NANO 2020

At the Center of Innovation

NANO at BGU

Spotlight on Applied Research at the Ilse Katz Institute for Nanoscale Science and Technology

אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

IKI Ilse Katz Institute for Nanoscale Science and Technology

BGN Ltd Of Ben-Gurion University

Ben-Gurion University of the Negev, founded in 1969, aspires to fulfill the vision of Israel's first Prime Minister, David Ben-Gurion, who believed that Israel's bright scientific future lay in the development of the Negev, Israel's vast southern desert. Today, as it approaches its 50th anniversary, the University is realizing its mandate to teach, conduct research and drive development in the Negev: close to 20,000 students are enrolled in six faculties at its campuses in Beer-Sheva, Sede Boqer and Eilat.
BGU is not only a well-established university in Israel; it has also acquired an international reputation. BGU conducts major world-class research in biotechnology, arid zone research, conversion and inter-religious encounters, cyber security, energy, European politics and society, Hebrew literature, Jewish thought, nanotechnology, neuroscience, robotics, water and agriculture, and much more. Our special commitment to the community means that thousands of students take part in community-oriented activities and special tutoring projects while pursuing academic excellence.
The University welcomes exciting challenges in innovative fields of research and strives to bring new opportunities to Beer-Sheva and the Negev while continuing its pursuit of academic excellence and expanding its contribution to the community.

BGN Technologies, the University's technology transfer company, is responsible for the commercialization of the expertise and inventions of the University's researchers. Through creative partnering with industry and investors in the development of novel technologies originating in Ben-Gurion University of the Negev, BGN brings value to the technological marketplace. BGN files patent applications worldwide in the name of BGU and manages the University's patent and IP portfolio. It continually seeks new prospective strategic partners, licensees and investors.

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NANO at BGU

Spotlight on Applied Research

The Ilse Katz Institute for Nanoscale Science and Technology

The Ilse Katz Institute for Nanoscale Science and Technology (IKI) at Ben-Gurion University of the Negev (BGU) was founded in 2006 and operates under the Israeli National Nanotechnology Initiative (INNI). In 2007, the Israeli government decided to establish the area of nanoscience as a national priority project with the goal of creating a research infrastructure that will be the basis for nano-industries in Israel. The IKI brings under one roof a community of scientists working on aspects of these fields related to the understanding and manipulation of matter at reduced dimensionality.

The vision for the Ilse Katz Institute at BGU is to establish it as a center of world-class scientific research through the development of nanoscience and nanotechnology. To realize this vision, we promote, enable and support innovative nanoscale research and education at BGU, by

- Recruiting and supporting leading researchers
- Attracting excellent students to the field
- Establishing and operating state-of-the-art research infrastructure
- Promoting industry-academia interactions in order to focus and implement research
- Developing and encouraging interdisciplinary research interactions through seminars and workshops
- Raising the necessary funding for the execution of this mission

Cutting-edge research in nanotechnology is carried out at the IKI in a variety of areas, such as energy conversion and storage, nano-photonics, nano-biotechnology, nano-medicine, biophysics, water purification and desalination, biological and chemical sensing, quantum science and technology, thin films and nano-materials synthesis, characterization and interactions.

In 2011, the INNI established the Focal Technology Areas (FTAs), a competitive program aimed at large-scale applied nano research carried out at Israeli institutions. The IKI is proud to be the only institute to lead two such multi-million five-year projects.

In support of nanoscale research at BGU and the entire academy, as well as by industry and government, the IKI provides state-of-the-art facilities for nano-scale fabrication and characterization.

Being part of BGU, we believe that the Institute must play a major role in the education of scientists and engineers, as well as in the transfer of knowledge to the broader community. We thus offer and support a unique and competitive interdisciplinary graduate program for PhD in nanotechnology, as well as a double major undergraduate program.

IKI

Prof. Yuval Golan, IKI Director

Focal Technology Area 1: Nano-Biomedical Research

Bio-Inspired Nano-Carriers for Sub-Cellular Targeted Therapeutics

Research Leader

Prof. Joseph Kost
Department of Chemical Engineering; Dean of The Faculty of Engineering Sciences

Research

Our research in the nono-biomedical Focal Technology Area (FTA) develops bio-inspired nano-carriers (NCs) aimed at sub-cellular targeting of therapeutics for the treatment of cancer and metabolic diseases. Uniquely, this program's focus on drug delivery systems and includes aspects such as: design of new nano-carriers, synthesis and characterization, intra-cellular trafficking, sub-cellular recognition, and localized cargo discharge, up to the level of in-vivo proof of efficacy. The benefits of our NCs will be dramatic for both doctors and patients, providing lower drug toxicity, more specific targeting and possibly reduced treatment costs. Getting the active compound to where it is needed and effectively delivering it, is one of the holy grails in the treatment of diseases ranging from inflammation to cancer.

Our NC encapsulated therapeutics provide both patient and payer value by:
- Using approved drugs and finding better ways of delivering them to their targets.
- Using bioinspired compounds for drug delivery that may extend the product and patent lifecycles of drugs, via reformulation of existing compounds.
- Developing new drugs and drug combinations that can be delivered together to increase the efficacy and potency for unmet medical indications.

Applications & Products

Our 5 year FTA has focused on the following:
- Two RNAi nanoparticle drugs; targeting breast and ovarian cancer in NCs.
- Peptidic NC delivery of Lonidamine to mitochondria.
- NC-mediated inner membrane delivery of Phosphoinositides to modulate autophagy (a metabolic disease).
- Development of two specific gene therapy plasmid DNA vectors for the treatment of cancer.

Focal Technology Area 2: Nano-Photonics Research

SWIR (Short Wave Infrared) to Visible Image Up-Conversion Integrated Device

Research Leader

Prof. Gabby Sarusi
Unit of Electro-Optical Engineering

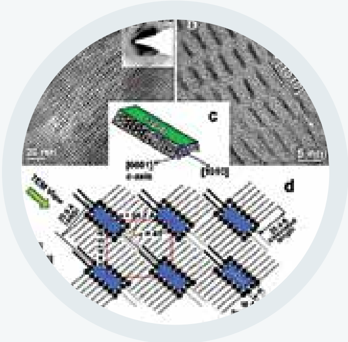
Research

An up-conversion imaging layer, which converts infrared images into visible images. It is composed of a quantum dots or quantum columns detection layer that absorbs the infrared light, and the absorption is enhanced by surface plasmons. Holes and electrons generated by the incidental SWIR light are drifted toward an OLED layer and recombined to generate visible photons. The lateral position of the absorbed IR photon is in full spatial registration with the emitted visible photon and thus, full imaging capability is feasible. This wavelength up-conversion is carried out through a linear conversion and with relatively high conversion efficiency, where an external electric field is induced to supplement the energy difference between the SWIR energy absorbed and the visible light energy emitted.

A second design option is to use a Liquid Crystal Optical Spatial Light Modulator (LC-OSLM) configuration. In this apparatus, the photo-excited charge carriers induce a localized electric field in the LC, so that the SWIR serves as the writing light. The reading light is a green light that is reflected locally from the location where there was absorption of SWIR light, thus generation the visible image.

Applications & Products

Light-weight SWIR glasses for drivers, fire fighters and for defense applications.



Nanomaterials @ Interfaces

Researcher

Prof. Yuval Golan
Department of Materials Engineering

Research

The aim of Prof. Golan's research is to identify and to understand the chemical and physical interactions and inter-facial processes that govern the formation of thin films and two- and three-dimensional assemblies of ordered nanoparticle systems. This includes the direct deposition of semiconductor thin films on single crystal substrates and on ultra-thin organic film templates, as well as surfactant-controlled chemical deposition of nanoparticles of different shape and composition onto solid supports (from a solution or from the air-water interface using the Langmuir-Blodgett technique) in order to form ordered super-crystalline arrays of nanoparticles.

Characterization techniques include advanced electron microscopy, electron and x-ray diffraction techniques, plus a variety of optical techniques, such as photo-luminescence and optical absorption spectroscopy. Prof. Golan uses various synchrotron radiation techniques for structural characterization, including grazing incidence x-ray diffraction and grazing incidence small angle scattering.

Applications & Products

Coating of 2D and 3D semiconductor films onto single crystal and organic films at room temperature with very simple and inexpensive equipment, suitable for mass-production of products such as solar cells, detectors, etc.

Optoelectronic Devices from Polymers

Researcher

Dr. Rafi Shikler
Department of Electrical and Computer Engineering

Research

Prof. Shikler's group studies electronic and optical processes in optoelectronic devices based on polymers and organic molecules, in order to fabricate new devices and new architectures for operating devices.

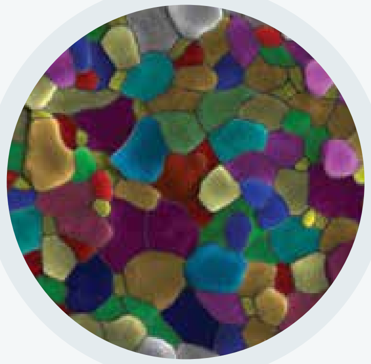
We approach the task from three different angles: In the first, we study degradation processes in organic devices such as organic solar cells, organic light emitting diodes, organic transistors and organic flash memories. We employ an atomic force microscope in combination with a Raman spectrometer to detect chemical changes with high spatial resolution. We have already developed a new approach to surface-enhanced Raman spectroscopy that allows selective vertical studies on degradation processes in organic devices with vertical structures such as OLED and OSC. We also study charge retention in organic flash memories in order to develop improved architecture for information storage.

The second angle focuses on the integration of different optoelectronic devices to form a new device. We are part of a joint project working on combining an IR detector with an OLED structure for a night vision system, where we are responsible for the fabrication of the OLED and its integration with a transparent cathode. We are also working on combining organic solar cells with an organic thin film transistor for light detection.
The final angle focuses on the study of new materials for devices.

Applications & Products

Optoelectronic devices based on polymers and organic molecules:

- OLED
- Wave guides
- Magnetic, light and pressure sensors
- Organic flash memory
- Large-scale organic photovoltaic



Polycrystalline Transparent Ceramics

Researcher

Prof. Nachum Frage
Department of Materials Engineering

Research

The mechanical and optical properties of polycrystalline ceramics are controlled by microstructural features such as grain size, porosity and presence of second phases. To achieve high transparency of the polycrystalline ceramics it is important to create a microstructure that contains a minimal fraction of scattering centers. In fully dense single phase ceramics, the transparency increases with the increment of grain size due to the decreasing fraction of grain boundary regions. On the other hand, the mechanical properties (strength and hardness) of polycrystalline ceramics with an average grain size larger than 0.5 µm significantly decrease. Thus, the optical transmittance and the mechanical properties of the polycrystalline ceramic change according to grain size in opposite directions, and an optimal compromise between the functional properties of the ceramics has to be determined and realized. High pressure spark plasma sintering (HPSPS) apparatus allows the fabrication of nano-structured ceramics. The primary focus of our research is to determine the optimal parameters of the SPS process for the fabrication of fully dense polycrystalline ceramics with the appropriate functionality required from the final product.

HPSPS-processed nanostructured magnesium aluminate spinel specimens display a transparency of 82%, 1700HV hardness, and bending strength of about 280 MPa. Nd:YAG specimens fabricated by HPSPS display a very good combination of mechanical properties along with optical properties. The laser performance of the HPSPS specimen is comparable with ceramics fabricated by a conventional two stage method that is much more prolonged and expensive.

Applications & Products

Polycrystalline transparent ceramics (magnesium aluminate spinel and yttrium aluminum garnet) with a unique combination of mechanical and optical properties for armor and laser applications were fabricated through high-pressure spark plasma sintering of nano-size powders.

Peptide Matrices for Promoting Bone Regeneration

Researcher

Prof. Hanna Rapaport
Avram and Stella Goldstein-Goren Department of Biotechnology Engineering

Research

A multifunctional peptide matrix was developed to act as a hydrogel scaffold for inducing bone regeneration and repair. The hydrogel provides a unique template for bone bio-mineralization and supports cell differentiation through a safe physio-chemical mode of action. It is a purely synthetic bone regeneration medical device, consisting of a designed, novel PFD5 peptide that was found to shorten healing time and increase the rate of bone regeneration in-vivo, in small and large animal models.

The technology combines innovative interdisciplinary expertise in the design of functional peptides, bio-mineralization and tissue regeneration while enabling the biological mechanisms of bone augmentation.

Applications & Products

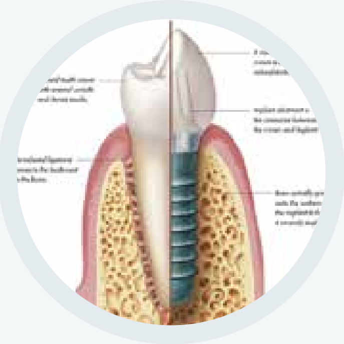
Bone-graft, peptide-based compositions that accelerate bone tissue regeneration for orthopedic and dentistry applications.

Market Potential

Our peptide-based hydrogel bone graft substitute targets a variety of needs and indications in orthopedics and dentistry, including fracture healing and unmet bone regeneration needs in osteoporosis patients. The market for bone grafts is and will continue to be driven by the risks associated with the use of autograft bone, as well as the need to achieve superior and optimum bone fusion, speedy patient recovery, the need to eliminate multiple surgeries, a rising number of spinal fusion procedures, and increasing use of tissue-engineered bone in joint replacements.

Patent Status

US and EU patents granted.



Novel Coatings for Titanium Bone Implants for Dental and Orthopedic Applications

Researcher

Prof. Hanna Rapaport
Avram and Stella Goldstein-Goren Department of Biotechnology Engineering

Research

Multifunctional peptides were developed to efficiently coat titanium implants while enhancing bio-mineralization and bone tissue regeneration at the implant surface. The synthetic peptides act as a calcium depot for the bone forming cells, inducing their adhesion and proliferation. The technology combines innovative interdisciplinary expertise in the design of functional coating peptides, bio-mineralization and tissue regeneration, thereby facilitating the biological mechanisms of bone regeneration.

The first in-vivo testing in small animals has demonstrated significant advantages in mechanical properties over standard titanium implants.

Applications & Products

Coating materials and processes consisting of peptide-based compositions that enable rapid integration and long-term success of titanium implants for orthopedic and dentistry applications.

Advantages

Improved direct bone formation onto the surface of titanium implants, consequently reducing the failure rate of bone implants due to aseptic loosening and infection.

Patent Status

US and EU patents pending

3D Full-Field Optical Coherence Microscope @Nano-Scale

Researchers

Prof. Ibrahim Abdulhalim
Unit of Electro-Optical Engineering

Dr. Avner Safrani
Unit of Electro-Optical Engineering

Research

Parallel phase shifted interference full-field images are recorded in real time, together with a shift algorithm, to extract the phase and the envelope of the interference signal.

Optical metrology method which allows 3D imaging for a variety of applications, ranging from biological research to the semiconductor industry.

Proprietary technology enables ultra-high speed, accurate 3D analysis of sub-micron structures, including: non-contact 3D surface profiling; defect inspection; real-time tilt measurement; high speed dynamic focusing control; 3D live imaging of biological samples; high frequency vibration analysis, and more.

Product

Over the counter 3D real-time video-rate imaging microscope.

Status

Fully operational on bench prototype. Full-scale microscope in Q2 2015.

Patent Status

2 patents pending.

Nanoparticles for Intracellular Delivery of Drugs

Researcher

Prof. Smadar Cohen
Avram and Stella Goldstein-Goren Department of Biotechnology Engineering

Research

Within the FTA framework, Prof. Cohen's lab has developed nanoparticles targeted for intracellular delivery of drugs. The nanoparticles can encapsulate a wide variety of cargo, including nucleic acids, such as siRNA, and insoluble small molecules with anti-cancer activities.

Advantages

- Nanoparticles are made of biocompatible materials, calcium ions and polysaccharides
- Their fabrication is simple and easy; It merely requires mixing the components together in aqueous ("green") conditions and at room temperature. The mechanism underlying their formation is based on electrostatic interactions between the components
- The nanoparticles have an average diameter of 100 nm with a narrow size distribution and have a mild anionic zeta potential (-6 mV). These features enable their efficient entry into the cell cytoplasm
- We demonstrated excellent efficacy, and in the case of siRNA, we showed tumor-specific knockdown of the targeted mRNA (STAT 3 and VEGF)

Applications & Products

- Hepatocarcinoma siRNA therapeutics
- Breast cancer chemotherapy
- Cardiovascular miRNA therapeutics

Patent Status

Two patent applications pending.

The Atom Chip Lab

Researcher

Prof. Ron Folman
Department of Physics

Research

Prof. Folman conducts experimental and theoretical studies related to quantum optics and specifically, matter-wave optics (i.e., atom optics with ultra-cold atoms). Prof. Folman constructs chips that interface with single or groups of atoms, called Atom Chips. The Atom Chip brings together the best of both worlds: the relatively mature field of micro- and nano-fabrication and the new set of scientific rules provided by quantum theory. Together they form quantum technology, with the promise of novel applications. The chip is at room temperature, while the atoms are cooled by lasers to nano-Kelvin.

The group works on questions related to fundamental studies of quantum mechanics such as decoherence and interferometry, and for applications such as clocks, inertial navigation, gravitational field sensing, magnetic sensing, and steps towards quantum communications and computing. For example, the group is now building the next generation of miniature atomic clocks (with cold atoms) together with AccuBeat, constructing miniature magnetic sensors for IAI and NATO, and is even applying such sensors for the probing of neurons.

Applications & Products

- Atomic clock, magnetic sensors, gravitational sensors, acceleration sensors
- Photonics: chip-scale sensors for trace amounts of materials down to singe atoms
- Materials and surface science by surface probing

Large Extension of Depth of Field for Cameras and Imaging Systems

Researchers

Prof. Ibrahim Abdulhalim
Unit of Electro-Optical Engineering

Dr. Iftach Klapp
Unit of Electro-Optical Engineering

Dr. Itzik August
Unit of Electro-Optical Engineering

Research

Prof. Abdulhalim's research group has developed a proprietary method based on generation and multiplexing of several phase masks using a liquid crystal device with annular electrodes operated with small voltage.

Applications & Products

- Survey and camera market
- Cell phone market
- Endoscopy market
- Optical microscopy market
- Optical inspection systems market

Advantages

- Compact module that can fit into existing imaging systems
- Can be integrated with cell phones
- The LC device can be used for applications such as super resolution, tunable dark field and phase contrast microscopy

Electro-Optic Modulator based on a Metal-Ferroelectric Nanocomposite

Researcher

Prof. Shlomi Arnon
Department of Electrical and Computer Engineering

Research

The requirement for fast and high information rate communications necessitates new revolutionary devices to replace conventional technologies. Prof. Arnon's technology for modulating light in both visible and infra-red is based on incorporating metal nanoparticles (NP) within a ferroelectric (FE) thin-film. By merging the electro-optical properties of FE thin-films with the local surface plasmon phenomena of metal NPs, Arnon is able to achieve control over the optical properties of the metal–dielectric system under an external electric field.

Product

Electro–optic modulator.

Advantages

The modulator has many advantages, including: high data rate, low power consumption, low drive voltage, low cost, and integrate-ability with other active semiconductor devices. To date, the laboratory has carried out extensive theoretical work and published its findings in leading journals in the field of optics.

High Performance Hybrid Nanocomposite Materials

Researcher

Prof. Oren Regev
Department Chemical Engineering

Research

Innovative nanocomposite materials, based on loading epoxy polymer with hybrid nano-fillers: the first nano-filler is the newly discovered graphene, and the second is carbon nano-tubes, already applied in automotive parts and large-area coating due to its extraordinary strength. Prof. Regev's lab harnesses nano-fillers' novel properties for the purpose of manufacturing a lightweight, strong and resilient material that will provide reinforcement in a number of key mechanical challenges for structural adhesives (used to adhere key elements in complex structures), or serve as traditional composite materials elements.

The uniqueness and innovativeness of this technology is the integration of two types of nano-fillers, which differ in morphology and properties. By using hybrid filling, we harness both nano-fillers' morphologies in producing a positive synergetic nanocomposite, i.e., yielding better performance (Fracture toughness 2.5 MPa*m0.5 and flexural strength of 120 MPa) than a composite with a single nano-filler. We postulate that the combination of two types of nano-nanofillers will form a highly compact 3D network, providing a more effective means for stress transfers and hence, reinforcement.

Applications & Products

- Applicative and simple technology for employing nano-fillers in composite materials and polymer industries.
- Strong and lightweight composite materials.

Market Potential

The US demand for adhesives and sealants for 2017 is anticipated to be about 9.8 billion pounds, valued at over $11 billion. The composite materials–aerospace market is anticipated to grow to 46,175 metric tons, valued at $4.5 billion by 2022.

The field of nano-fillers is a rapidly growing market. The production of nanotubes had grown by over 450% percent between 2008 and 2011, with price dropping below $1/g, which increases its attractiveness and business feasibility.

Nanomaterials and Device Structures for Photovoltaic Solar Energy Conversion

Researcher

Prof. Eugene A. Katz
Alexandre Yersin Department of Solar Energy and Environmental Physics

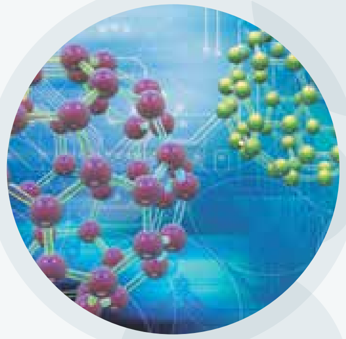
Research

Prof. Katz conducts research with the aim of resolving the greatest challenges facing the development of novel photovoltaic devices and to combine high efficiency, stability and reproducibility in a single inexpensive device. His investigations encompass three directions:

- Development of inexpensive, efficient and stable materials and solar cells based on organic semiconductors, fullerenes, carbon nanotubes and nanoclusters, organic-inorganic (perovskite) hybrids.
- The study of photovoltaic conversion under ultra-high concentration of sunlight (up to 15,000 suns).
- Development of novel concepts and device architectures for ultra-efficient photovoltaics (external photon recycling, light management, ultra-thin photoactive structures, etc.).

Applications & Products

Various photovoltaic cells based on novel nanomaterials and device structures.



High ZT Thermoelectric Materials

Researcher

Prof. Yaniv Gelbstein
Department of Materials Engineering

Research

The search for alternative energy sources is at the forefront of applied research. In this context, thermoelectricity, or the direct conversion of thermal energy into electrical energy, plays an important role, particularly for the exploitation of waste heat. Materials for such applications should exhibit thermoelectric potential and high thermodynamic and mechanical stability.

Prof. Gelbstein's lab is investigating many classes of thermoelectric materials for various power generation applications, including automotive, marine and PV-TE. Both high efficiency and nano-structure stability under practical application conditions are considered, and both experimental and theoretical approaches are being applied to achieve the group's agenda. Advanced methods for nano-structuring of bulk thermoelectric materials, including thermodynamic / physical metallurgy driven nano-features methods, are investigated. So far, high maximal thermoelectric figure of merit (ZT) values of >2 were obtained with reasonable stability characteristics, placing the materials developed by the group at the forefront of the most advanced thermoelectric materials developed globally.

Applications & Products

Thermoelectric generator in the range of 300-600W output electrical power for automotive applications (gasoline engines), converting the waste exhaust heat generated into useful electrical power.

Tunable Light Emitters using Carbon Quantum Dots

Researcher

Prof. Raz Jelinek
Department of Chemistry

Research

A new technology has been developed for fabrication of solid-state lighting devices comprising luminescent carbon dots (C-dots) encapsulated in transparent polymer films. The simple one-step synthesis scheme yields luminescent films in which colors can be tuned by selection of the carbon dots embedded.

Goals and Benefits

- Simple and "green" technology for production of transparent luminescent films having different colors.
- Inexpensive and non-hazardous reagents. Technology is easily scalable.
- Generation of "warm" light, particularly warm white light is feasible.

Applications & Products

- Light emitting devices
- Light converters
- Light transformer sheets, for example in greenhouse applications

Patent Status

Patent applications pending.

Chemo- and Bio-Sensors based on a Chromatic Polymer

Researcher

Prof. Raz Jelinek
Department of Chemistry

Research

Prof. Jelinek's lab has been working in the past few years on the development of color and fluorescence sensors based on *polydiactylene* (PDA), a unique chromatic polymer. Different PDA matrices (films, gels, solutions) undergo color and fluorescence transformations induced by the interactions of different analytes. This PDA technology can be used for detection of water contaminants, heavy metals, pathogenic bacteria and more.

Goals and Benefits

- Commercially available polymer that can be easily molded into varied configurations.
- Generic technology that can be implemented for detection of varied analytes.
- Sensing platform that employs both visible color changes and fluorescence transformations.

Applications & Products

- Color sensors for water pollutants
- Bacterial sensors
- Sensors for heavy metals in water

Transparent Conductive Gold Films

Researcher

Prof. Raz Jelinek
Department of Chemistry

Research

New technology for spontaneous deposition and patterning of thin gold layers upon surfaces. The technology is based on crystallization/reduction of a gold complex upon polar surfaces. Conductive and transparent films can be generated on planar, non-planar, and flexible surfaces.

Advantages

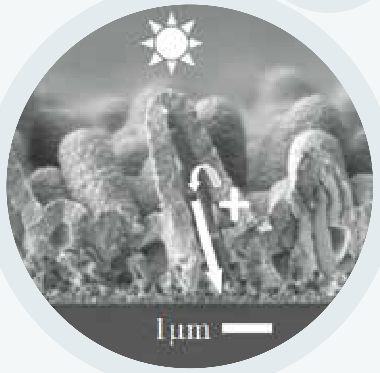
- Simple synthesis scheme using cheap and readily-available reagents.
- Generic technology that can be implemented on varied surfaces, as well as microwires, fibers, sponges, etc.
- Technology can be easily scaled to larger surface areas.

Applications & Products

- Transparent conductive electrodes
- Smart displays
- Piezo-resistive pressure sensors
- Physiological pressure sensors

Patent Status

A patent application has been submitted and more than 10 papers published in leading journals.



Photovoltaic Materials and Applications

Researcher

Dr. Iris Visoly-Fisher
Alexandre Yersin Department of Solar Energy and Environmental Physics

Research

Dr. Visoly-Fisher's research focuses on developing low-cost photovoltaic devices via wet processing of organic and inorganic materials using novel deposition methods.

While the cost of commercial Si-based photovoltaic (PV) technology, converting sunlight to electricity, has dropped substantially in the past several years and reached grid-parity, the need to decrease costs is still of high priority to broadening its use off grid, as well as for niche applications such as building integrated photovoltaics and disposable energy sources.

Accordingly, our work mainly deals with the following topics:

- Novel device configurations, which can be deposited using low-cost methods such as wet processing at room temperature, thereby eliminating the need for high-vacuum clean rooms and high temperature processes.
- Long-term device stability of low cost devices, a necessary requirement for their commercialization.

Results and Products Highlights

- Semiconductor-sensitized PV cells were developed using chemical bath deposition and electrodeposition of semiconductors for devices operating in the IR range towards utilization as constituents in low cost tandem solar cells for wide spectrum utilization.
- Accelerated stability studies of organic and hybrid PV materials and devices, aimed at rapid screening of materials and device configurations. We use concentrated natural sunlight for high acceleration factors, and have shown that independent control of the temperature, sunlight intensity and ambient can contribute to understanding degradation mechanisms. These methods were applied to studies of the recently developed perovskite PV materials.
- Metal-free molecular junctions on ITO were developed, allowing the study of light-induced effects on transport in self-assembled porphyrin molecular junctions. We have shown photo-induced charge transfer between porphyrins and ITO surface states in the visible range, relevant to solar cells and OLEDs, and showed photovoltaic currents in monolayer-based junctions, towards extreme miniaturization of organic PV devices.

Targeted Nanomedicines for Cancer Therapy

Researcher

Dr. Ayelet David
Department of Clinical Biochemistry and Pharmacology

Research

We design novel therapeutic polymers to create nano-sized medicines (nanomedicines) with superior efficacy and minimal side effects. The new biocompatible therapeutic polymers are composed of three main components:

- Water-soluble polymeric backbone, such as HPMA (N-(2-hydroxypropyl)methacrylamide) or polyethylene glycol-b-polyethylenimine (PEG-b-PEI) as a drug carrier.
- Therapeutic molecules: chemotherapeutic agents, anti-inflammatory drugs, oligonucleotides.
- Cell targeting ligands to provide cell specificity and enhance drug efficacy.

The new therapeutic polymers were found to be very useful at several pre-clinical settings, in:

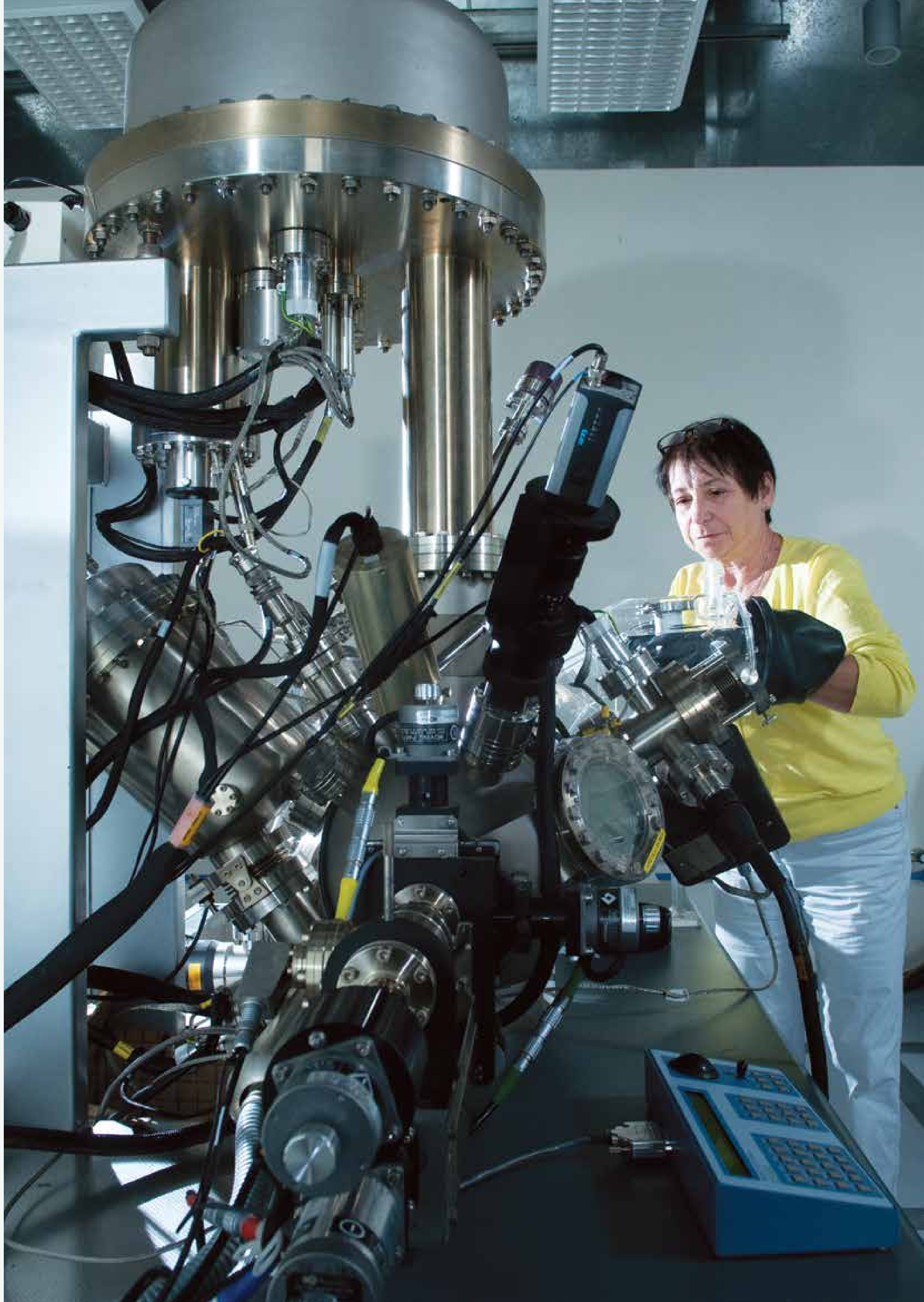
- Targeting drugs to primary tumors, to metastases and to inflammatory lesions, thus preventing cancer progression and further controlling inflammation.
- Preventing the formation of cancer metastases and further inhibiting leukocytes infiltration into inflamed sites, without the need for conventional drug cargos.
- Improving the intracellular penetration of therapeutic polymers upon exposure to external stimuli (i.e., light or polyanionic molecules).
- Detecting a variety of cancer and inflammatory diseases, including colorectal cancer, from the luminal aspect of the colon.

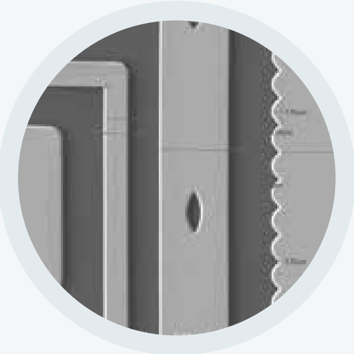
Applications & Products

- E-selectin targeted nanomedicines for controlling cancer progression and preventing metastasis.
- Stimuli-responsive polymers for drug delivery.
- Polymeric imaging probes for non-invasive detection of cancer and inflammatory diseases.

Patent Status

Patent on E-selectin targeted nanomedicines (tumor vascular targeted system) granted; Two additional patents covering composition of matter for different applications currently pending worldwide.





The Nano-Fabrication Center

Dr. Erez Golan
Head of the Nano-Fabrication Center

The Nano-Fabrication Center at Ben-Gurion University of the Negev is a facility serving the academy, industry, and government. The Nano-Fabrication Center has been operating since February 2005, when Fab1 was opened. Today it includes three fabrication areas and two nanolabs.
The Nano-Fabrication complex incorporates state-of-the-art R&D and prototype fabrication infrastructure for Nano/Microelectronics, BioMEMS, BioChip, Microfluidics, Multielectrode array, Nanophotonics and Optoelectronics and Nano/Micro systems (MEMS).

Equipment and Infrastructure

The Nano-Fabrication Center consists of three independent clean room sub-areas (Fab1, Fab2, Fab3) with class 100 to 10000 and two Nanolabs: the Electrical and Optical Characterization of Devices NanoLab and the Packaging NanoLab (including wafer/chip bonding, wire bonding, die saw and more).

The advanced cutting-edge nano-fabrication equipment used in all our labs and Fabs, enables us to offer comprehensive services, including: Thin film deposition; etching; lithography; bonding; baking; dicing and polishing; mask fabrication and wafers cleaning; and devices analysis and characterization.

The Nano-Fabrication Center also provides the unique possibility of HAR etching on sapphire, glass, silicone and other substrates; making line/space and holes with a diameter less than 10nm; producing nanowires; design and fabrication of reflective and antireflective surface structures and coating, blazed grating and plasmonic structures, and high quality optical micro disk/ring structures; precision nanolithography, and more.

Our Services

- Process design
- Process development
- Process integration
- Process characterization
- Full high-resolution litho service (with resolution of less than 10nm)
- Small volume production service (from concept to final product)
- Optic, thermal, and electrical simulations and tolerance analysis

Advantages and added value of working with BGU Nano-Fabrication

- Accumulated knowledge and experience: We have the know-how, accumulated through experience and many successful projects in multidisciplinary fields
- Flexibility: Operational flexibility and variability in the development and fabrication process
- Time-to-Market: Short cycle timeframe from concept to production
- Interactivity: A collaborative and transparent working process at all stages

Selected clients

Defense: Elbit Systems – Elop, Rafael Defense Systems
Semiconductors: Applied Materials, Orbotech, KLA-Tencor, Jordan Valley Semiconductors, Nova Measuring Instruments
Other: Qlight Nanotech, SanDisk, Thales CMT Medical Technologies, KiloLambda, Acktar

The Characterization Laboratories Center

Dr. Tsiona Elkayam
Head of the Characterization Laboratories Center

The **Characterization Laboratories** at IKI serve as a support center for innovation and excellence in research by providing up-to-date technologies and cutting edge infrastructure for characterization analysis. The equipment is operated by professional technicians and supervised by an IKI faculty member. The Center promotes cooperation with industry by offering scientific and analysis solutions to hi-tech companies and others.

Equipment and Infrastructure

The Characterization Laboratories include the equipment for the following analyses:

Surface Analysis
- Scanning probe microscopy (SPM)
- X-ray photoelectron spectroscopy / auger electron spectroscopy (XPS/AES)
- Grazing incidence small angle x-ray scattering (GISAXS)

Spectroscopy
- Raman
- Fourier transform infrared spectroscopy (FTIR)
- FTIR polarization modulation measurements (solid and liquid samples)
- FTIR imaging microscopy
- Electron spin resonance (ESR)
- Fluorescence spectroscopy

Electron Microscopy
- Analytical transmission electron microscopy (A-TEM)
- Cryo transmission electron microscopy (Cryo-TEM)
- Ultra-high resolution scanning electron microscopy (UHR-SEM; EDS)
- Scanning electron microscopy (EDS)

X-Ray Analysis
- Powder x-ray diffraction
- Thin-film x-ray diffraction
- High resolution x-ray diffraction (double and triple-crystal geometry)
- Small and mid-angle x-ray scattering (SAXS)
- Wavelength dispersive x-ray fluorescence analysis (XRF)

Biophysical Characterization and Advanced Light Microscopy
- Total internal reflection fluorescence microscopy (TIRF)
- Near-field scanning optical microscopy (NSOM)
- Spinning disc confocal microscopy
- Imaging ellipsometery and Brewster angle microscopy
- Refractometery
- Contact angle measurements

Mass Spectrometry and Chromatography
- Orbitrap mass spectrometer
- MALDI-TOF mass spectrometer
- LC-MS GC-MS

Light Scattering
- Dynamic light scattering (DLS)
- Static light scattering (SLS)
- Zeta potential measurements

Thermal Analysis
- Differential scanning calorimetry (DSC)
- Thermogravimetric analysis (TGA)
- Micro DSC
- Isothermal titration calorimetry (ITC)

Cell Imaging and Manipulation
- Laser capture microscope
- Flow Cytometry
- FACS
- Imagestream

Contact us for more information:

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