., 2020.
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4. Ali Nadernezhad, Leonard Forster, Francesca Netti, Lihi Adler-Abramovich, Jörg Teßmar, and Jürgen Groll, "Rheological Analysis of the Interplay Between the Molecular Weight and Concentration of Hyaluronic Acid in Formulations of Supramolecular HA/FmocFF hybrid hydrogels", Polym J. ,2020.
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6. Lialy Khadeja, Irena Grigoriants, Michal Halperin-Sternfeld, Aviv Yona and Lihi Adler-Abramovich, "Sonochemical Functionalization of Cotton and Non-Woven Fabrics with Bio-Inspired Self-Assembled Nanostructures", Isr. J. Chem. 2019, 59, 1-8.
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8. Moumita Ghosh, Michal Halperin-Sternfeld, Itzhak Grinberg and Lihi Adler-Abramovich, "Injectable Alginate-Peptide Composite Hydrogel as a Scaffold for Bone Tissue Regeneration", Nanomaterials, 2019, 9(4), 497.
9. Priyadarshi Chakraborty , Tom Guterman, Nofar Adadi, Moran Yadid, Tamar Brosh, Lihi Adler-Abramovich, Tal Dvir and Ehud Gazit, "A Self-Healing, All-Organic, Conducting, Composite Peptide Hydrogel as Pressure Sensor and Electrogenic Cell Soft Substrate", ACS Nano. 2019.
10. Carlo Diaferia, Moumita Ghosh, Teresa Sibillano, Enrico Gallo, Mariano Stornaiuolo, Cinzia Giannini, Giancarlo Morelli, Lihi Adler-Abramovich and Antonella Accardo, "Fmoc-FF and Hexapeptides-Based Multicomponent Hydrogels as Scaffold Materials", Soft Matter, 2019, 15, 487-496.
11. Priyadarshi Chakraborty, Moumita Ghosh, Lee Schnaider, Nofar Adadi, Wei Ji, Darya Bychenko, Tal Dvir, Lihi Adler-Abramovich and Ehud Gazit, "Composite of Peptide-Supramolecular Polymer and Covalent Polymer Comprises a New Multifunctional, Bio-Inspired Soft Material", Macromol. Rapid Commun., 40, 18, 2019, 1900175.

Prof. Karen Avraham

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Research title:
Genomics and therapeutics of hereditary hearing loss

Research Abstract
A major goal in auditory science is to understand how the cells of the inner ear develop to provide the exquisite precision of hearing. The inner ear collects sounds and transforms mechanical forces into electrical signals. At a molecular level, the interactions of DNA, RNA and proteins of the auditory system orchestrate a remarkable feat that is summarized in our ability to hear. Our group is asking the questions: (1) What are the genes that lead to hearing loss and how are they involved in normal function of the inner ear? (2) How does regulation of gene expression govern the pathways that determine inner ear function, and how do alterations in regulation, on a genetic and epigenetic level, contribute to the pathology of deafness?

Publications
1. Cohen R, Amir-Zilberstein L, Hersch M, Woland S, Taiber S, Matsuzaki F, Bergmann S, Avraham KB, Sprinzak D. (2020) Shear forces drive precise patterning of hair cells in the mammalian inner ear. Nat Comm, in press.
2. Krohs C, Bordeynik-Cohen M, Messika-Gold N, Elkon R, Avraham KB, Nothwang HG. (2020) Expression pattern of cochlear microRNAs in the mammalian auditory hindbrain. Cell Tissue Res, in press.
3. Danial-Farran N, Chervinsky E, Nadar Ponniah PT, Cohen Barak E, Taiber S, Khayat M, Avraham KB, Shalev SA. (2020) Homozygote loss-of-function variants in the human COCH gene underlie hearing loss. Eur J Hum Genet, online ahead of print. PMID: 32939038
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7. Dror AA, Taiber S, Sela E, Handzel O, Avraham KB. (2020) A mouse model for benign paroxysmal positional vertigo (BPPV) with genetic predisposition for displaced otoconia. Genes Brain Behav. 2:e12635. PMID: 31898392
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Research title:

Molecular mechanisms regulating the protein kinase GSK-3 and their implications in human diseases

Research Abstract

Abnormal activity of GSK-3 is a causative factor behind a broad spectrum of neurodegenerative disorders. Inhibition of GSK-3 is a promising therapeutic approach in treating these disorders. In this project, we developed selective GSK-3 inhibitors that in contrast to most GSK-3 inhibitors that function as ATP competitive inhibitors, are substrate competitive inhibitors (*SCIs*). We designed a pharmacophore model and virtually screened molecules databases. Three potential hits were identified, and accordingly, new molecules were designed and synthesized. The new SCIs showed IC_{50} values of ~1 microM and showed 'good' pharmacological properties, including plasma stability, metabolic microsomal degradation and low inhibition of CYP proteins. Our future studies will test the therapeutic activity of the new GSK-3 SCIs in Huntington's diseases models.

Publications

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Research title:

Structural perspective of ion channels and prenyltransferases modulation

Research Abstract

Enzymes are biological catalysts crucial for all cellular functions in every biological system. Most enzymes are proteins, and their ability to specifically accelerate chemical reactions by orders of magnitude relies on their structure, dynamics and allosteric regulation. Our lab utilizes cutting-edge molecular methods to delineate the structural basis underlying the activity and regulatory mechanisms of two types of enzymes: ion channels, catalyzing the movement of ions across cell membranes, and prenyltransferases, synthesizing moieties for post-translational protein modifications. More importantly, by studying the impact of disease-causing mutations on the function of both types of these essential enzymes, we elucidate the molecular basis of their activity and pave the roads towards future rational design on novel therapeutic options.

Publications

1. Michal Lisnyansky Bar-El, Su Youn Lee, Ah Young Ki, Noa Kapelushnik, Anat Loewenstein, Ka Young Chung, Dina Schneidman-Duhovny, Moshe Giladi, Hadas Newman and Yoni Haitin, "Structural Characterization of Full-Length Human Dehydrodolichyl Diphosphate Synthase Using an Integrative Computational and Experimental Approach", Biomolecules, 2019, 9, 11, 660.
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Research title:

HK022 bacteriophage site-specific recombinase integrase as a tool for human genome manipulation and gene therapy

Research Abstract

All approaches developed so far for human genetic diseases (HGD) treatment are not sufficiently effective due to low gene correction efficiency and substantial immune responses to the gene delivery vehicles and gene-editing systems. Thus, there remains an essential unmet need and challenge to develop efficient technology for HGD therapy.
We have developed new efficient and safety technology for HGD therapy. It is based on bacteriophage HK022 site-specific recombinase Integrase (Int) catalyzed recombinase mediated cassette exchange reaction (RMCE) for DNA correction in any region of human genome. This technology allows replacing a specific human genomic harmful sequence (containing a deleterious mutation, for example) flanked by two Int "*attB*"s with a normal sequence leading to a clean correction.

Publications

1. Weronika Karawacka, Christina Janko, HaraldUnterweger, Marina Mühlberger, Stefan Lyera, Nicola Taccardi, Andriy Mokhir, Wolfgang Jira, Wolfgang Peukert, Aldo R. Boccaccini, Mikhail Kolot, Richard Strauss, Christian Bogdan, Christoph Alexiou and Rainer Tietzea, "SPIONs functionalized with small peptides for binding of lipopolysaccharide, a pathophysiologically relevant microbial product", Colloids and Surfaces B: Biointerfaces, 174, 2019, 95-102.

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Research title:

Systems neuroscience

Research Abstract

G protein coupled receptors (GPCRs) are broadly expressed in the brain. They mediate responses to many biologically active molecules and play an important role in diverse functions. As a consequence, they are crucial for normal brain function, play a paramount role in therapeutic intervention, and are targeted by ~40% of all presently marketed drugs.

Recently, it was demonstrated that the activity of many GPCRs is regulated by membrane potential. For example, the activity of cholinergic M2 muscarinic receptors and metabotropic glutamate receptors mGluR3 is reduced by depolarization, whereas that of M1 and mGluR1a is increased. However, a crucial question remains unanswered: what are the physiological roles of GPCR voltage dependence, its effects on neural activity, and relevance to behavior?

Publications

1. Hadas Lerner, Eyal Rozenfeld, Bar Rozenman, Wolf Huetteroth and Moshe Parnas, "Differential Role for a Defined Lateral Horn Neuron Subset in Naïve Odor Valence in Drosophila", Scientific Reports, 10, 2020, 6147.
2. Eyal Rozenfeld, Hadas Lerner and Moshe Parnas, "Muscarinic Modulation of Antennal Lobe GABAergic Local Neurons Shapes Odor Coding and Behavior", Cell Reports, 29, 10, 2019, 3253-3265.
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Research title:

Nanomotors and microfluidic platforms reveal neurodegeneration mechanisms

Research Abstract

The Lab's research is focused on understanding molecular mechanisms of neuro-degeneration and regeneration using advanced single molecule microscopy and novel NMJ-on-a-Chip platform that mimic the human motor unit. This novel Lab-on-a-Chip platform enable to grow patients' neurons and muscles on silicon chips, thus opening new possibilities for experimental studies of neuron degeneration and regeneration process, and to provide a strong tool for personalized medicine.

We are using:

- **Microfluidic devices:** In-house design and fabrication of compartmentalized microfluidic chambers for deciphering spatiotemporal process.
- **Live imaging:** High resolution live-cell imaging of axonal transport, NMJ activity, and protein synthesis.
- **iPSC-derived muscle and motor neurons:** Patient-derived motor neurons for investigating disease mechanisms in familial and sporadic ALS.

Publications

1. Altman T, Geller D, Kleeblatt E, Gradus-Pery T, Perlson E., "In Vitro Compartmental System Underlines the Contribution of Mitochondrial Immobility to the ATP Supply in the NMJ.", J Cell Sci., 2019.
2. Chein M, Perlson E, Roichman Y., "Flow Arrest in the Plasma Membrane", Biophys J., 2019, 3, 117(5), 810-816.
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Research title:

Laboratory for cancer research and nanomedicine

Research Abstract

Tumor progression is dependent on a number of sequential steps. At the earliest stages, these involve initial tumor-vascular interactions and recruitment of blood vessels, as well as the establishment of the tumor cells' interactions with their surrounding microenvironment and its various immune, endothelial and connective cellular and extra-cellular components. Failure of a microscopic tumor, either primary, recurrent or metastatic, to complete one or more of these early stages, may delay the cancer's clinical manifestation. In fact, understanding these early processes may help us interrupt the cancer's progression, thereby preventing its occurrence, and particularly its recurrence and metastasis.
With relapse – arising from micrometastasis, dormant tumors or minimal residual disease - responsible for the majority of cancer deaths, the understanding of cancer dormancy and the stages of its awakening is most critical for early detection and treatment. And yet, surprisingly, this is one of the most neglected areas in cancer research, and its biological mechanisms are mostly unknown.
To tackle this challenge, we created several models of patient-derived cancer models, mimicking 3 pairs of malignancies: dormant *versus* fast-growing, primary *versus* metastatic and drug-sensitive *versus* drug-resistant. This was accomplished with cutting-edge techniques of patient-derived xenografts, 3D bio-printing and genetically-modified mouse models. The 3 models were then used to investigate the molecular changes in tumor-host interactions that govern the escape from dormancy, and contribute to tumor progression. Ultimately, our study led to the discovery of novel drug targets, and provided important tools for the design of novel nano-sized cancer theranostics (therapeutics and diagnostics). Our libraries of precision nanomedicines are synthesized as highly controlled micellar, nanogels, coiled or globular particulated supramolecular structures, consisting of linear, hyperbranched or dendritic polymers, based on polyglutamic acid (PGA), polyethyleneglycol (PEG), poly(N-(2-hydroxypropyl)methacrylamide) (HPMA) copolymer, polyglycerol, poly-lactic acid (PLA), poly(lactic-coglycolic acid) (PLGA) and hybrid systems.
Our vision is that our multidisciplinary approach will revolutionize our perception of tumor progression and consequently the way we diagnose and treat cancer.

Publications

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13. Alessio Malfanti, Anna Scomparin, SabinaPozzi, HadasGibori, Adva Krivitsky, Rachel Blau, Ronit Satchi-Fainaro, Francesca Mastrotto, Paolo Caliceti and Stefano Salmaso, "Oligo-Guanidyl Targeted Bioconjugates Forming Rod Shaped Polyplexes as a New Nanoplatform for Oligonucleotide Delivery", Journal of Controlled Release, 310, 2019 58-73.
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15. Nir Hananya, Ofir Press, Alakesh Das, Anna Scomparin, Ronit Satchi-Fainaro, Irit Sagi and Doron Shabat "Persistent Chemiluminescent Glow of Phenoxy-dioxetane Luminophore Enables Unique CRET-Based Detection of Proteases", Chem. Eur. J., 2019, 25, 14679–14687.
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Research title:

Nano scale functional genomics and proteomics analyses of mast cell activation

Research Abstract

Our primary interest is the molecular basis of allergic and mast cell-related diseases, including pseudo-allergies induced by drugs and the role of mast cells in the tumor microenvironment and during neurogenic inflammation. Specifically, we explore the mechanisms underlying release of allergic (i.e. histamine) and inflammatory (i.e. cytokine) mediators from activated mast cells under allergic and inflammatory settings.

Our research focuses on deciphering the signaling networks that link mast cell activation with mediator release, and characterization of genes that could serve as cellular targets for the future development of anti-allergic drugs. To this end, we combine functional genomics and phenotype-driven screens of mast cells, activated by multiple stimuli, in order to recapitulate human pathophysiological conditions. Research methods used include: confocal microscopy in live and fixed cells; gene cloning; quantitative RT-PCR; pull-down-assays; mass spectrometry; and bioinformatics.

Current projects in the lab include:

- Exploring the functional impact of the size and position of the mast cell secretory granules in health and diseases such as mastocytosis.
- Exploring the complex relationships between mast cells and cancer- the good, the bad and the ugly.
- Decoding the Rab networks that control mast cell functions during pseudo-allergies and neurogenic inflammation.

Publications

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2. Ofir Klein and Ronit Sagi-Eisenberg, "Anaphylactic Degranulation of Mast Cells: Focus on Compound Exocytosis", Journal of Immunology Research, 2019, 9542656.
3. Yaara Gorzalczany and Ronit Sagi-Eisenberg, "Role of Mast Cell-Derived Adenosine in Cancer", Int. J. Mol. Sci., 2019, 20(10), 2603.
4. Ofir Klein, Rebecca A. Krier-Burris, Pia Lazki-Hagenbach, Yaara Gorzalczany, Yang Mei, Peng Ji, Bruce S. Bochner and Ronit Sagi-Eisenberg, "Mammalian Diaphanous-Related Formin 1 (mDia1) Coordinates Mast Cell Migration and Secretion Through its Actin-Nucleating Activity", Journal of Allergy and Clinical Immunology, 144, 4, 2019, 1074-1090.
5. Lihie Eisenberg, Michal Eisenberg-Bord, Avital Eisenberg-Lerner and Ronit Sagi-Eisenberg, "Metabolic Alterations in the Tumor Microenvironment and Their Role in Oncogenesis", Cancer Letters, 484, 2020, 65-71.

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Research title:

MicroRNA, non-coding RNA, circulating DNA, deep sequencing, genomics, human diseases

Research Abstract

The Shomron research team focuses on the analysis of genomics, aimed at understanding human disease. Combining high-throughput methods and bioinformatics, our team explores DNA mutations and gene regulators, such as microRNAs, in order to reach a global systems perspective on the mechanistic roles these play during disease development.

Our projects include: Identifying DNA mutations and RNA molecules located at the intersection of several oncogenes; Controlling metastatic breast cancer via nanoparticles releasing microRNAs; Revealing the molecular effects on pharmacogenomics and personalized medicine; Exposing pathogens in human tissues based on Nanopore sequencing and deep learning.

Overall, the Shomron team pursues research that aims to deepen our understanding of the development of diseases in order to generate a significant impact through translating ideas into clinical reality.

Publications

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Research title:

Information processing: from nanoscale single synapses to memory functions

Research Abstract

The long-term goal of our study is to understand cellular, molecular and network-wide mechanisms underlying the transition from normal brain physiology to Alzheimer's disease (AD) pathology.
Utilizing an integrated system that combines FRET spectroscopy / 2photon-FLIM, high-resolution optical imaging, electrophysiology, molecular biology and biochemistry, we explore the causal relationships between ongoing neuronal activity, structural rearrangements within synaptic signaling complexes and plasticity of individual neurons and the entire neural networks. This integrated system has enabled us to identify new principles and novel molecular targets that critically influence synaptic and memory functions, initiating AD-associated synaptic dysfunctions. Specifically, we have identified hyperactivity of excitatory hippocampal synapses as a primary mechanism initiating synaptic dysfunctions, and have also found the mechanism underlying these synaptic changes.
We believe that the integrated system we have developed to measure structure-function relationships at the single synapse level may contribute to a better understanding of the initiation of AD-related neuronal and synaptic dysfunctions, ultimately leading to a new therapeutic approach by reversing hippocampal hyperactivity in Alzheimer's patients.

Publications

1. Styr B, Gonen N, Zarhin D, Ruggiero A, Atsmon R, Neta Gazit N, Braun G, Frere S, Vertkin I, Shapira I, Harel M, Heim L, Katsenelson M, Rechnitz O, Fadila S, Derdikman D, Rubinstein M, Geige T, Ruppin E and Slutsky I, "Mitochondrial Regulation of the Hippocampal Firing Rate Set Point and Seizure Susceptibility", Neuron, 102, 5, 2019, 1009-1024.
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4. Jonathan Lezmy, Hana Gelman, Maxim Katsenelson, Boaz Styr, Eliav Tikochinsky, Maya Lipinsky, Asher Peretz, Inna Slutsky and Bernard Attali, "M-Current Inhibition in Hippocampal Excitatory Neurons Triggers Intrinsic and Synaptic Homeostatic Responses at Different Temporal Scales", Journal of Neuroscience, 2020, 40 (19), 3694-3706.
5. Wolfgang Becker, Samuel Frere and Inna Slutsky, "Recording Ca++ Transients in Neurons by TCSPC FLIM", Advanced Optical Methods for Brain Imaging, 2019, 103-110.

Prof. David Andelman

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Research title:

Polymeric nanotemplates and nanostructures (theory)

Research Abstract

My group specializes in studying soft matter and biological systems in collaboration with several experimental teams worldwide. In particular, we explore the properties of self-assembling polymers, and ways to manipulate them at patterned surfaces and in thin film geometries, in relation with nano-lithography. In another line of research, we explore bio- and soft matter systems in which charges play an important role. We investigate ionic liquids at charge interfaces and membranes, and the response of ionic solutions and charged macromolecules to external electric fields.

Publications

1. Y. Avni, R. Podgornik and D. Andelman, "Behavior of Charge-Regulated Macro-ions Near a Critical Point", J. Chem. Phys. 153, 024901.1-11 (2020).
2. Y. Hosaka, S. Komura, and D. Andelman, "Shear Viscosity of Two-State Enzyme Solutions", Phys. Rev. E 101, 012610.1-11 (2020).
3. Y. Avni, R. M. Adar and D. Andelman, "Charge Oscillations in Ionic Liquids: A Microscopic Cluster Model", Phys. Rev. E (Rapid Communication) 101, 010601.1-6 (2020).
4. X. Xu, X.-K. Man, M. Doi, Z.C. Ou-Yang and D. Andelman, "Defect Removal by Solvent Vapor Annealing in Thin Films of Lamellar Diblock Copolymers", Marcomolecules 52, 9321-9333 (2019).
5. R. M. Adar, S. A. Safran, H. Diamant and D. Andelman, "Screening Length for Finite-size Ions in Concentrated Electrolytes", Phys. Rev. E 100, 042615.1-8 (2019).
6. Y. Zhu, K. Aissou, D. Andelman and X.-K. Man, "Orienting Cylinder-Forming Block Copolymer Thin Films: The Combined Effect of Substrate Corrugation and Its Surface Energy", Macromolecules 52, 1241-1248 (2019).
7. Y. Avni, D. Andelman and R. Podgornik, "Charge Regulation with Fixed and Mobile Charged Macromolecules", Curr. Opin. Electrochem. 13, 70-77 (2019).

Prof. Roy Beck-Barkai

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Research title:

Experimental biophysics

Research Abstract

In many significant biological functions, the four basic building blocks (proteins, lipids, sugars and nucleic acids) aggregate to form supramolecular structures and assemblies. The forces and interactions responsible for these assemblies are composed of a set of interactions with energy scales ranging from thermal fluctuations (a few KT) to specific covalent bonds (100's of KT). Relevant length scales in biological systems span many orders of magnitude, from the single amino acid through polypeptide chains, protein complexes and organelles, all the way up to cells and organs. These different length scales present enormous challenges, both experimentally and theoretically.

In order to properly study biological systems and the interactions within them, it is important to have complementary techniques covering different length and energy scales, in proximity to their natural environment. In our laboratory, we purify the subunit biological building blocks, using a variety of state-of-the-art biochemical and molecular techniques. We then reassemble them in precise conditions to extract the underlying physics pertaining to their supramolecular forces, dynamics and steady-state structures, particularly as they appear in healthy and diseased states.

We use small- and wide-angle x-ray scattering (SAXS & WAXS) techniques to cover length scales from 0.1-100 nm. These techniques are suitable for measuring weak scattering from biological systems in their natural environment. Detailed analysis and advanced computational techniques are regularly used to convert the reciprocal space to real-space structures, and enable studies on the nature of the interactions within the biological assemblies. SAXS, in particular, provides a ready means for determining inter-filament spacing and interactions. Recent advances in solid-state type x-ray detectors and high-flux microfocus x-ray sources allow investigation of dynamic structural events, as well as highly penetrated measurements. Conveniently, these approaches do not require staining or other modifications, and thus do not perturb our system, allowing easier access to the supramolecular forces underlying self-assembly, and simplifying data analysis.

Publications

1. B. Gutman, M. Mrejen, G. Shabat, R. Avinery, Y. Shkolnisky and R. Beck, "Super-Resolution Retrieval in Small-Angle X-ray Scattering", Journal of Applied Crystallography, 2020, In Press.
2. M. Segal, L. Ozery, G. Slor, S. Wagle, T. Ehm, R. Beck and R. Amir, "The Architectural Change of the Shell-Forming Block from Linear to V-Shaped Accelerates Micellar Disassembly but Slows the Complete Enzymatic Degradation of the Amphiphiles", Biomacromolecules, 2020, In Press.
3. I. Morgan, R. Avinery, G. Rahamim, R. Beck and O. Saleh, "Glassy Dynamics and Memory Effects in an Intrinsically Disordered Protein Construct", Physical Review Letters, 125, 2020, 05800.
4. S. Bera, B. Xue, P. Rehak, G. Jacoby, W. Ji, L. Shimon, R. Beck, P. Král, Y. Cao and E. Gazit, "Self-Assembly of Aromatic Amino Acid Enantiomers into Supramolecular Materials of High Rigidity", ACS Nano 14, 2, 2020, 1694-1706.
5. G. Jacoby, I. Portnaya, D. Danino, H. Diamant and R. Beck, "Delayed Nucleation in Lipid Particles", Soft Matter 16, 2020, 347-255 .
6. S. Mondal, V. Basavalingapp, G. Jacoby, L. Shimon, R. Beck and E. Gazit, "Functional Coiled-Coil Like Assembly by Knob-into-Hole Packing of Single Heptad Repeat" ACS Nano 13, 11, 2019, 12630-12637.
7. R. Avinery, M. Kornreich and R. Beck, "Universal and Accessible Entropy Estimation Using a Compression Algorithm", Physical Review Letters, 123, 2019, 17810.
8. I. Chakraborty, G. Rahamim, R. Avinery, Y. Roichman and R. Beck, "Nanoparticle Mobility over a Surface as a Probe for Weak Transient Disordered Peptide-Peptide Interactions", Nano Letters 19, 9, 2019, 6524-6534.
9. S. Bera, S. Mondal, Y. Tang, G. Jacoby, E. Arad, T. Guterman, R. Jelinek, R. Beck, G. Wei and E. Gazit, "Deciphering the Rules for Amino Acid Co-Assembly Based on Interlayer Distances", ACS Nano, 2019, 13, 2, 1703–1712.

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Research title:

Quantum transport in layered 2D materials

Research Abstract

We are interested in the physics of collective excitation in crystalline materials. We wish to observe/understand/control the way electrons/photons/phonons and additional "lattice-induced" particles act in predesigned devices and ultra-pure mediums.

Publications

1. Eran Sela, Yakov Bloch, Felix von Oppen, Moshe Ben Shalom, "Quantum Hall response to time-dependent strain gradients in graphene" Physical Review Letters, Doi 124.026602, 2020.
2. Lior Ella, Asaf Rozen, John Birkbeck, Moshe Ben-Shalom, David Perello, Johanna Zultak, Takashi Taniguchi, Kenji Watanabe, Andre K Geim, Shahal Ilani and Joseph A Sulpizio, "Simultaneous voltage and current density imaging of flowing electrons in two dimensions", Nature Nanotechnology, 14, 2019, 480–487.
3. Joseph A. Sulpizio, Lior Ella, Asaf Rozen, John Birkbeck, David J. Perello, Debarghya Dutta, Moshe Ben-Shalom, Takashi Taniguchi, Kenji Watanabe, Tobias Holder, Raquel Queiroz, Alessandro Principi, Ady Stern, Thomas Scaffidi, Andre K. Geim and Shahal Ilani, "Visualizing Poiseuille flow of hydrodynamic electrons", Nature, 576, 2019, 75–79.
4. AI Berdyugin, SG Xu, FMD Pellegrino, R Krishna Kumar, Alessandro Principi, Iacopo Torre, M Ben Shalom, Takashi Taniguchi, Kenji Watanabe, IV Grigorieva, Marco Polini, AK Geim and DA Bandurin, "Measuring hall viscosity of graphene's electron fluid", Science, 364, 6436, 2019, 162-165.
5. Eran Sela, Yakov Bloch, Felix von Oppen and Moshe Ben Shalom, "Quantum Hall response to time-dependent strain gradients in graphene", Phys. Rev. Lett. 124, 2020, 026602.

Prof. David J. Bergman

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Research title:

Nanoplasmonics and other physical properties of composite media in Solid State Physics and Biology

Research Abstract

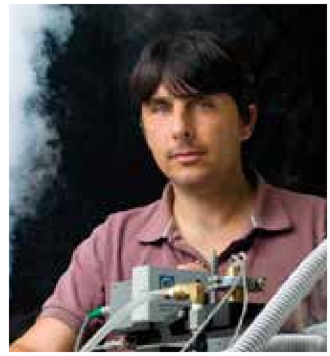
Our research is focused on the following topics:

1. Magneto-transport and magneto-optics in metal-dielectric composite media, when the Hall resistivity in the metallic constituent is greater than the Ohmic resistivity
2. Nano-plasmonics in such a medium
3. Macroscopic physical phenomena in social wasps: the exploitation of thermoelectric cooling to regulate the body temperature of the Oriental Hornet; the exploitation of ultrasonic acoustic resonances by worker hornets and worker bees in the construction of highly symmetric combs in a hornets' nest or beehive

Publications

1. Yakov M. Strelniker and David J. Bergman, "Surface versus localized plasmons in an assembly of metal-dielectric parallel flat slabs in the presence of an in-plane magnetic field", Phys. Rev. B, 102, 2020, 035302.
2. David J. Bergman and Yakov M. Strelniker, "Macroscopic magnetoresistance of an assembly of parallel flat conducting slabs", Phys. Rev. B 100, 2019, 214204.
3. Yakov M. Strelniker and David J. Bergman, "Angular anisotropy of thermoelectric properties of a periodic composite medium in the presence of a magnetic field", Journal of Electronic Materials, 48, 2019, 4507–4514.
4. David J. Bergman and Edward M. Kosower, "Theory of new states, FEXs, Fast-formed EXcited states by the combination of an IR photon and water", Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 215, 2019, 303-306.
5. David J. Bergman, "Scattering electromagnetic eigenstates of a two-constituent composite where both the electric permittivity and the magnetic permeability are nonuniform", Plasmonics: Design, Materials, Fabrication, Characterization, and Applications, XVIII, 11462, 2020.

Prof. Yoram Dagan



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Research title:

Correlated quantum materials

Research Abstract

Our group is working on quantum phenomena in strongly correlated materials including unconventional superconductors, emergent phenomena at oxide interfaces such as superconductivity and magnetism, combining orders at interfaces, i.e. superconductivity and ferroelectricity, superconductivity and magnetism, ferroelectricity and ferromagnetism, topological insulators and superconductors and quantum spin-liquids.

Research achievements include: Measuring the spin-orbit interaction in strontium titanate-based oxide interfaces and understanding its effect on superconductivity both for (100) and (111) directions.; understanding the role of electronic correlations in the band structure of interfaces and its effects on quantum oscillations and transport properties; designing and fabricating quantum wires without spin degeneracy from strontium titanate based oxide interfaces; understanding the evolution of the Fermi surface in doped topological insulators; understanding the role of oxygen, holes and electrons in electron-doped cuprate superconductors; finding exotic superconductivity and possible quantum spin liquid in various polytypes of tantalum di-sulfide.

Future directions include: Combining orders of ferroelectricity, superconductivity, and magnetism at oxide interfaces, interface enhanced superconductivity, quantum oscillations in candidate spin liquids and exotic superconductors.

Publications

1. Udit Khanna, P.K. Rout, Michael Mograbi, Gal Tuvia, Inge Leermakers, Uli Zeitler, Yoram Dagan and Moshe Goldstein, "Symmetry and Correlation Effects on Band Structure Explain the Anomalous Transport Properties of (111) LaAlO3/SrTiO3", Phys. Rev. Lett. 123, 2019, 036805.
2. Mograbi, M., Maniv, E., Rout, P., Graf, D., Park, J.-H. and Dagan, Y., "Vortex excitations in the insulating state of an oxide interface", Physical Review B 99, 2019, 094507.
3. G Tuvia, Y Frenkel, PK Rout, I Silber, B Kalisky, Y Dagan, "Ferroelectric Exchange Bias Affects Interfacial Electronic States", Advanced Materials, 2020, 2000216.
4. A Ribak, R.M. Skiff, M. Mograbi, P.K. Rout, M.H. Fischer, J. Ruhman, Y. Dagan and A. Kanigel,"Chiral superconductivity in the alternate stacking compound 4Hb-TaS2, Science advances 6 (13), 2020, aax9480.

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Research title:

Melting of nanograins; Superconductivity in nanograin composites

Research Abstract

Prof. Guy Deutscher works on fundamental and applied aspects of superconductivity. He has focused on the properties of superconductor near the metal to insulator transition where, surprisingly, unusually strong superconductivity is observed in materials such as oxides and cermets, including high temperature superconductors and granular superconductors. Another research area is the development of superconducting tapes for power applications. The techniques used include thin film growth, transport, tunnelling, Tera-Herz and muon spectroscopy. Research achievements include the discovery that free spins are present in cermet films composed of nano-scale aluminum dots surrounded by oxide, consistent with a metal to insulator transition that is of the Mott type, and a transition from conventional superconductivity to Bose Einstein condensation near the transition. Resonators based on such cermets have a large inductance and low losses, which is favorable for the design of elements for Quantum Computing. Another achievement is the development of superconducting tapes composed of cuprate thin films grown on sapphire ribbons, which are very promising as basic elements of fault current limiters that can improve network stability.

Publications

1. Aviv Glezer Moshe, Eli Farber and Guy Deutscher, “Granular superconductors for high kinetic inductance and low loss quantum devices”, Appl. Phys. Lett., 117, 2020, 062601.
2. Pascal Tixador , Markus Bauer, Christian-Eric Bruzek, Albert Calleja, Guy Deutscher, Bertrand Dutoit, Fedor Gomory, Luciano Martini, Mathias Noe, Xavier Obradors, Marcela Pekarˇcíková, and Frédéric Sirois,”Status of the European Union Project FASTGRID”, IEEE Transactions on Applied Superconductivity, 29, 5, 2019, 5603305.
3. Aviv Glezer Moshe, Eli Farber and Guy Deutscher, “Optical conductivity of granular aluminum films near the Mott metal-to-insulator transition”, Phys. Rev. B 99, 2019, 224503.
4. Nimrod Bachar, Aviad Levy, Thomas Prokscha, Andreas Suter, Elvezio Morenzoni, Zaher Salman and Guy Deutscher, “Kubo spins in nanoscale aluminum grains: A muon spin relaxation study”, Phys. Rev. B 101, 2020, 024424.

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Research title:

Detecting RNA editing associations with miRNAs

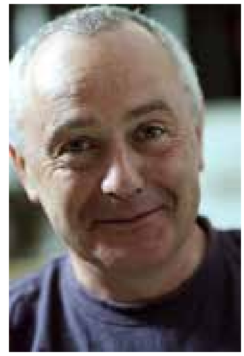
Research Abstract

RNA modifications play an important role in regulating gene expression. A-to-I RNA editing is unique among these modifications, because it not only alters the fate of RNA molecules, but also 'recodes' the genetic information they contain. Recent studies have identified multiple conserved recoding sites that are under positive selection, and have functional and evolutionary importance. However, systematic mapping of the editome across the animal kingdom has also revealed that most editing sites are located in non-coding mobile elements, and these sites are thought to play a critical role in protecting against activation of innate immunity by self-transcripts. In our lab we use computational techniques to study various aspects of this phenomenon. Our work includes the development of methods for detection and quantification of editing, analysis of the genomic determinants affecting editing, and their evolution.

Publications

1. Shalom Hillel Roth, Erez Y. Levanonand Eli Eisenberg, "Genome-wide quantification of ADAR adenosine-to-inosine RNA editing activity", Nature Methods, 16, 2019, 1131–1138.
2. Hagit T. Porath, Esther Hazan, Hagai Shpigler, Mira Cohen, Mark Band, Yehuda Ben-Shahar, Erez Y. Levanon, Eli Eisenberg and Guy Bloch, "RNA editing is abundant and correlates with task performance in a social bumblebee", Nature Communications, 10, 2019, 1605.
3. Amos A Schaffer, Eli Kopel, Ayal Hendel, Ernesto Picardi, Erez Y Levanon and Eli Eisenberg, "The cell line A-to-I RNA editing catalogue", Nucleic Acids Research, 48, 11, 2020, 5849–5858.
4. Michal Barak, Hagit T. Porath, Gilad Finkelstein, Binyamin A. Knisbacher, Ilana Buchumenski, Shalom Hillel Roth, Erez Y. Levanon and Eli Eisenberg, "Purifying selection of long dsRNA is the first line of defense against false activation of innate immunity", Genome Biology, 21, 26, 2020.
5. Isabel C Vallecillo-Viejo, Noa Liscovitch-Brauer, Juan F Diaz Quiroz, Maria F Montiel-Gonzalez, Sonya E Nemes, Kavita J Rangan, Simon R Levinson, Eli Eisenberg and Joshua J C Rosenthal, "Spatially regulated editing of genetic information within a neuron", Nucleic Acids Research, 48, 8, 2020, 3999–4012.
6. Claudio Lo Giudice, Domenico Alessandro Silvestris, Shalom Hillel Roth, Eli Eisenberg, Graziano Pesole, Angela Gallo and Ernesto Picardi, "Quantifying RNA editing in deep transcriptome datasets", Front. Genet., 11, 194, 2020.
7. Niko Popitsch, Christian D Huber, Ilana Buchumenski, Eli Eisenberg, Michael Jantsch, Arndt von Haeseler and Miguel Gallach, "A-to-I RNA editing uncovers hidden signals of adaptive genome evolution in animals", Genome Biology and Evolution, 12, 4, 2020, 345–357.

Prof. Alexander Gerber



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Research title:
Hall effect spintronics

Research Abstract
Spintronics is an emerging field of basic and applied research in physics and engineering, where the electron's magnetic degree of freedom - its spin - may be exploited for classical and quantum information processing. Carrying information in both the charge and spin of an electron potentially enables devices with greater functional diversity.

Our research focuses mainly on the spin-dependent Hall effect in a variety of artificial nanoscale materials, and on its application in a new generation of magnetic sensors, magnetic random access memories, logic devices and molecular and gas sensing.

Publications
1. Noga Eden, Gregory Kopnov, Shachar Fraenkel, Moshe Goldstein and Alexander Gerber, "Longitudinal and transverse magnetoresistance in films with tilted out-of-plane magnetic anisotropy", Phys. Rev. B, 99, 064432 (2019).
2. Sudhansu Sekhar Das, Gregory Kopnov and Alexander Gerber, "Kinetics of the lattice response to hydrogen absorption in thin Pd and CoPd films", Molecules, 25(16), 3597 (2020).
3. G. Kopnov and A. Gerber, "High mobility conducting channel at semi-insulating GaAs–metal oxide interfaces", Journal of Applied Physics, 127, 175302 (2020).
4. S.S. Das, G. Kopnov, and A. Gerber, "Positive vs negative resistance response to hydrogenation in palladium and its alloys", AIP Advances 10, 065129 (2020).

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Research title:

Theory of low-dimentional nanoscale electronic and photonic systems

Research Abstract

My research concerns the theory (both analytical and numerical) of nanoscale and low-dimensional quantum condensed matter systems, including: semiconductors, normal and superconducting metals, carbon-based materials, topological insulators and ultracold atomic gases. These systems offer the fascinating challenge of understanding the interplay between quantum interference, strong correlations, topology and nonequlibrium dynamics. Furthermore, they are important as the basic building blocks of future devices, including quantum simulators and quantum computers.

Publications

1. Liron Levy and Moshe Goldstein, "Entanglement and disordered-enhanced topological phase in the Kitaev chain", Universe 5, 33 (2019), proceedings of the 7th International Conference on New Frontiers in Physics (ICNFP 2018).
2. Vladislav D. Kurilovich, Pavel D. Kurilovich, Igor S. Burmistrov, and Moshe Goldstein, "Helical edge transport in the presence of a magnetic impurity: The role of local anisotropy", Phys. Rev. B 99, 085407 (2019).
3. Noga Eden, Gregory Kopnov, Shachar Fraenkel, Moshe Goldstein, and Alexander Gerber, "Longitudinal and transverse magnetoresistance in films with tilted out-of-plane magnetic anisotropy", Phys. Rev. B 99, 064432 (2019).
4. Gal Shavit, Baruch Horovitz, and Moshe Goldstein, "Generalized open quantum system approach for the electron paramagnetic resonance of magnetic atoms", Phys. Rev. B 99, 195433 (2019).
5. Eyal Cornfeld, Eran Sela, and Moshe Goldstein, "Measuring fermionic entanglement: Entropy, negativity, and spin structure", Phys. Rev. A 99, 062309 (2019).
6. Jukka I. Väyrynen, Moshe Goldstein, and Yuval Gefen, "Superconducting correlations out of repulsive interactions on a fractional quantum Hall edge", Phys. Rev. Lett. 122, 236802 (2019).
7. Igor S. Burmistrov, Moshe Goldstein, Mordecai Kot, Vladislav D. Kurilovich, and Pavel D. Kurilovich, "Dissipative and Hall viscosity of a disordered 2D electron gas", Phys. Rev. Lett. 123, 026804 (2019).
8. Udit Khanna, Prasanna K. Rout, Michael Mograbi, Gal Tuvia, Inge Leermakers, Uli Zeitler, Yoram Dagan, and Moshe Goldstein, "Symmetry and correlation effects on band structure explain the anomalous transport properties of (111) LaAlO3/SrTiO3", Phys. Rev. Lett. 123, 036805 (2019).
9. Pavel D. Kurilovich, Vladislav D. Kurilovich, Igor S. Burmistrov, Yuval Gefen, and Moshe Goldstein, "Unrestricted electron bunching at the helical edge", Phys. Rev. Lett. 123, 056803 (2019).
10. Moshe Goldstein, "Dissipation-induced topological insulators: A no-go theorem and a recipe", SciPost Phys. 7, 067 (2019).
11. Gal Shavit, Baruch Horovitz, and Moshe Goldstein, "Bridging between lab and rotating frame master equations for open quantum systems", Phys. Rev. B. 100, 195436 (2019), Editors' Suggestion.
12. Noa Feldman and Moshe Goldstein, "Dynamics of charge-resolved entanglement after a local quench", Phys. Rev. B 100, 235146 (2019).
13. Gal Shavit and Moshe Goldstein, "Topology by dissipation: Transport properties", Phys. Rev. B 101, 125412 (2020).
14. Seung-Sup B. Lee, Jan von Delft, and Moshe Goldstein, "Non-Fermi-liquid Kondo screening under Rabi driving", Phys. Rev. B 101, 085110 (2020).
15. Sachar Fraeknel and Moshe Goldstein, "Symmetry resolved entanglement: Exact results in 1D and beyond", J. Stat. Mech. (2020) 033106 (2020).

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Research title:

Quantum transport phenomena in topological and strongly correlated matter

Research Abstract

Our areas of research include: mesoscopic and low-dimensional physics; Quantum transport phenomena; Topological phases of matter: Quantum Hall effects, topological insulators, semi-metals and superconductors; Fractional and non-Abelian quantum statistics; and Berry phase effects.

Publications

1. Valerio Peri, Marc Serra-Garcia, Roni Ilan and Sebastian D. Huber, "Axial-field-induced chiral channels in an acoustic Weyl system", Nature Physics, 15, 2019, 357–361.
2. Jan Behrends, Roni Ilan and Jens H. Bardarson, "Anomalous conductance scaling in strained Weyl semimetals", Phys. Rev. Research 1,2019, 032028.
3. Arbel Haim, Roni Ilan and Jason Alicea, "Quantum anomalous parity hall effect in magnetically disordered topological insulator films", Phys. Rev. Lett. 123, 2019, 046801.
4. Henrik Schou Røising, Roni Ilan, Tobias Meng, Steven H. Simon and Felix Flicker, "Finite temperature effects on Majorana bound states in chiral p-wave superconductors", Nature Reviews Physics, 2, 2020, 29–41.
5. Valerio Peri, Tena Dubček, Agnes Valenti, Roni Ilan and Sebastian D. Huber, "Weyl orbits without an external magnetic field", Phys. Rev. B 101, 2020, 235117.
6. Leslie M. Schoop, Xi Dai, R. J. Cava and Roni Ilan, "Special topic on topological semimetals—New directions", APL Materials 8, 2020, 030401.
7. Emmanouil Xypakis, Jun-Won Rhim, Jens H. Bardarson and Roni Ilan, "Perfect transmission and Aharanov-Bohm oscillations in topological insulator nanowires with nonuniform cross section", Phys. Rev. B 101, 2020, 045401.
8. Daniel Sabsovich, Tobias Meng, Dmitry I. Pikulin, Raquel Queiroz and Roni Ilan, "Pseudo field effects in type II Weyl semimetals: new probes for over titled cones", Journal of Physics: Condensed Matter, 2020, In Press.
9. Dmitry I Pikulin and Roni Ilan, "Bulk-boundary quantum oscillations in inhomogeneous Weyl semimetals", New Journal of Physics, 22, 2020, 013035.

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Research title:

Nanomechanics and quasicrystals (theory)

Research Abstract

Nanomechanics

State of the art nano-electromechanical and nano-optomechanical systems can now be fabricated with lateral dimensions down to a few nanometers, which enables normal frequencies that routinely exceed 1 GHz, and the cooling of resonators down to their quantum ground states. As a consequence, they offer great opportunities for the study of mechanics in physical regimes that have been previously inaccessible experimentally. The Lifshitz group is concerned with the theoretical study of nanomechanical systems. These studies cover a broad range of topics, from the mesoscopic physics of phonons and their interaction with electrons, the classical nonlinear dynamics of coupled nanomechanical resonators, and the quantum behavior of human-made nanoscale devices.

Quasicrystals

The Lifshitz group is also involved in unrelated theoretical research in the field of quasicrystals. These crystals—which are not periodic but nevertheless possess perfect long-range order—offer interesting opportunities for studies at the nanoscale. One particular direction that is pursued by the group, and is relevant at the nanoscale, is the thermodynamic stability of quasicrystals made of soft macromolecules, and their controlled self-assembly.

Publications

1. Ron Lifshitz, "The power of analogy in physics: from Faraday waves through soft matter to complex metallic alloys", Acta Cryst. A 75 (2019) e418.
2. Lior Ben Arosh, M.C. Cross, Ron Lifshitz, "Quantum limit-cycles and the Rayleigh and van der Pol oscillators," in preparation (2020).

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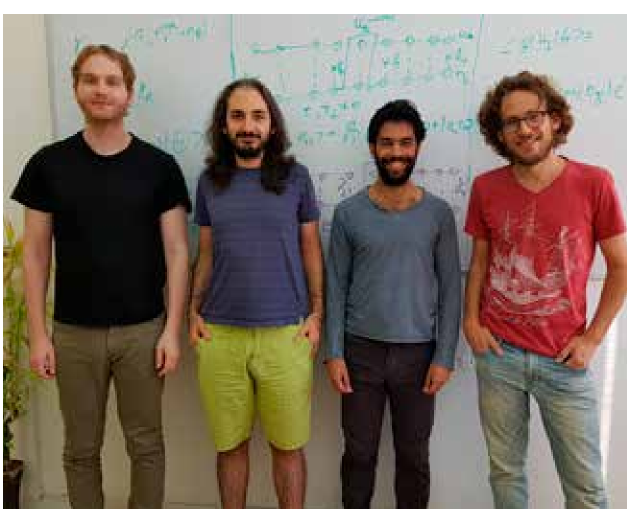
Research title:

Mesoscopic systems and topological phases of matter

Research Abstract

We conduct theoretical studies in the field of strongly correlated electron quantum systems in condensed matter. In such systems, the particles (electrons/photons/ atoms) cannot be considered independently. Rather, their behavior at low temperatures is governed by collective many-body physics. The superimposed wavy nature of these particles may lead to exotic phenomena, and problems addressed by this field are exceptionally rich and complex. Moreover, basic research of many-body physics in confined systems is highly pertinent to the fast-developing technology of devices at the nanometer scale, such as small electronic devices based on photonic cavities or cold atom systems. Our theoretical studies apply advanced field-theory approaches, such as path integrals, "bosonization" and the renormalization group.



Publications

1. Daniel Azses, Rafael Haenel, Yehuda Naveh, Robert Raussendorf, Eran Sela, Emanuele G. Dalla Torre, "Identification of symmetry-protected topological states on noisy quantum computers", Phys. Rev. Lett. 125, 120502 (2020).
2. Eran Sela, Yuval Oreg, Stephan Plugge, Nikolaus Hartman, Silvia Lüscher and Joshua Folk, "Detecting the universal fractional entropy of majorana zero modes", Phys. Rev. Lett., 123, 147702 (2019).
3. Eyal Cornfeld, Eran Sela and Moshe Goldstein, "Measuring fermionic entanglement: entropy, negativity, and spin structure", Phys. Rev. A 99, 062309 (2019).
4. Marcello Calvanese Strinati, Sharmistha Sahoo, Kirill Shtengel and Eran Sela, "Pretopological fractional excitations in the two-leg flux ladder", Phys. Rev. B 99, 245101 (2019).
5. Eyal Cornfeld, L. Aviad Landau, Kirill Shtengel and Eran Sela, "Entanglement spectroscopy of non-Abelian anyons: Reading off quantum dimensions of individual anyons", Phys. Rev. B 99, 115429 (2019).
6. Eran Sela, Yakov Bloch, Felix von Oppen and Moshe Ben Shalom, "Quantum Hall response to time-dependent strain gradients in graphene", Phys. Rev. Lett. 124, 026602 (2019).
7. Pedro L. S. Lopes, I. Affleck and E. Sela, "Anyons in multichannel Kondo systems", Phys. Rev. B 101 085141 (2019).

Prof. Haim Suchowski

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Research title:

Femto-nano dynamics, nonlinear metamaterials, quantum coherent control

Research Abstract

Remarkable breakthroughs in science throughout history are inherently linked to advances in the study of light-matter interactions. For the past two decades, we have witnessed major advances in nano-optics and ultrafast physics, allowing for the exploration of phenomena in higher spatial and temporal resolution than ever before.

Research at our lab aims to merge these extreme resolution capabilities of space and time, in order to provide a window onto ultrafast spatio-temporal dynamics at the nanoscale. In particular, we are interested in exploring the ultrafast hot electron dynamics and related nonlinear effects in plasmonic nano-structures and metamaterials. Our current goal is to understand the effect of the nanoparticle's geometry and environment on the spatio-temporal evolution of the hot electron, and its relation to nonlinear optical generation.

Our research is driven by an attempt to combine theoretical microscopic models with novel experimental measurement methods, including: pulse-shaping-based measurements, ultrafast pump-probe spectroscopy, ultrashort light sources and near field microscopy.

We are also interested in exploring geometric quantum coherent control schemes. This approach, based on continuous (Lie) group theory, provides a route for determining whether a quantum system is controllable, not controllable or sub-controllable. Such methods have been harnessed in recent years to study control in many quantum and classical systems, such as nuclear magnetic resonance, optical spectroscopy, coherent control, solid state physics and frequency conversion.

Publications

1. I. Malkiel, M. Mrejen, L. Wolf, H. Suchowski, "Machine learning for nanophotonics", MRS Bulletin 45 (3), 221-229 (2020).
2. L. Michaeli, D. Ben Haim, M. Sharma, H. Suchowski, T. Ellenbogen, "Spectral interferometric microscopy for fast and broadband phase characterization", Advanced Optical Materials, 2000326 (2020).
3. T. Coen, H. Greener, M. Mrejen, L. Wolf, H. Suchowski, "Deep learning based reconstruction of directional coupler geometry from electromagnetic near-field distribution", OSA Continuum 3 (8), 2222-2231 (2020).
4. E. Bahar, U. Arieli, M. Mrejen, H. Suchowski, "Coherent control of the noninstantaneous nonlinear power-law response in resonant nanostructures", Physical Review B 101, 035141 (2020).
5. I. Malkiel, M. Mrejen, L. Wolf, H. Suchowski, "Machine learning for nanophotonics", MRS Bulletin 45, 221-229 (2020).
6. L. Michaeli, H. Suchowski, T. Ellenbogen, "Near-infrared tunable surface lattice induced transparency in a plasmonic metasurface", Laser and Photonics Review, 199204 (2019).
7. E. Kyoseva, H. Greener, H. Suchowski, "Detuning-modulated composite pulses for robust quantum control", Physical Review A 100, 032333 (2019).
8. Y. Erlich, A. Rangelov, G. Montemezzani, H. Suchowski, "Robust efficient and broadband second harmonic generation of ultrashort pulses in composite crystals", Opt. Lett. 44, 3837 (2019).
9. E. Lifshitz, U. Arieli, S. Katz, I. Nir, A. Levanon, M. Mrejen, H. Suchowski, "High resolution multi-scan compact Fourier-transform infrared spectrometer", Opt. Lett. 44, 3126 (2019).
10. U. Arieli, M. Mrejen, H. Suchowski, "Broadband coherent hyperspectral near-field imaging of plasmonic nanostructures", Opt. Exp. 27, 9815 (2019).
11. M. Mrejen, L. Yadgarov, A. Levanon, H. Suchowski, "Exciton-polariton dynamics in WSe2 by ultrafast near-field imaging", Science Advance 5, eaat9618 (2019).

PART 3

COLLABORATIONS, AWARDS, STAFF AND ACKNOWLEDGMENTS

Collaborations

The following is a list of the Center's researchers' collaborations including external academia during January 2019 – September 2020 that are funded by external grants. The list is sorted by the researcher's last name.

1. Dr. Lihi Adler-Abramovich collaborates with Nathan Gianneschi (Northwestern University, USA) on Enzyme-responsive nanoparticles for targeted delivery, accumulation, and retention of drugs to diseased and inflamed oral tissues; funded by NWU-TAU research grant.
2. Prof. David Andelman collaborates with M. Doi and X.K. Man (Beihang Univ, China) on Nanostructures in polymeric films; funded by ISF-NSFC Program.
3. Prof. David Andelman collaborates with R. Podgornic (UCAS, China) on Structure and correlations in ionic liquids and solutions; funded by ISF-NSFC program.
4. Prof. David Andelman collaborates with H. Orland (IPhT, CE-Saclay, France) on Non-equilibrium effects in charged soft matter; funded by Sackler Program.
5. Prof. David Andelman collaborates with S. Komura (TMU, Japan) on Electrokinetic effects and active matter; funded by TAU-TMU exchange program.
6. Prof. Ady Arie collaborates with Benoît Boulanger (Univ. Grenoble Alpes, France) on Triple-photon generation; funded by Imaginano.
7. Prof. Roey Amir collaborates with Dr. Lorenzo Albertazzi (Institute for Bioengineering of Catalonia, Spain) on Bio-orthogonal catalysis for cancer therapy (THERACAT); funded by European Union's Horizon 2020.
8. Prof. Uri Ashery collaborates with Georg Nagel (University of Wurzburg, Germany) on Analyzing PKA-dependent synaptic plasticity in the hippocampal mossy fiber synapse using novel optogenetic tools; funded by DFG.
9. Prof. Karen Avraham collaborates with Gwenaelle Geleoc and Jeffrey Holt (Boston Children's Hospital, Harvard Medical School, USA) on Gene therapy for deafness in Middle Eastern populations; funded by US-Israel Binational Science Foundation.
10. Prof. Karen Avraham collaborates with Bethlehem University, University of Washington and National Institutes of Health/NIDCD, (Palestine Authority, USA, USA) on Genomic approaches to discovery and characterization of genes for inherited hearing loss; funded by Moein Kanaan, Mary-Claire King.
11. Prof. Itai Benhar collaborates with Dr. Meital Gal-Tanamy (Bar-Ilan University, Medical School of Safed, Israel) on Isolation of SARS-CoV-2-neutralizing antibodies by phage display of human antibodies and by single B-cell cloning from Immunized mice; funded by ISF-Corona.
12. Dr. Gili Bisker collaborates with Prof. Niv Vega (Emory University, USA) on Monitoring worm gastrointestinal dynamics using fluorescent single-walled carbon nanotubes; funded by Tel Aviv - Emory research collaboration fund.
13. Dr. Gili Bisker collaborates with Prof. Alan Kin-Tak Lau (Swinburne University of Technology, Melbourne, Australia) on Graphene foam composite incorporating single-walled carbon nanotubes for enhanced acoustic performance; funded by Tel Aviv University - Swinburne University of Technology Collaboration.
14. Prof. Amir Boag collaborates with Prof. Prof. Lomakin (UCSD, USA) on Lorenz gauge-based algorithms for large-scale hybrid quantum-electromagnetic simulations; funded by BSF.
15. Prof. Amir Boag collaborates with Prof. Maffucci (University of Cassino and Southern Lazio, Italy) on Terasse-terahertz antennas with self-amplified spontaneous emission; funded by EU Horizon-2020.
16. Prof. Ori Cheshnovsky collaborates with Alex Zunger (University of Colorado Boulder, USA) on Direct band gap In silicon core shell structures; funded by NSF/BSF.
17. Dr. Guy Cohen collaborates with Emanuel Gull (University of Michigan, USA) on Dynamical mean field theory of nonequilibrium interfaces; funded by BSF.
18. Dr. Guy Cohen collaborates with Eitan Eidelstein (NRCN, Israel) on Multiorbital interactions in strongly correlated solids; funded by PAZY.
19. Dr. Guy Cohen collaborates with Kavan Modi (University of Monash, Australia) on Simulating complex quantum dynamics on near-term quantum machines; funded by AFTAM.
20. Prof. Yoram Cohen collaborates with Ian Duncan (University of Madison-Wisconsin, USA) on Diffusion MRI in white matter myelin disorders; funded by United States-Israel Binational Science Foundation (BSF).
21. Prof. Yoram Dagan collaborates with Harold Hwang (Stanford U. USA) on Oxide interfaces; funded by BSF.
22. Prof. Guy Deutscher collaborates with Tixador (Grenoble, France) on Fastgrid; funded by EU 2020.
23. Prof. Haim Diamant collaborates with Stefan Egelhaaf (University of Düsseldorf, Germany) on Colloidal glass transition; funded by GIF.
24. Prof. Yuval Ebenstein collaborates with Elmar Weinhold (Aachen University, Germany) on Lab-on-a-chip cancer

diagnostics by quantification of epigenetic markers; funded by Research Innovation Authority Nano Israel –Germany.

25. Prof. Yuval Ebenstein collaborates with Natalie Gassman (University of South Alabama, USA) on Co-detection of DNA adducts and methylation sites as predictive biomarkers for exposures; funded by NIH/R21.

26. Prof. Eli Eisenberg collaborates with Joshua Rosenthal (Marine Biological Laboratory, USA) on Recoding in cephalopods; funded by BSF.

27. Prof. Eli Eisenberg collaborates with Meng-How Tan (Nanyang U., Singapore) on Editing throughout development; funded by ISF-Singapore.

28. Prof. Hagit Eldar-Finkelman collaborates with Hanoch Senderowitz (Bar Ilan University, Israel) on Novel GSK-3 inhibitors for treating neurodegenerative disorders; funded by Kamin -innovation Research Authority.

29. Prof. Hagit Eldar-Finkelman collaborates with Stanford University (USA) on Neurodegenerative diseases: towards personalized diagnosis and drug screening; funded by Neurodegenerative consortium - Koret Research Fund.

30. Dr. Dinorah Friedmann-Morvinski collaborates with Michael Berger (HUJI, Israel) on Immunotherapy of glioblastoma with metabolically superior bi-specific CAR-T cells; funded by ISF-IPMP program.

31. Prof. Ehud Gazit collaborates with Ron Naaman and Yossi Paltiel (Weizmann Institute and Hebrew University) on Peptide spintronics; funded by MOST.

32. Prof. Ehud Gazit collaborates with Junbai Li (Chinese Academy of Science) on Peptide assemblies; funded by ISF (Israel-China Program).

33. Prof. Alexander Golberg collaborates with George Guo-Qiang CHEN (Tsinhua University, China) on PHA production from seaweed; funded by XIN.

34. Prof. Alexander Golberg collaborates with Martin Yarmush (Rutgers, USA) on Scar reduction with electroporation; funded by BSF.Prof.

35. Amir Goldbourt collaborates with Prof. Ye Xiang (Tsinghua University, China) on A synergetic approach to elucidate structure and dynamics of mature and premature filamentous bacterial viruses by combining Magic-angle spinning NMR and cryoEM; funded by NSFC-ISF.

36. Prof. Amir Goldbourt collaborates with Prof. Tatyana Polenova (University of Delaware, USA) on New quadrupolar NMR techniques for emerging NMR technologies: atomic-resolution characterization of challenging metal sites in bioinorganic and catalyst materials; funded by BSF.

37. Prof. Ilan Goldfarb collaborates with Yongmei Jin and Ranjit Pati (Michigan Technological University, USA) on Systematic exploration and control of magnetic properties of epitaxial silicide nanostructures: multiscale modelling and experiments; funded by NSF-BSF.

38. Dr. Moshe Goldstein collaborates with Vladimir Manucharyan (University of Maryland, USA) on Quantum simulation in superconducting nanocircuits; funded by BSF.

39. Prof. Diana Golodnitsky collaborates with Margret Wohlfahrt-Mehrens (ZSW – Zentrum für Sonnenenergie- und Wasserstoff-Forschung, Baden-Württemberg, Germany) on High-energy, safe, lithium metal-free sulfur/silicon battery; funded by MOST.

40. Dr. Yoni Haitin collaborates with Dr. Petr Man (BIOCEV, Prague, CZ) on CLIC5Oxi; funded by EU_FTICR_MS Project.

41. Prof. Yael Hanein collaborates with Gerardo Sosa (KIT, Germany) on Flexible skin sensors; funded by DFG.

42. Dr. Joel Hirsch collaborates with Enno Klussmann (Max Delbrück Center for Molecular Medicine, Helmholtz Association Germany) on Novel mechanisms of regulation of cardiac L-type Ca channels by protein kinase A; funded by GIF (CI).

43. Dr. Joel Hirsch collaborates with Ka Young Chung (Sungkyunkwan University, Korea) on Structural and mechanistic studies of Kv7.2-3 channels; funded by ISF.

44. Dr. Joel Hirsch collaborates with Emanuele Paci (University of Leeds, UK) on Structural and mechanistic studies of Kv7.2-3 channels; funded by ISF.

45. Prof. Oded Hod collaborates with Juan Peralta (Central Michigan University, USA) on Electronic transport in open quantum systems; funded by Israel Science Foundation.

46. Prof. Oded Hod collaborates with Oren Tal (Weizmann Institute of Science, Israel) on Magnetic control over the fundamental structure of atomic wires; funded by MOST.

47. Prof. Oded Hod collaborates with Leeor Kronik (Weizmann Institute of science, Israel) on Development of interlayer potentials for layered materials; funded by ISF.

48. Prof. Oded Hod collaborates with Alexandre Tkatchenko (Université du Luxembourg) on Development of interlayer potentials for layered materials; funded by ISF.

49. Prof. Micha Ilan collaborates with Li Z. (Shanghai Jiao Tong Univ., China) on The community structure and function of sponge microbial symbionts from

different habitats and their changes with time and space; funded by ISF.

50. Prof. Micha Ilan collaborates with Giovine M. (Univ. Genoa, Italy) on Sponge mariculture for innovative biotechnological exploitations; funded by Ministry of Science & Italian Ministry of Foreign Affairs.

51. Dr. Mikahil Kolot collaborates with Prof. Christoph Alexiou (University Hospital Erlangen, Germany) on Development of a nanoparticle based anti-tumor gene therapy for treatment of breast cancer; funded by DFG.

52. Dr. Alexander Kotlyar collaborates with Prof. Deyev (Institute of Bioorganic Chemistry, Moscow, Russia) on Development of new therapeutic strategies for specific elimination of cancer cells and tumors; funded by MOST.

53. Dr. Alexander Kotlyar collaborates with Prof. Porath (HUJI, Israel) on Next generation sequencing based on DNA nanoelectronics; funded by MOST.

54. Dr. Noa Lachman-Senesh collaborates with Prof. Reshef Tenne (Weizmann Institute of Science, Israel) on Nanocomposite of poly L-lactic acid; funded by Israel Innovation Authority/ Kamin.

55. Dr. Noa Lachman-Senesh collaborates with Prof. Josiah Hester and Prof. Matthew Grayson (Northwestern University, Il, USA) on Resistance tomography with 2D sensor membranes; funded by NSF-BSF.

56. Prof. Ron Lifshitz collaborates with Michael Cross and Keith Schwab (Caltech, USA) on Nonlinear quantum nanomechanics; funded by BSF.

57. Prof. Hadas Mamane collaborates with Prof. Shizhong Li (Tsinghua University, China) on Nanocellulose co-produced with bioethanol from sweet sorghum stalks; funded by XIN.

58. Prof. Hadas Mamane collaborates with Kimberly A. Gray (North Western University, USA) on Anti-COVID-19 high-touch surfaces using photocatalytic transparent films; funded by NU-TAU.

59. Dr. Ben Maoz collaborates with Prof. Vatine (BGU, Israel) on Establishing a human relevant brain-on-a-chip platform for elucidating pathways and cellular dysfunction in Parkinson's disease; funded by APPD.

60. Prof. Gil Markovich collaborates with Alexander Govorov (Ohio University, USA) on Ultraviolet plasmonics for circular dichroism enhancement or amplification for sensing biomolecules; funded by BSF.

61. Prof. Touvia Miloh collaborates with Prof. O. Velev (NCSU, USA) on Electrokinetic; funded by BSF.

62. Dr. Iftach Nachman collaborates with Assa Zitner (Israeli Institute for Biological Research, Israel) on Using machine learning on imaging and expression profiling data to classify toxin effects on cell cultures; funded by LSRI.

63. Prof. Abraham Nitzan collaborates with Maxim Sukharev (Arizona State University, USA) on Molecular plasmonics; funded by BSF.

64. Prof. Abraham Nitzan collaborates with Michel Thortwart (Germany) on Dielectric solvation and energy transfer; funded by DFG.

65. Dr. Vered Padler-Karavani collaborates with Hongzhi Cao (Shandong University, China) on Synthesis and evaluation of tumor-associated glycans for cancer immunotherapy; funded by NSFC-ISF.

66. Dr. Vered Padler-Karavani collaborates with David Smadja (Paris Descartes University and European Georges Pompidou Hospital, Paris, France) on Immunology of non-human glycosylation in a new bioprosthetic total artificial heart; funded by the Elizabeth and Nicholas Slezak Super-Center.

67. Dr. Vered Padler-Karavani collaborates with Zalig Eshhar, Anat Globerson-Levin (Sourasky Medical Center, Israel) on Immunotherapy targeting glycosylation in cancer; funded by Spark Tel Aviv Mentoring Program.

68. Dr. Moshe Parnas collaborates with Robert J. Kittel (Leipzig University, Germany) on Linking the molecular organization of active zones to temporal neural coding; funded by DFG.

69. Prof. Dan Peer collaborates with Prof. Raymond Schiffelers (UMC Utrecht, Netherlands) on Immunotherapy; funded by Horizon 2020 ERC.

70. Prof. Dan Peer collaborates with Prof. Alan Packared (Boston Children Hospital, USA) on Leuko Theranostic; funded by ERC.

71. Prof. Emanuel Peled collaborates with Martin Winter (Helmholtz-Institute Münster, Germany) on Synthesis, investigation and optimization of -novel siloxane-based electrolytes and lithium SEI for high power batteries applications; funded by MOST.

72. Prof. Eran Perlson collaborates with Yi Rao, Bai Lu, Weiwen Wang (Peking University, China, Tsinghua University-China; Institute of Psychology, CAS-China) on The mechanisms of BDNF-TrkB signaling in neurodegenerative disease; funded by Ministry of Science and Technology State of Israel, China-Israel flagship projects brain sciences.

73. Prof. Eran Perlson collaborates with Benoit Charlot, Florence Rage, Marcus Krüger, Silvestro Conticello, Pim Pijnappel, Józef Dulak and Duygu Cetinkaya (IES, France; IGMM, France; University of Cologne, Germany, ISPRO, Italy; Erasmus MC, Netherlands; Jagiellonian University,

Poland, Hacettepe University, Turkey) on Personalised medicine for neurodegenerative diseases; funded by JPND-Multinational research projects.

74. Prof. Shachar Richter collaborates with Jinying Yuan (Tsinghua University, China) on Development of novel responsive polymers for biomedical applications; funded by XIN.

75. Prof. Shachar Richter collaborates with Koray Aydin (NorthWestern University, USA) on Novel two- and three dimensional materials for photothermal applications; funded by TAU-Northwestern fund.

76. Prof. Shachar Richter collaborates with Nicolas Voelcker (Monash University, Australia) on Development of novel materials for hyperthermia treatment; funded by Monash-TAU.

77. Dr. Brian Rosen collaborates with James Rondinelli (Northwestern University, USA) on Multi-dimensional defect chemistry in oxide catalysts; funded by BSF.

78. Dr. Brian Rosen collaborates with Dario Dekel (Technion, Israel) Carbide supports for AEM Fuel cells; funded by INREP 2.

79. Dr. Brian Rosen collaborates with David Zitoun (Bar Ilan University, Israel) on Carbide supports for PEM fuel cells; funded by INREP 2.

80. Prof. Yossi Rosenwaks collaborates with Universität Erlangen-Nürnberg (Germany) and Technion (Israel) on Development of a CMOS compatible nanosensors for internet of things applications; funded by Nanotechnology Germany –Israel.

81. Prof. Arie Ruzin collaborates with Leonid Chernyak (USF, USA) on GaN radiation defects; funded by BSF.

82. Prof. Natan Zvi Shaked collaborates with Claus Duschl and Michael Kirschbaum (Fraunhofer Institute (IZI BB), Potsdam, Germany) on Phase imaging on a dielectrophoretic chip for rare biological cell classification; funded by Nano-Germany Collaboration Magneton (Ministries of Economy of Israel and Germany).

83. Prof. Ronit Sagi-Eisenberg collaborates with Stephen Galli (Stanford University, CA, USA) on Elucidating the roles of the small GTPase Rab5 in regulating mast cell secretory granule biogenesis and compound exocytosis; funded by BSF.

84. Prof. Ronit Sagi-Eisenberg collaborates with Mitsunori Fukuda (Tohoku University, Japan) on Mechanisms, regulation and significance of secretory granule positioning in mast cells; funded by ISF.

85. Prof. Ronit Sagi-Eisenberg collaborates with Nicolas Gaudenzio (Université de Toulouse, France) on Mechanisms, regulation and significance of secretory granule positioning in mast cells; funded by ISF.

86. Prof. Ronit Sagi-Eisenberg collaborates with Peng Ji and Bruce S. Bochner (Northwestern University, USA) on mDia1 coordinates mast cell migration and secretion through its actin nucleating activity; funded by ISF.

87. Prof. Jacob Scheuer collaborates with Filippo Capolino and Ozdal Boyraz (Univ. of California, Irvine, USA) on Frozen mode regime for light amplification and generation; funded by AFOSR.

88. Prof. Daniel Segal collaborates with Yan-Mei Li (Tsinghua, China) on Inhibitors against Aβ aggregation; funded by ISF.

89. Prof. Daniel Segal collaborates with Yan-Mei Li (Tsinghua, China) on Mannitol-based small molecules for inhibiting aggregation of α-synuclein; funded by XIN.

90. Prof. Daniel Segal collaborates with Alan Schoenfeld (Adelphi University, USA) on Arginin refolding of pVHL; funded by Israel Cancer Association, the Cancer Biology Research Center in Tel Aviv University, and the VHL Alliance.

91. Prof. Eran Sela collaborates with Emanuelle Dalla Torre (Bar-Ilan, Israel) on Simulating entanglement dynamics on quantum computers; funded by Israel Science Foundation-Quantum.

92. Prof. Eran Sela collaborates with Robert Raussendorf and Vito Scarola (UBC, Canada and Virginia Tech USA) on The computational power of quantum matter: algorithms and characterization; funded by Binational-Science foundation.

93. Prof. Eran Sela collaborates with Prof. Kirill Shtengel (UC Riverside, USA) on Non-Abelian anyons in quasi-one dimensional cold atom systems; funded by Binational-Science foundation.

94. Prof. Yosi Shacham-Diamand collaborates with Prof. M. Ghosh (TiET, India) on The digital village; funded by TTFSCoE.

95. Prof. Yosi Shacham-Diamand collaborates with Marc Madou (UCI, USA) on Plant based sensors; funded by UCI Internal.

96. Prof. Yair Shokef collaborates with Bulbul Chakraborty and Aparna Baskaran (Brandeis University, USA) on active matter; funded by BSF.

97. Prof. Yair Shokef collaborates with Chase Broedersz (Ludwig-Maximilians-Universität München, Germany) on active matter; funded by TAU-LMU.

98. Prof. Inna Slutsky collaborates with Silvio Rizzoli)U Gottingen, Germany(on The role of mitochondrial and ER Ca2+ stores in the homeostasis of

hippocampal circuits and its failures in Alzheimer's disease; funded by Volksvagen.

99. Prof. Inna Slutsky collaborates with Silvio Rizzoli (U Gottingen, Germany) on Homeostasis of hippocampal circuits: From intracellular Ca2+ stores to firing stability; funded by DFG.

100. Prof. Inna Slutsky collaborates with Tara Keck (UCL, UK) on Failures of neuronal homeostasis in Alzheimer's disease and ageing; funded by BIRAX.

101. Prof. David Sprinzak collaborates with Steve Blacklow (Harvard Medical School, USA) on Time resolved dissection of notch activation; funded by BSF.

102. Prof. David Sprinzak collaborates with Brian Gebelein (Cincinnati Children's Hospital, USA) on Elucidating the notch transcriptional response; funded by NSF-BSF.

103. Prof. David Sprinzak collaborates with Laure Bally-Cuif (Institut Pasteur, CNRS, France) on Homeostasis of adult neural stem cells; funded by ERC.

104. Prof. Haim Suchowski collaborates with Jeffery Moses (Cornell University, USA) on Adiabatic four wave mixing; funded by BSF.

105. Prof. Tamir Tuller collaborates with Prof. Gur Yaari (BIU) on Generating a fast solution for SARS-CoV-2 and the next viral epidemic; funded by ISF.

106. Prof. Tamir Tuller collaborates with Prof. Dmitrij Frishman (TUM) on Deciphering overlapping regulatory signals in viral transcripts; funded by DFG.

107. Prof. Tamir Tuller collaborates with several researchers and companies on Developing improved pipelines for CRISPR technology; funded by MAAGAD, innovation authority.

108. Prof. Tamir Tuller collaborates with Prof. Gur Yaari (BIU) on Generating a fast solution for SARS-CoV-2 and the next viral epidemic; funded by MOST.

109. Prof. Michael Urbakh collaborates with Profs. Quanshui Zheng and Ming Ma (Tsinghua Univ., China) on Robust superlubricity in large-scale heterogeneous layered material junctions: experiment and computation join forces; funded by NSFC-ISF.

110. Dr. Yariv Wine collaborates with Arnaud Marchant, Danielle Lilleri and Margaret Ackerman (Belgium, Italy and USA) on Antibody mediated control of cytomegalovirus at the materno-fetal interface; funded by Infect-ERA.

111. Dr. Yariv Wine collaborates with US researchers (USA) on Detailed molecular analysis of the antibody response to protein therapeutics; funded by BSF.

112. Dr. Yariv Wine collaborates with Dapeng Zou (China) on Serum antibodies repertoire; funded by China Science Foundation.

113. Prof. Meital Zilberman collaborates with Prof. Yehuda Ullmann (Technion) on Hemostatic bioadhesives; funded by the Israeli Medical Corps.

114. Prof. Meital Zilberman collaborates with Prof. Yehuda Ullmann (Technion) on Soy protein based wound dressings; funded by the Israeli Medical Corps.

115. Dr. Ines Zucker collaborates with Uwe Huebner and Jorg Drewes (Technical University of Munich, Germany) on In-situ chemical oxidation (ISCO) by passive dissolution of ozone gas using gas-permeable membranes for remediation of petroleum-contaminated ground water; funded by the German-Israeli water technology cooperation program.

Special Awards

The following is a partial list of special awards that were received by the Center's researchers during January 2019 – September 2020. The list is sorted by researcher's last name.

1. Dr. Lihi Adler-Abramovich - Multifunctional Personalized Self-Assembled Biomaterials for Bone Regeneration, ERC-starting grant, awarded by European Research Council in 2020.
2. Prof. Karen Avraham - Ernest and Bonnie Beutler Research Program of Excellence in Genomic Medicine Award, awarded by Beutler Research Program in 2019.
3. Prof. Yuval Ebenstein - ERC-COG EU-Horizon 2020 awarded in 2019.
4. Prof. Tal Ellenbogen - Kadar Family Award for Outstanding Research awarded by the Naomi Prawer Foundation in 2020.
5. Prof. Ehud Gazit - Rappaport Prize for Excellence in the Field of Biomedical Research awarded by the Bruce and Ruth Rappaport Foundation in 2019.
6. Prof. Diana Golodnitsky - Fellow of Electrochemical Society awarded by the ECS in 2020.
7. Prof. Yael Hanein - Senior Member awarded by National academy of inventors in 2019.
8. Prof. Micha Ilan - Franco Bovio award awarded by APAI Genoa, Italy.
9. Prof. Gil Markovich - The Tenne Family Prize for Nano Scale Sciences, awarded by the Israel Chemical Society in 2019.
10. Prof. Abraham Nitzan - Plyler Prize in Molecular Spectroscopy awarded by the American Physical Society in 2019.
11. Prof. Abraham Nitzan - Theoretical Chemistry Award awarded by the American Chemical Society in 2020.
12. Dr. Vered Padler-Karavani - European Commission H2020 ERC Proof of Concept grant awarded by ERC in 2020.
13. Prof. Dan Peer - Roche Distinguished Scientist Program awarded by Roche in 2020.
14. Prof. Emanuel Peled - Samson - Prime Minister's Prize for Innovation in Alternative Fuels and Smart Mobility Awarded by Israel MOS and PMO in 2019.
15. Prof. Shachar Richter – Distinguished Visiting Professor awarded by the Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia in 2019.
16. Prof. Ronit Satchi-Fainaro - The 2020 Youdim Family Prize for Excellence in Cancer Research awarded by the Technion- Israel Institute of Technology in 2020.
17. Prof. Ronit Satchi-Fainaro - The 2020 Kadar Family Award for Outstanding Research at Tel Aviv University, awarded by the Board of Governors in 2020.
18. Prof. Ronit Satchi-Fainaro - The 2020 Michael Bruno Memorial Award awarded by the Israel Institute for Advanced Studies (IIAS) in 2020.
19. Prof. Ronit Satchi-Fainaro - The 2020 Humboldt Foundation Bessel Research Prize awarded by the Humboldt Foundation in 2020.
20. Prof. Doron Shabat - Kolthoff Prize awarded by the Technion in 2019.
21. Prof. Doron Shabat - Prize of Excellence awarded by the Israel Chemical Society in 2020.
22. Prof. Michael Urbakh - ICS Prize of Excellence awarded by the Israel Chemical Society in 2019.

Staff

Core Staff

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Ms. Michal Shenhar	Administrative Director
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Prof. Lihi Adler-Abramovich	Faculty of Medicine
Prof. Amit Kohn	Materials Science and Engineering

* Prof. Itai Benhar of the Faculty of Life Sciences replaced Prof. Dan Peer on 1/10/2020.

Acknowledgments

Building

- The Roman Abramovich Nanoscience and Nanotechnology Building
- The Sagol Center for Regenerative Biotechnology

Centers and Institutes

- The Chaoul Center for Nanoscale Systems
- The Center for Nanostructuring-- James Russell DeLeon
- The Marian Gertner Institute for Medical Nanosystems
- The Ilona Rich Institute for Nanoscale Bioscience and Biotechnology
- The Jack H. Skirball National Center for Biomedical Nanoscience

Laboratories

- Di Laudadio Laboratory for Photolithography
- Robert Goldberg Laboratory for Focus Ion Beam Nano Structuring
- The Dr. Teodoro Jack and Dorothea Krauthamer Laboratory for Scanning Electron Microscopy
- A.V.B.A. Student Laboratory for Electron Beam Lithography

Facilities and Equipment

- D&M Magali Ltd. - Aviva Moldawsky
- Vinci Technologies - Mr. Renaud Presberg
- Meeting Room - Ms. Sara Weis
- Frank Lowy through Pa'amei Tikva Nanotechnology Research Fund
- Infrastructure Equipment for Nanotechnology Research - Wolfson Family Charitable Trust
- Focused Ion Beam System (FIB)- VATAT (Planning & Budgeting Committee of the Council of Higher Education)

Chairs

- The Hermann and Kurt Lion Chair in Nanosciences and Nanotechnologies
- The Raymond and Beverly Sackler Chair in Clusters and Nanoparticles
- The Bernard L. Schwartz Chair in Nanoscale Information Technology
- The Edouard Seroussi Chair for Protein Nanobiotechnology

Research Funds

- Norman and Doreen Kingston
- Nanotechnology Research Fund in Cooperation with Clal Biotechnical Industries
- Support for Nanotechnology Research donated by the Gilman Foundation

Scholarships

- The Buchman Heyman Fund
- The Cohen Family Doctoral Fellowship for the Study of Nanoscience
- Shlomo Eliahu
- The Herbert and Sharon Glaser Fund
- Elie Horn
- Berthe Jabes
- Claire and Thierry Jabes
- Brian Leaver
- Renauld Presberg
- Francoise and Sylvain Reingewitz
- Ezekiel Solomon
- Walanpatrias Stiftung (Fund)

General

- Tel Aviv University-Northwestern University Nanoscience and Nanotechnology Initiative—Roman Abramovich
- The Israel Nanotechnology National Initiative (INNI) program, founded by TELEM

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