



# INDUSTRY GUIDE TO TECHNION

Research Projects > Research Services > Technology Transfer



*Cover:* Electromagnetic Collapse of Metallic Cylinders  
Optical Microscope

Mr. Zev Lovinger and Prof. Daniel Rittel  
Dynamic Fractures Laboratory  
Faculty of Mechanical Engineering

Small hollow metallic cylinders are collapsed onto a copper core using intense electromagnetic fields. The experiment lasts a few microseconds. Optical (light) microscopy is used to characterize the deformed microstructure of the cylinder.

From *LABSCAPES* exhibition at Technion, created and curated by Mrs. Anat Har-Gil.

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From the very beginning, the relationship between the Technion and Israeli industry has been of prime importance. As early as 1925, Menachem Ussishkin, a mining engineer by profession, opened his keynote address at the opening ceremony

of the Technion with the following words: "Basic research and applied research are the two sides of the same coin." Indeed, throughout its history the Technion has supported applied research, viewing its relationship with industry as being of prime importance. Technion graduates have been responsible for transforming the basis of the Israeli economy from agriculture to high-tech, and play a major role in the Start-Up Nation phenomenon.

As we enter the second century of its existence, the relationship between the Technion and industry is becoming even more important. In order to serve the Israeli economy effectively, it is vital that industry be aware of current research at the Technion, and the advanced facilities and services the Technion offers. The prime goal of this booklet is to make this kind of information easily available. For each Faculty we have given a short history and a summary of the main themes of its activities and links to the relevant topics and facilities, including QR Codes, names of staff, and contact details.

We hope that you will find this booklet informative and useful.

Prof. Peretz Lavie

A handwritten signature in black ink, appearing to be 'P. Lavie', written over a light blue grid background.

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<http://www.linkedin.com/edu/technion---israel-institute-of-technology-13396>



<http://www.youtube.com/user/Technion>



Technion - Israel Institute of Technology is a public research university in Haifa, Israel. Founded in 1912, it is the oldest university in Israel. The Technion offers degrees in science and engineering, and related fields such as architecture, medicine, industrial management, and education. It has 18 academic faculties and 52 research centers. Since its founding, it has awarded 95,821 degrees, and its graduates are cited for providing the skills and education behind the creation and defense of the State of Israel.

### Interesting facts

→ Out of 59,100 Technion graduates who are currently of working age, a quarter (24%) are either CEO's or VP's. Another 41% hold management positions.

→ 10,882 Technion graduates, or 18.4% of all graduates, work or have worked, in startup companies.

→ 13,500 Technion graduates, nearly a quarter of all graduates, have initiated a business.

→ 15% of Technion female graduates have also launched businesses.

→ Of all Technion graduates, 35% work in industry, and 12% work in R&D; thus nearly half of all graduates are employed in jobs that either directly produce goods and services, or help design and create them.

→ Of all Technion graduates employed in industry, 75% are employed in high-tech industries.

**Source:** Technion's Contribution to the Israeli Economy through its Graduates, by Amnon Frenkel and Shlomo Maital, S. Neaman Institute Working Paper, January 2012

The Technion's 616 Faculty members currently include three Nobel Laureates in chemistry.

In 2012, the magazine Business Insider ranked the Technion among the World's top 25 engineering schools.

In 2011, the Technion partnered with Cornell University to submit a winning proposal to New York City to set up the Jacobs Technion Cornell Institute of Innovation (JTCII) on Roosevelt Island.

In 2013, the Technion embarked on establishing the Technion Guangdong Institute of Technology (TGIT) in Shantou, Guangdong Province, China.

In 2013, Technion was ranked in sixth place in the world for entrepreneurship and innovation, in the first comprehensive survey conducted by the MIT.

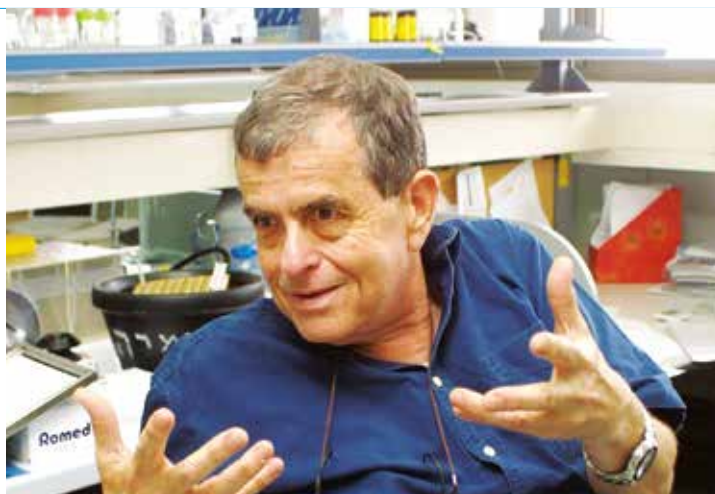
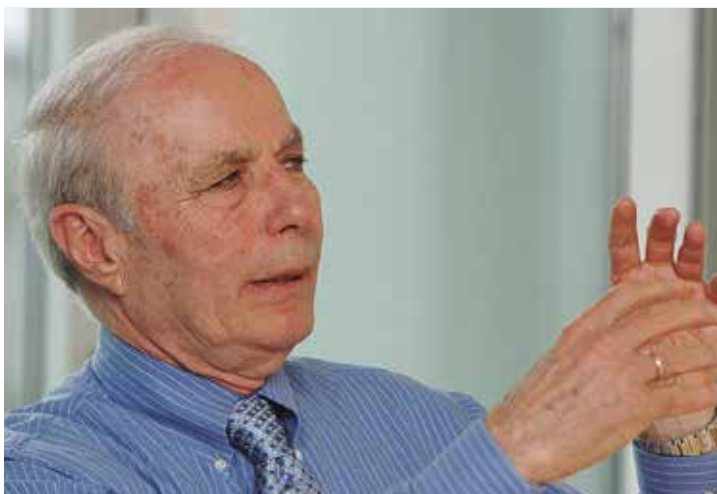
In 2013, the Center for World University Rankings ranked the Technion 66th in the World.



# ABOUT THE TECHNION







In 2013, the Shanghai Academic Ranking rated the Technion as 77<sup>th</sup> in its list of the World's top 100 universities.

In 2013, the Technion was the only school outside of the United States to make it into the top 10 on a new Bloomberg Rankings list of schools whose graduates are CEOs of top US technical companies.

**(l-r)**

**Dist. Prof. Avram Hershko**

*Nobel Prize Laureate in Chemistry 2004*

**Dist. Prof. Aaron Ciechanover**

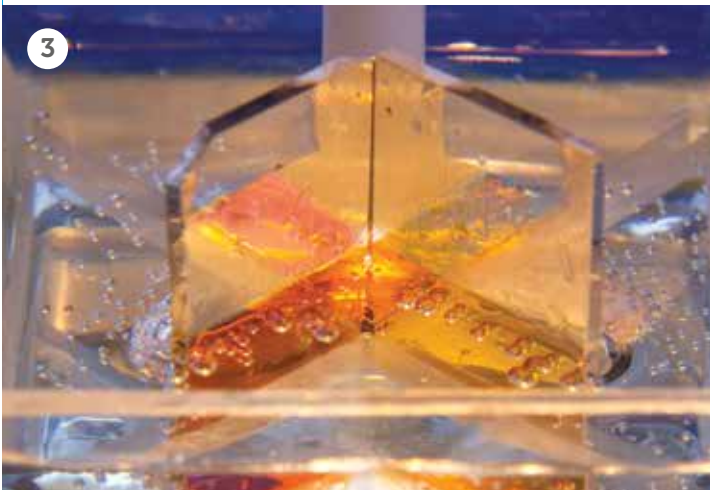
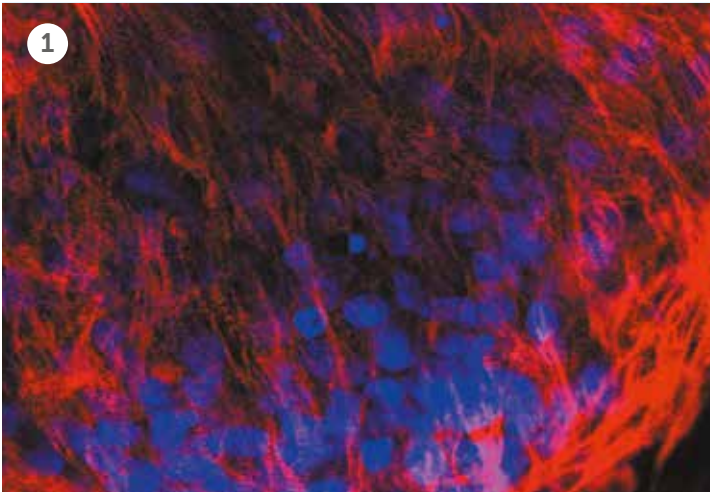
*Nobel Prize in Chemistry 2004*

**Dist. Prof. Dan Shechtman**

*Nobel Prize Laureate in Chemistry 2011*

**Dist. Prof. Arie Warshel**

*Nobel Prize Laureate in Chemistry 2013*



- 1 **Human Embryonic Stem Cells**  
first derived by Prof Joseph Itskovitz-Eldor for research and clinical applications
- 2 **Azilect® (Rasagiline), monotherapy for early stage Parkinson's disease**  
Investigated by Technion Profs. Moussa Youdim and John Finberg and developed by Teva Neuroscience
- 3 **New meethod for splitting water molecules into hydrogen and oxygen**  
could revolutionize energy storage of hydrogen-based fuels
- 4 **World's only mechanical guidance system for spine surgery with FDA clearance by Mazor Robotics.**
- 5 **Developed by Sealantis, SealV is a protein-free, bio-compatible, bio-resorbable vascular sealant and the safest and most effective sealant for vascular surgery procedures available.**





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# RESEARCH COOPERATION WITH INDUSTRY



<http://liaison.technion.ac.il>

### Contact

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# LIAISON OFFICE

The Liaison Office promotes research and development opportunities for Technion researchers and partners in Israel and around the World. The Liaison Office offers a proactive and time-efficient interface for creating partnerships between Technion researchers and industries. Upon receiving a list of an industry's technological needs, it can search the Technion campus for suitable researchers and facilities, and promote customized cooperation. The Liaison Office not only initiates the process of collaboration, but also closely follows the entire process, and assists in its various stages.

### Industry-Academia Cooperation and Services

The Technion provides a wide range of R&D opportunities for national, international and global companies searching for a technological edge through collaboration. The combination of world-class researchers, a wide spectrum of state-of-the-art facilities and laboratories, research centers and institutes, together with extensive experience with industrial partners, ensure that the Liaison Office offers the highest level of cooperation.

### Technion Liaison Office Services for Industries:

- ③ Translating an industry's needs into scientific and technological requirements
- ③ Coordinating campus resources with an industry's technological needs
- ③ Linking relevant researchers with industrial partners
- ③ Coordinating visits, networking sessions, and seminars with industries.
- ③ Meetings with relevant researchers
- ③ Mediating between industry and the researchers' needs and viewpoints
- ③ Assisting in finding the appropriate financial tools for each project
- ③ Providing assistance during all phases of the project

Making contact  
with Industry  
and other  
partners



Visiting the  
partner



Arranging  
the partner's  
visit to the  
Technion



Evaluation  
of cooperation  
potential



Forming a  
research  
cooperation  
project



**Mutual Advantages of Industry-Academic Cooperation**

Risk and cost reduction of R&D | Shortening time to market | Access to research and industrial infrastructures | Access to the wide range of resources of academic and industrial knowledge | Direct access to future skilled employees | A platform for upgrading and educating industrial staff | Public awareness through high visibility collaboration | Initiating research projects based on industrial needs

**Modes of Cooperation**

The Liaison Office has extensive experience with European Union Framework programs, as well as programs of the Office of the Chief Scientist of the Ministry of Economy (OCS), and other relevant programs. The OCS programs are jointly funded by the OCS itself, and by industry. The five main programs that deal with technology transfer are: Magnet, MagneTon, Nofar, Kamin, and Meymad, described below.

**EU Framework Programs**

The main core activity of the Liaison Office is to encourage and assist researchers and their partners in forming research consortia, and developing training and career development networks and individual excellence projects, all within EU Framework programs.

***These industry-relevant programs include:***

**Technological Consortia:**

This is the main funding tool for sustainable strategic collaboration between stakeholders in a specific topic. A successful consortium includes relevant partners, from idea to market, on a specific technological topic. The more industry-oriented consortium should be naturally top-down market-driven. The more generic type normally deals with the development of a setup of new technologies, examining their feasibility in future applications, products, and markets. Some consortia may extend into a community, combining research and training, as well as academic and business and technology transfer. The partnership consortium may cooperate with other consortia and projects.

**Future and Emerging Technologies (FET):**

Part of the European Horizon 2020 program will be FET activities. This program provides the greatest potential for academia to collaborate with industry in the European frame. FET will be the most innovative applied

research tool, with focus on the development and transfer of cutting-edge knowledge between industry and academia.

#### **Innovation in Small and Medium Enterprises (SME):**

This is a 3-stage program aimed at the start-up and promotion of new emerging innovative companies in the EU. 1st Stage - Feasibility risk IP pilot activity, individual start-up with a €50,000 budget, up to 6 months duration, 2nd Stage - Demonstration prototype design scale-up and business plan with a €1-3 million budget over 1-2 years (Co-fund), 3rd Stage - Commercialization fund-raising by a COSME-EU funding consortium or other organization.

#### **Research and Innovation Staff Exchange (RISE):**

This aims at the promotion of international industry and academia staff exchange, with the goal of knowledge transfer between sectors.

#### **Innovative Training Networks (ITN):**

This provides support for training of early stage researchers (less than 5 years with MSc degree) in multi-partner networks, including a strong industrial focus. Under the ITN umbrella is the European Industrial Doctorate (EID) program funding doctorate positions with a minimum of 50% of the time spent within the industry.

#### **European Research Council - Proof of Concept (ERC POC):**

Researchers who have received an ERC grant can apply for a subsequent Proof of Concept (POC) grant to fund further development of results which have market potential. This can include demonstration models for industry, licensing, or the creation of spinoff companies. Funding is approximately €150,000 for up to 18 months.

#### **Projects Directly Funded by Industry**

In this mode, the Technion carries out a research project that is guided by the industry's needs. Cooperation could be a fully-funded project, a combined industry and Technion research program, laboratory funding, a joint research center, or other arrangement. Terms of collaboration, including budget, duration, IP, or a combination with a framework agreement, would be adopted for each project. This is a flexible and pragmatic mode of operation.



<http://www.moital.gov.il/CmsTamat/Rsrc/MadaanEnglish/MadaanEnglish.html>

**Programs of the Office of the Chief Scientist**

**Magnet:**

This 3-5 year program supports the formation of industrial consortia with Israeli academic institutions, to perform joint generic pre-competitive research, technological development, and innovation in a particular topic, which may lead to a new generation of advanced products.

**Magneton:**

This 1-2 year program supports transfer of technology from an academic institution to an Israeli industrial company, in all fields. The ultimate budget of Magneton is NIS 3,400,000 in total, for both academia and industry. The Chief Scientist of the Ministry of Economy funds 66% of this budget, and 34% is funded by the industrial partner. The academic institution is funded 100% through this budget.

**Nofar:**

This program, lasting 12-15 months, supports advanced stages of applied academic research, not yet oriented towards a specific product, but already of interest to a business partner, and aims to bring the research to a mature phase. This program is limited to the feasibility phase. Later phases require other programs. This program enables an Israeli business partner (or an Israeli R&D subsidiary of an international company) to invest in it in the future, forming a cooperation based on the research achievements. The Chief Scientist of the Ministry of Economy funds 90% of the budget (maximum NIS 450,000), and 10% is funded by the industrial partner. The partner has the first right to examine the research results.

**Kamin:**

This is a 1-2 year program which bridges between basic and applied research that is not ready yet to be funded by industry. Kamin is open to all fields of science and technology. The maximum funding for a 1-year project is NIS 360,000, which is 90% of the requested budget. The maximum funding for a 2-year project is NIS 680,000, which is 85% of the requested budget. In special cases an additional year may be funded, the maximum funding being NIS 264,000, which is 66% of the requested budget.

#### **Meymad:**

The program promotes creative and innovative dual-use technologies, particularly aimed at the international market. Governmental funding is at the level of 50%-66% of the approved budget. The projects adopt either the Magnetron or Nofar scheme, according to the nature of the project. The maximum Magnetron-based budget is NIS 5 million for a research period of up to 30 months. For a Nofar-based project, the maximum budget is NIS 500,000 for a research period of up to 15 months.

#### **Bilateral and Multinational Industrial Programs**

In these frameworks, the Technion can sub-contract Israeli industries. The main participants are the industries funded by the Ministry of Economy, according to the Direct Industrial R&D Scheme. The other parties are funded by their national body, according to its rules. This scheme includes multinational programs, such as EUREKA, Galileo, and ETP-GTI ERANET programs, and additional bilateral funds, such as BIRD, CIIRDF, and KORIL-RDF.

#### **Additional Programs**

There are additional governmental programs for industry-academia collaboration, such as programs by the Ministry of Science, Technology and Space, the Ministry of Agriculture and Rural Development, the Ministry of Energy and Water Resources, and others. The Liaison Office, together with other units in TRDF, assists in locating available programs and in submitting a proposal.

#### **Faculty Services and Student Programs**

Various Technion faculties also have a person in charge of industrial cooperation, such as joint seminar days and carrying out relevant student projects based on particular industrial needs. These projects are specified by the industry, and are usually carried out by undergraduate students. The projects may include two mentors, one from industry and one from the Faculty. The industry receives a very high-level development solution at a very low cost. These projects interface, and preserve and continue the existing industry-academia relationship, and may affect the content of academic courses. As added value, these projects provide hands-on experience for the students, and prepare them for dealing with real-life problems. In many cases these students are later employed by the industry.

# INDUSTRIAL AFFILIATES PROGRAMS



The Industrial Affiliates Programs (IAPs) are intended to facilitate direct ties between academia and industry. Supported by corporate membership fees, these programs provide access for industry to research in departments, and programs of interest. IAP members typically attend meetings, receive copies of reports and publications, and have opportunities to recruit students. Any interested company may join an affiliate program. This framework transcends traditional borders to form win-win relationships, while achieving and maintaining excellence.



# RESEARCH EQUIPMENT AND INFRASTRUCTURE

## Accessing Information and the Use of Research Equipment and Infrastructure in the Technion

The Technion is comprised of 17 research faculties and a large number of research centers, institutes, and laboratories. The research performed by the Faculty, students and staff of these units is facilitated by the presence of hundreds of items of scientific and engineering equipment, in many cases with the most advanced capabilities in Israel, and in some cases in the World. For instance, in the field of visualization, Technion microscopes and other types of equipment allow researchers the ability to see natural and synthetic materials, from atoms all the way up to industrial structures. The Technion's advanced equipment is available for use to outside researchers, including those from industry.

## Finding the correct equipment or infrastructure

The Technion's website can aid industrial researchers and manufacturers in their search for specific equipment or other infrastructure that may be of assistance for their research requirements. General research sites that are good starting points are:



**Research faculties and interdisciplinary research centers**  
<http://www1.technion.ac.il/en/technion-research-units>



**Specific labs and equipment**  
[http://www.admin.technion.ac.il/manlam/Research\\_Equipment.html](http://www.admin.technion.ac.il/manlam/Research_Equipment.html)



**Specific research centers, with sub-listings of equipment present in the centers**  
[http://www.admin.technion.ac.il/manlam/Infrastructure\\_centers.html](http://www.admin.technion.ac.il/manlam/Infrastructure_centers.html)

### Use of Technion equipment

Scientific and engineering equipment can be found in the personal laboratories of Faculty members, as well as in Faculty Equipment Centers. Most of the larger and more expensive items of equipment can be found in the Technion's Interdisciplinary Research Centers. The regulations for each area are thus dependent on the responsible laboratory. The website links below can lead you to these centers, and include specific information on how to contact the responsible scientific team, as well as details of the capabilities of the equipment, requests for time, and costs. The teams responsible for the equipment are very knowledgeable about its performance, and will help in determining whether the equipment can perform your experiments, as well as how best to plan them. The major interdisciplinary infrastructure centers are:



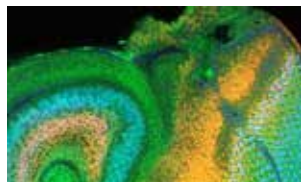
#### Russell Berrie Nanotechnology Institute (RBNI)\*

<http://rbni.technion.ac.il/?cmd=infrastructure.395>



#### Lorry I. Lokey Center for Life Science and Engineering

<http://isu.technion.ac.il>



#### Faculty of Medicine Center for Interdepartmental Equipment

<http://www.medicinelab.org.il/website/index.asp>



#### Solid State Institute

<http://solid-state.technion.ac.il>



#### Faculty of Chemical Engineering

<http://ceweb.technion.ac.il/research-labs>





**Schulich Faculty of Chemistry**  
<http://schulich.technion.ac.il/>  
**Facilities-Services-Schulich-Technion**



### Virtual Facility Map

[http://rbni.technion.ac.il/.upload/rbni\\_map2013%5B1%5D.swf](http://rbni.technion.ac.il/.upload/rbni_map2013%5B1%5D.swf)



# RESEARCH CONTRACTS

The Technion carries out various research activities with industry (both Israeli and multi-national), governments and public institutions.

*Agreements (as opposed to grants) between the Technion and industry typically fall into one of the following categories:*



Contractual arrangements depend on the parties' control over scope and timing of the activities, budgeting, the nature of the services provided or the research conducted, ownership in and to the intellectual property rights, and the relevant model of using thereof, type of research personnel involved, etc.

## Service Agreement / Laboratory Agreement

These agreements are typically used at the Technion in the following situations:

- ⌚ Rendering standard services at the various Technion centers and laboratories: for example, providing proteomic analysis at the Smoler Proteomics Center, microscope work by the Titan Microscope at the Material Engineering Faculty, or conducting preclinical trials at the Pre-Clinical Research Authority.

For such services, standard agreements address industry's concerns and requirements, such as full ownership of the results, confidentiality obligations, etc.

Ⓢ Technion personnel render a service based on specific equipment and expertise therein, providing the results to a client; while no intellectual input is required and no scientific publications are sought by Technion personnel.

For such services we use our standard laboratory agreement appropriate to the industry/client’s requirements.

Research Agreements

Typically, industry from one side and Technion personnel from the other side, wish to conduct a specific research project, aimed at generating useful and valuable intellectual property. Such a project may be based on intellectual property or know-how originating from the Technion, the Industry, or even available in the public domain.

Research activities to be performed by Technion personnel vary. We at the Technion recognize that working with a large university can be challenging, and we are therefore committed to simplifying the process. We take a flexible approach, tailoring solutions to meet the specific needs of all parties, especially the need of industry to use the results of such a research project to improve its own capabilities. Each research agreement is unique, and receives our full attention.

Research agreements include many aspects, as specifically required for the related project, including the research scope and program, related budget and schedule of payments, reports, confidentiality obligations, academic publication issues, responsibility and liability, and intellectual property ownership and related terms for the right to the use thereof.

In general, the process begins with defining the scope of the work and the expected timeline and budget with the relevant Technion personnel. Research progress and related deliverables are reported in a timely manner, following a schedule agreed by the Technion and the industry.

Following the initiation of such agreements, the research authority and the legal department proceed as follows. The research authority will



contact the industry asking for a representative to be responsible for all project-related matters, as well as a contact person responsible for payment by the industry. The legal department will handle the related agreement setting, negotiating all relevant terms, while balancing parties' requirements and expectations.

*Some important issues will need to be addressed in the agreement:*

**Academic Publication:**

The research team varies from one project to another. It usually includes a Technion faculty member, senior research personnel, such as post-doctoral fellows, research assistants, professional engineers and technicians, and students. The research team is required to publish its work, even if it is part of a sponsored research project. As the project results may be more strategic and competitive in nature, we usually set a proper mechanism, granting the industry a reasonable time to review the draft of the publication and protect related intellectual property prior to publication. Of course, such publications will not include any confidential industry information.

**Intellectual Property Rights - Ownership and the Right to Use:**

According to our standard model, any intellectual property rights arising out of a research project performed by a Technion research team are owned exclusively by the Technion. In the case that both parties have contributed to the generation of the intellectual property (i.e., inventorship contribution), the rights are jointly owned. The industry is granted the first option to receive an exclusive right to use the intellectual property (both the Technion's and the jointly-owned rights) for its own use, under commercial terms to be further negotiated with the Technion. Such commercial terms shall include the relevant consideration that the Technion will be paid for using the IP (usually royalties), relevant field of use/application, agreements regarding IP protection expenses, etc.

**Best Efforts - No liability for implementation of deliverables:**

It is important to understand that funding a research project is different from hiring a commercial entity for up-scaling, improving, designing, or developing products. The Technion is an academic institution performing research work; hence we cannot guarantee the success of research projects and success in reaching the expected outcomes. The research activities shall be performed on a 'Best Efforts' basis, and

	<p>the Technion shall release itself from any liability related to realizing the outcome in products or services.</p> <p><b>Conflicts of interest, ethics and regulations:</b></p> <p>The Technion has established ethics, bylaws and other regulations which may influence research activities. For example, the principal investigator of a certain industry-funded research project that has also provided private consulting services to the industry in the past may have a conflict of interest.</p> <p>It is not necessarily the case that all conflicts must be eliminated, but they must be disclosed and properly managed. Mechanisms exist for handling conflict situations.</p> <p><b>Framework Collaborative Research Agreement</b></p> <p>With large and frequent funding industrial partners, the Technion looks favorably on establishing framework agreements to which specific research projects are appended.</p> <p>A framework collaborative research agreement involves a standard set of terms to apply to all research activities which the industry sponsors at the Technion. An agreed-upon Statement of Works (SoW) with the specific details is worked out on a case-by-case basis, and is subject to the framework terms.</p> <p>A framework collaborative research agreement is usually tailored for the industrial partner's specific field, and may grant the partner more flexible terms than those in standard agreements.</p> <p><b>Major Research Centers:</b></p> <p>Such a center is established based on substantial industry commitment. The terms of use of a center's derived intellectual property are tailor-made on a case-by-case basis.</p> <p><b>Summary</b></p> <p>The Technion is committed to building strong relationships with our industrial partners, contributing to their economic development and competitiveness. These valuable partnerships help boost the Technion's research excellence and deliver solutions to industry's current challenges and needs.</p>
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# TECHNOLOGY TRANSFER

Home to three Nobel Laureates, the Technion is recognized as the game changer, the secret behind Israel becoming a technological powerhouse. As Israel's first university, it has a long history of taking seemingly impossible challenges and turning them into opportunities. The Technion is credited worldwide for its ability to generate start-ups, its remarkable ability to innovate, and its deep relationship with industry. Ranked sixth worldwide for entrepreneurship and innovation (according to a survey conducted recently by MIT in collaboration with Skolkovo), the Technion has made a significant impact in all fields of applied science and technology, including electronics, information technology, water management, nanotechnology, life sciences, chemistry, clean-tech, materials engineering, and aerospace engineering.



Technion Research &  
Development Foundation



Technion  
Technology  
Transfer



[www.t3.technion.ac.il](http://www.t3.technion.ac.il)

### Technion Technology Transfer - T<sup>3</sup>

The Technion Research and Development Foundation Ltd. (TRDF) is a fully-owned subsidiary of the Technion. Among others, TRDF, through T<sup>3</sup> –Technion Technology Transfer – is responsible for the commercialization of the Technion's intellectual property (IP). TRDF's policy for commercialization of technologies developed by Technion researchers and employees is derived from the Technion's vision and goals. T<sup>3</sup> aims to commercialize technologies developed at the Technion primarily via (a) license agreements and raising investment/funding for further development of discoveries/inventions, and (b) establishment of spin-off companies. The main purpose of T<sup>3</sup> is to open the doors to innovation, facilitating the transformation of new ideas into successful products and companies in World markets.

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Chief Executive Officer

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T<sup>3</sup>'s mission is to provide the tools needed to facilitate and support the transformation of scientific discoveries and innovations into real-life, applied solutions. By creating optimal alliances between scientists, industry and investors, T<sup>3</sup> enables the smooth transfer of technologies to the commercial sector.



A close-up photograph of a robotic gripper, likely from Mazor Robotics, holding a clear plastic bag filled with a bright green liquid. The bag has the text 'MAZOR Robotics' and 'HANDLE WITH CARE' printed on it. A hand wearing a blue nitrile glove is visible on the right, holding the gripper. The background is a plain, light-colored surface.

**WHAT  
MAKES  
ISRAEL  
ONE OF  
THE MOST  
INNOVATIVE  
PLACES ON  
EARTH?**



As part of TRDF, T<sup>3</sup>'s success in bridging between the laboratory and the marketplace has been critical in confirming the Technion's position as a global pioneer of innovation. Through its activities, T<sup>3</sup> aims to ensure that the companies to which Technion IP is licensed, and new incorporated spin-off companies based on Technion IP, will contribute to Israel's economy, advancement and welfare, and that the products they develop will improve the quality of life and longevity of the citizens of Israel and the World.

During recent years, T<sup>3</sup> has enjoyed a robust and marked increase, both in the number of patent families originating from Technion research, and in the number of commercialization successes.

#### T<sup>3</sup>'s activities include:

- ③ Analysis of new inventions and concepts developed at the Technion.
- ③ Protection and maintenance of IP.
- ③ Licensing technologies developed at the Technion.
- ③ Incorporation of spin-off companies based on Technion IP.
- ③ Support and investments in Technion-affiliated companies.
- ③ Negotiation and approval of the IP and business aspects of agreements with industry.

#### Into Business

In its commercialization efforts, T<sup>3</sup> is guided by the belief that a key component in bridging the gap between scientific innovation and commercial success is the development of a coherent high-throughput methodology of technology transfer. This involves creativity, time, tenacity, and an excellent team of professionals. T<sup>3</sup>'s commercialization strategies are customized to meet the requirements of each venture. It is this ability to adapt to the needs of investors and the market that has made T<sup>3</sup> a winning pioneer in world-class technology transfer.

For more information:  
[www.t3.technion.ac.il/entrepreneurship](http://www.t3.technion.ac.il/entrepreneurship)

**T<sup>3</sup>'s main commercialization avenues include:**

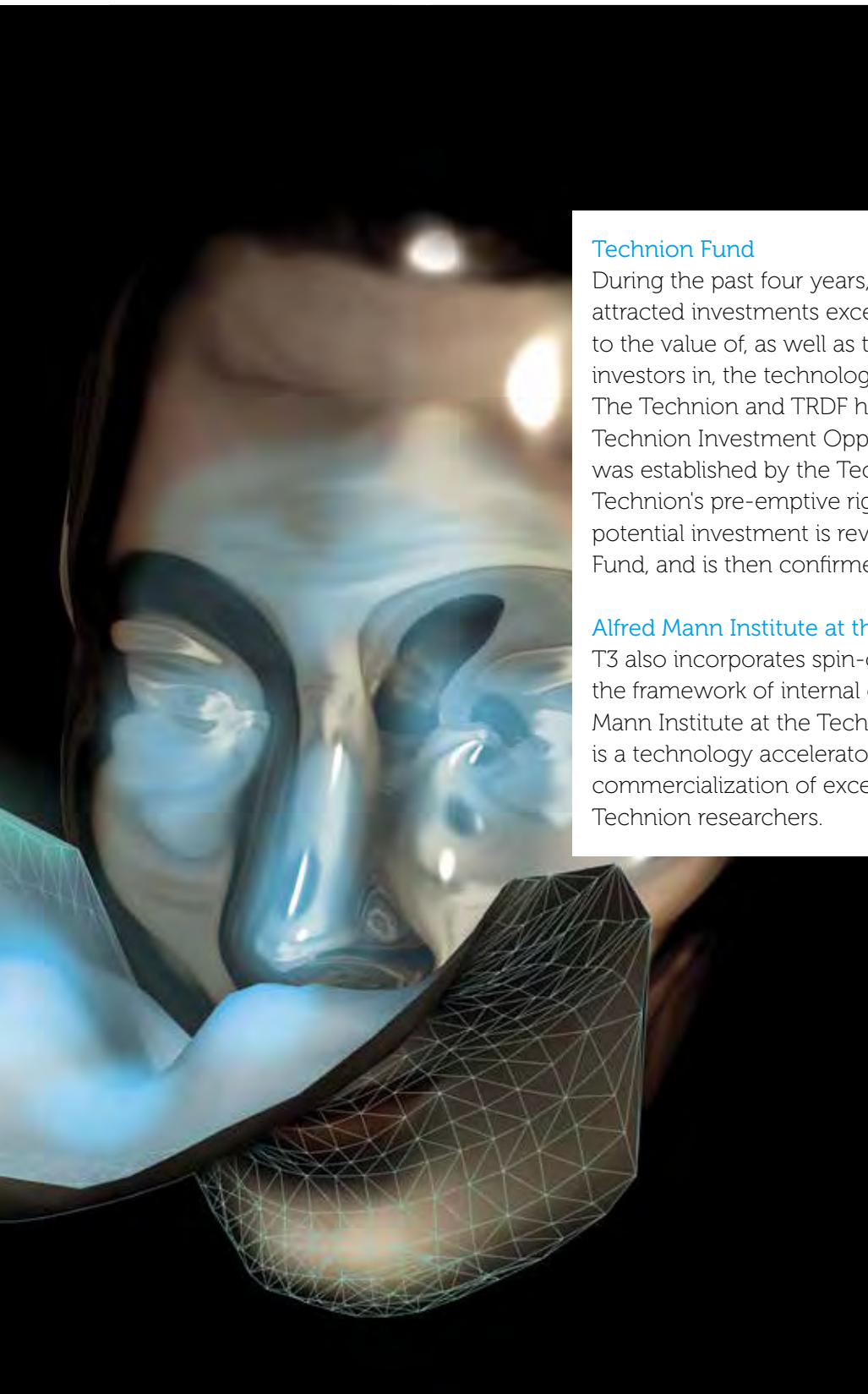
- ⌚ The Entrepreneur in Residence (EIR) program, in which entrepreneurs are engaged in a joint effort to identify applications for technologies, and to form start-up companies. As part of this program, in exchange for equity royalties, the EIR program invites entrepreneurs to commercialize the Technion's groundbreaking technologies. The program introduces experienced entrepreneurs to the Technion's research environment, offering them all the support needed to identify promising technologies and launch start-up companies.
- ⌚ Licensing of Technion intellectual property (IP) to established companies.
- ⌚ Incorporation of spin-off companies based on Technion IP within the framework of incubators, based on seed (usually angel) investments.

T<sup>3</sup> aims, as far as possible, to enable the technology transfer by licensing (against royalties) the technologies to companies in Israel, so that they continue to contribute to the development and prosperity of the country's economy.

**Technologies for commercialization**

**Available Technologies**

With over 600 granted patents and over 850 patents pending, T<sup>3</sup> brings you the best in Technion know-how and research. You can check our database of available technologies for commercialization, and also subscribe to new technology updates at: [www.t3.technion.ac.il](http://www.t3.technion.ac.il).



### Technion Fund

During the past four years, Technion-originated companies have attracted investments exceeding \$200 million. Such investments testify to the value of, as well as the confidence of sophisticated private investors in, the technologies emanating from the Technion. The Technion and TRDF have formed a limited partnership – the Technion Investment Opportunities Fund. This \$10 million fund was established by the Technion and TRDF in order to exercise the Technion's pre-emptive rights in its portfolio of companies. Each potential investment is reviewed by the Investment Committee of the Fund, and is then confirmed by its Executive Committee.

### Alfred Mann Institute at the Technion (AMIT)

T3 also incorporates spin-off companies based on Technion IP in the framework of internal commercialization, such as the Alfred Mann Institute at the Technion (AMIT). AMIT, established in 2006, is a technology accelerator, which supports the development and commercialization of exceptional biomedical innovations conceived by Technion researchers.





<http://www.amitechnion.com>

Contact

[amit-info@trdf.technion.ac.il](mailto:amit-info@trdf.technion.ac.il)



**Alfred Mann Institute at the Technion (AMIT)**

The Alfred Mann Institute at the Technion (AMIT) is a technology incubator, which supports the development and commercialization of exceptional biomedical innovations conceived by Technion researchers. Established in 2006 by Dr. Alfred E. Mann, an American entrepreneur and philanthropist, the Institute aspires to bridge the gap between academic research and commercial success.

AMIT pursues the creation of significant value for patients, by nurturing research creativity with structured development and sophisticated commercialization.

By creating significant commercial value, we position subsidiaries for later stage technology transfers, generating significant returns for the Technion and the inventors.

AMIT has a multidisciplinary core team of employees and consultants, led by Dr. Zeev Gilkis, a former corporate investment manager and a director of several high-tech and biotech companies. It operates under the common control of the Technion, the American Technion Society (ATS), and the Alfred E. Mann Foundation (AMF).

Four ventures currently operate as part of AMIT: Sealantis Ltd., which develops alga-mimetic tissue adhesives; ACC, which develops anti-cancer therapeutics; Sanoculis, which develops revolutionary devices for glaucoma treatment; and Accellta, which develops and markets stem-cell technologies.

Located on the Technion campus and part of the Technion community; AMIT is the home for Technion researchers who envision the transformation of their discoveries and inventions into viable products for the benefit of patients and healthcare providers.

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**<http://www.bio-rap.com>**

**BioRap Technologies Ltd.**

BioRap Technologies Ltd. is a technology transfer company built upon patented technologies and creative innovations developed by the research scientists of the Rappaport Institute for Research in the Biomedical Sciences at the Technion. Biorap Technologies provides a one-stop shop for advancing the development of groundbreaking discoveries by fostering strategic collaborations with industry through licensing, sponsored research, and new venture agreements. The Rappaport Institute, which is housed within the Rappaport Faculty of Medicine of the Technion-Israel Institute of Technology, consistently introduces promising new technologies, which can then be developed into products and services that benefit society and human health worldwide.

**BioRap Technologies encompasses three main areas of activity:****Technologies for licensing:**

- ③ Novel Molecules - For the treatment of inflammatory, autoimmune, cardiovascular disease and cancer.
- ③ Medical Diagnostics - Novel markers for diabetes complications, cancer, autoimmune diseases, and both common and rare inherited genetic disorders.
- ③ Specialized Technology - Cell therapy using light-sensitive ion channels for cardiac and neurodegenerative modulation.
- ③ Therapeutics/Vaccines - Novel therapeutic vaccines for cancer treatment.

***In-vivo/in-vitro* services for biomedical companies:**

- ③ Bioresearch Tools - Protein-protein interactions, stem cell technologies, and experimental cell platforms.
- ③ Personalized Cancer Therapy - Novel targets and biomarkers based on host response.
- ③ Immuno-based Platform: A novel platform for discovery of therapeutic antibodies and soluble receptors for treating inflammatory, autoimmune diseases and cancer.

- ⑨ Genomics Core Facility - The Genomics Core facility at the Rappaport Institute provides genomic services to Rappaport investigators and external users. Our goal is to facilitate the utilization of state-of-the-art technologies and bioinformatics support in genomics research by academic researchers, clinician scientists at hospitals, and scientists in pharmaceutical and biotech companies nationwide.

**Genomics Core Facility:**

The Genomics Core facility at the Rappaport Institute provides genomic services to Rappaport investigators and external users. Our goal is to facilitate the utilization of state-of-the-art technologies and bioinformatics support in genomics research by academic researchers, clinician scientists at hospitals, and scientists in pharmaceutical and biotech companies nationwide.

**Accomplishments:**

Azilect®, an effective drug in the treatment of the signs and symptoms of Parkinson’s disease, currently marketed by Teva Pharmaceuticals world-wide, was invented by Prof. Emeritus Moussa Youdim and Prof. Emeritus John Finberg, members of the Rappaport Institute.

# INTERDISCIPLINARY RESEARCH PROGRAMS



Lorry I. Lokey Interdisciplinary Center  
for Life Sciences and Engineering



TECHNION AUTONOMOUS  
SYSTEMS PROGRAM



Grand Technion  
Energy Program





## Lorry I. Lokey Interdisciplinary Center for Life Sciences and Engineering



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The Lorry I. Lokey Interdisciplinary Center for Life Sciences and Engineering provides a unique opportunity to bring the worlds of medicine, life sciences, and engineering together. Where else but at the Technion, a leader in high-tech and innovation in fields of engineering and medicine, could such a center be created? Nobel Prize laureate Aaron Ciechanover had a vision of this Center, and it was adopted with enthusiasm by Lorry I. Lokey, a longtime supporter of research and educational institutions.

The Lokey Center brings together the diverse but related fields of systems biology, bioinformatics, proteomics, tissue regeneration and stem cell biology, genomics, imaging, bio-processing engineering, structural biology, metabolomics and information processing. The Center provides state-of-the-art equipment to a cadre of outstanding researchers, allowing inter-disciplinary exchange between scientists with various areas of expertise. The Center provides an environment of excellence to foster creative research in life sciences, with the complementary skills in engineering and technology. It offers these scientists tools to help solve problems associated with basic life sciences and biomedical engineering, create new diagnostic techniques in medicine, and extend the frontiers of knowledge in science and technology.

# LOKEY CENTER

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35



## Research Areas

Systems Biology ➔ Genomics ➔ Proteomics ➔ Bioinformatics ➔ Tissue Regeneration and Stem Cell Biology ➔ Imaging and microscopy ➔ Cell Analysis ➔ Bioprocess Engineering ➔ Information Processing ➔ Structural Biology ➔ Biological networks ➔ Metabolomics

## Facilities at Emerson Life Sciences Building

National Proteomics Center ➔ Bioinformatics Knowledge Unit ➔ Technion Center for Structural Biology ➔ LS&E Infrastructure Unit ➔ Technion Genome Center





# LIFE SCIENCES AND ENGINEERING INFRASTRUCTURE CENTER

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## Services and Instruments:

Microscopy and imaging

Flow cytometry

Histology unit

Technion Genome Center

Real-time qPCR

The Life Sciences and Engineering (LS&E) Infrastructure Center was set up in 2007 as a collaborative venture between the LS&E at the Lokey Center and the Russell Berrie Nanotechnology Institute (RBNI).

The main aim of the Center is to provide state-of-the-art technology and expertise to researchers from diverse disciplines, including biology, biotechnology, bioengineering, chemistry, chemical engineering, food engineering, material engineering, and physics.

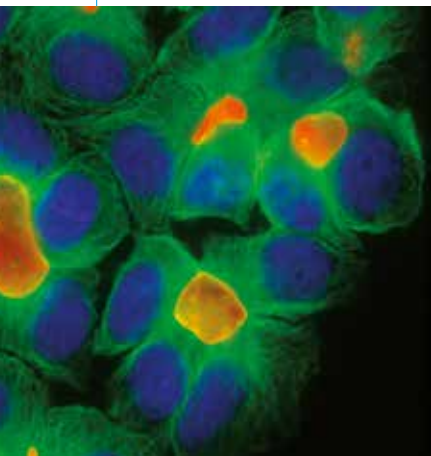
The Center serves researchers from the Technion, as well as from other academic institutions and industry. It organizes seminars and workshops on the most up-to-date technology and applications.

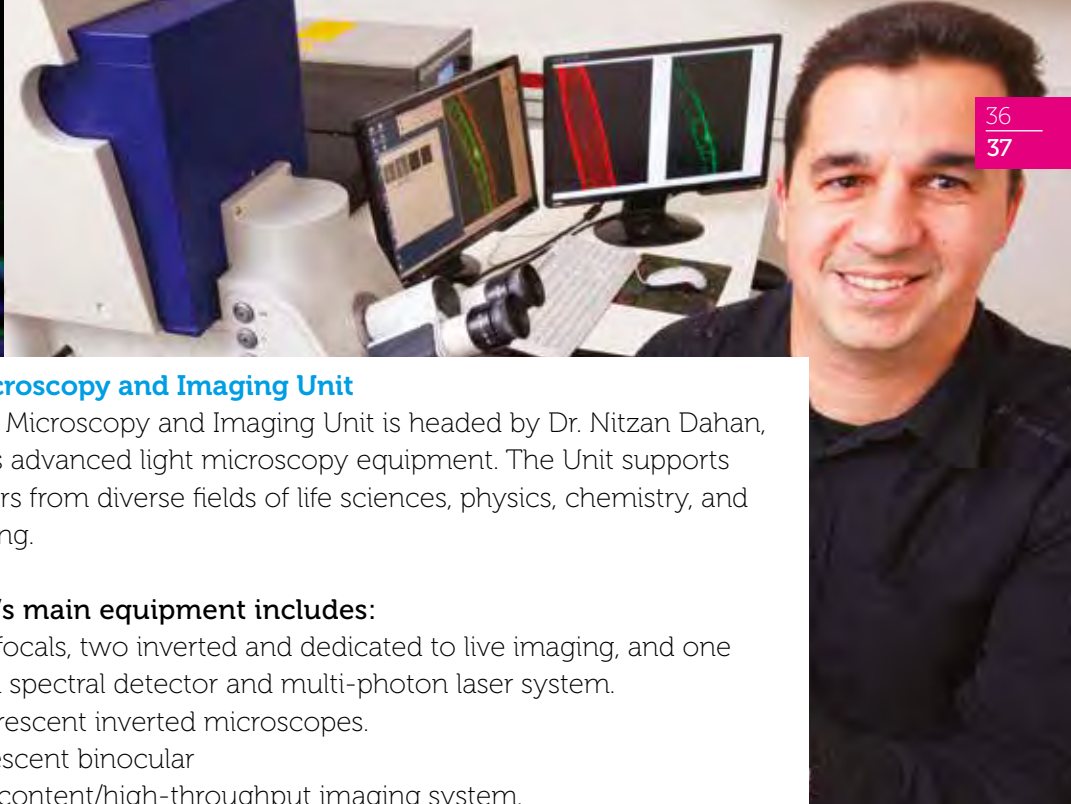
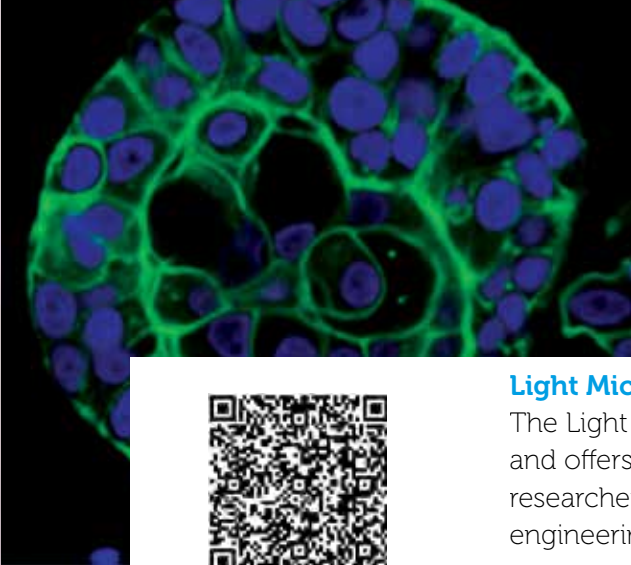
At the LS&E Infrastructure Center, users receive full training and support, from designing the experiments to data analysis. The Technion team includes scientists who are experts in their field to provide the best service.

## The Center has 3 major divisions:

- ⊗ Light Microscopy and Imaging Unit
- ⊗ Flow Cytometry Unit
- ⊗ Genomic facility services - the Technion Genome Center

The Center is open to all users at the Technion as well as other academic institutions and industry.





### Light Microscopy and Imaging Unit

The Light Microscopy and Imaging Unit is headed by Dr. Nitzan Dahan, and offers advanced light microscopy equipment. The Unit supports researchers from diverse fields of life sciences, physics, chemistry, and engineering.

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#### The Unit's main equipment includes:

- ⊕ 3 confocals, two inverted and dedicated to live imaging, and one with a spectral detector and multi-photon laser system.
- ⊕ 2 fluorescent inverted microscopes.
- ⊕ Fluorescent binocular
- ⊕ High-content/high-throughput imaging system.
- ⊕ Dedicated image analysis and processing software.

The Unit provides service and support, from designing the experiment to data analysis, with a full software range of: Imaris, Image J/FIJI, ZEN, AxioVision, and InCell Investigator.

#### Applications include:

- ⊕ Fast image acquisition for live cell imaging and time-lapse studies
- ⊕ Z-Stacks for localization of cells in living tissues and 3-D reconstruction
- ⊕ High-resolution localization of sub-cellular compartments and quantities co-localization
- ⊕ Spectral imaging and detection
- ⊕ Fluorescence resonance energy transfer – FRET
- ⊕ Multi-channel fluorescence imaging
- ⊕ Quantitative co-localization
- ⊕ Fluorescence recovery after photo-bleaching – FRAP
- ⊕ Multi-photon imaging
- ⊕ Automated slide imaging
- ⊕ Cell-based assays and detection, including: compound screening, Phenotypic profiling, RNAi screening, Whole organism imaging, Cell lineage studies, Cell cycle studies, Cell migration, Organelle and protein trafficking, Morphology analysis, DNA content analysis, and Apoptosis/cell viability



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**<http://isu.technion.ac.il/ISU/Templates/showpage.asp?DBID=16&NGID=16&TMID=846&FID=551>**

**Flow Cytometry Unit**

The Flow Cytometry Unit has two analyzers and a sorter:

- ⊕ Analyzer: BD FACS Calibur - 2 lasers, 4 channels
- ⊕ Analyzer: BD LSR-II - 4 lasers, 12 channels and High Throughput System (HTS)
- ⊕ Sorter: BD FACS Aria-III - a four-laser sorter with 12 channels that can sort the analyzed particles or cells for further growing and analysis

The Unit serves all the Technion's units, as well as other academic institutions and industry.

The Unit provides service, from designing the experiment to data analysis, with a full software range of FSC express and ModFit

**Additional services:**

The Unit also has two real-time quantitative PCR's (ABi and Bio-Rad).

In the Histology Unit there are cryostatic, paraffin-embedded and EM-sample preparation facilities.



## TechnionGenomeCenter

### Technion Genome Center

As part of the LS&E Infrastructure Center since 2009, the Technion Genome Center (TGC) is at the forefront of sequencing technology, providing state-of-the-art services to researchers from diverse disciplines.

TGC plays a central role in enabling the Technion's researchers to find answers to the pressing questions of the 21st century develop genome technology.

TGC offers a range of services from designing the experiment, through library preparation and sequencing, to bioinformatics analysis.

The mission of TGC is to maintain and expand its role as Israel's leading sequencing facility, and therefore TGC continuously upgrades its equipment as new technology becomes available. TGC's team, located in the Technion's new Emerson Life Sciences Building, includes highly-trained and experienced scientists, bioinformaticians and molecular biology specialists who have a proven record of working together with researchers from the Technion, other universities, and industry. TGC's customers include all Israeli universities, research institutes, hospitals and genetic institutes, as well as industrial companies and start-ups.

### TGC's state-of-the-art equipment includes:

- ⊕ Illumina HiSeq 2500
- ⊕ Illumina MiSeq
- ⊕ Agilent Bravo automation system for sample preparation
- ⊕ Agilent TapeStation 2200 - DNA and RNA quality control
- ⊕ Covaris E220 - DNA shearing system
- ⊕ Advanced molecular biology laboratory

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# TECHNION CENTER FOR STRUCTURAL BIOLOGY



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The center was jointly established by the Russell Berrie Nanotechnology Institute (RBNI) and the Lorry I. Lokey Interdisciplinary Center for Life Sciences and Engineering (LS&E). In order to enhance molecular-level biomedical research at the Technion, the LS&E took the initiative in establishing the Technion Center for Structural Biology (TCSB). Headed by the highly experienced structural biologist Dr. Hay Dvir, the TCSB provides both expertise and infrastructure for macromolecular crystallography to enable state-of-the-art structural biology research on campus. TCSB is equipped with the most advanced infrastructure for macromolecular crystallography anywhere in the Middle East, including state-of-the-art robotic and automation systems for high-throughput crystal growth and X-ray data collection. The Center is engaged in molecular studies of wide-ranging areas in life sciences, with an emphasis on functional and mechanistic understanding of the interaction between biological macromolecules such as proteins and DNA. Dissecting biological processes with such high-resolution approaches is often crucial in unraveling the molecular basis of diseases and for the rational development of therapeutics via structure-based drug design.



<http://bku.technion.ac.il>



**Price list**

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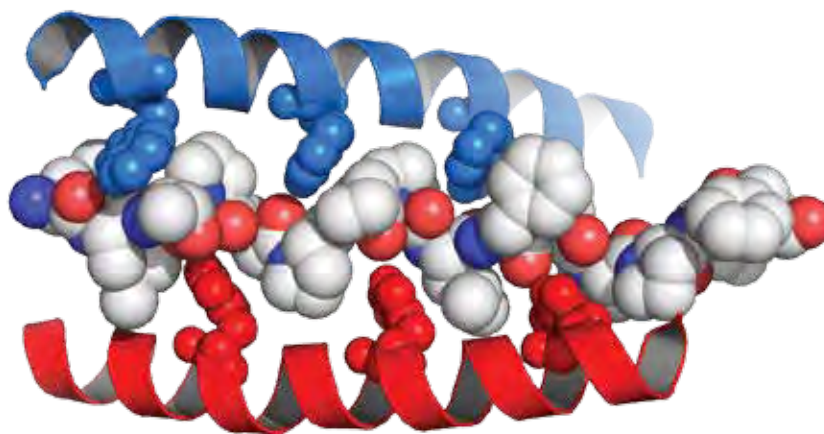
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# BIOINFORMATICS KNOWLEDGE UNIT (BKU)



The Bioinformatics Knowledge Unit (BKU) provides science researchers at the Technion and its affiliated hospitals with computational methods and tools to make their research more productive, saving time, effort and cost. BKU provides consulting to individual laboratories, arranges workshops and seminars for students, technical, and academic staff, and makes state-of-the-art computing tools, data resources, and computing power available to all. Consulting activities include help-desk services as well as involvement in research projects and grants. Other modes of cooperation are possible, and ideas and suggestions are welcome.

#### Research Areas

The BKU provides consultation services to researchers and staff of the faculties of life sciences and exact sciences at the Technion and its affiliated hospitals. We aim to establish cooperation with researchers. Currently we support research in, amongst others, genomics and high-throughput data analysis (RNA-seq, ChIP-seq, etc.), application of R-system, phylogenetic analysis, protein-protein and protein ligand docking, molecular dynamics, structure-based mutational analysis, and novel gene annotation.





E

**NANCY AND STEPHEN  
GRAND TECHNION  
ENERGY PROGRAM  
(GTEP)**



The Nancy and Stephen Grand Technion Energy Program brings the best science and engineering researchers together to work in a broad interdisciplinary track to discover and exploit alternative and renewable energy sources, to search for and develop alternative non-carbon-based fuels, to seek solutions for more efficient energy use, and to reduce the environmental damage caused by the production and burning of fossil fuels.

#### Research Areas

Alternative Fuels • Energy Storage and Conversion • Renewable Energy Sources • Energy Conservation.

Proposed research topics that these areas will address are: expanded uses for solar energy, including solar photo-voltaic cells, for the generation of electricity, solar-powered air conditioning and solar process heat; development of non-carbon-based alternative fuels; biomass generation of combustible gases; wind turbine design; energy storage; optimization of urban planning for energy conservation; improving engine performance by reducing friction and using advanced combustion processes; and the development of power sources for microelectronic devices.



#### Contact:

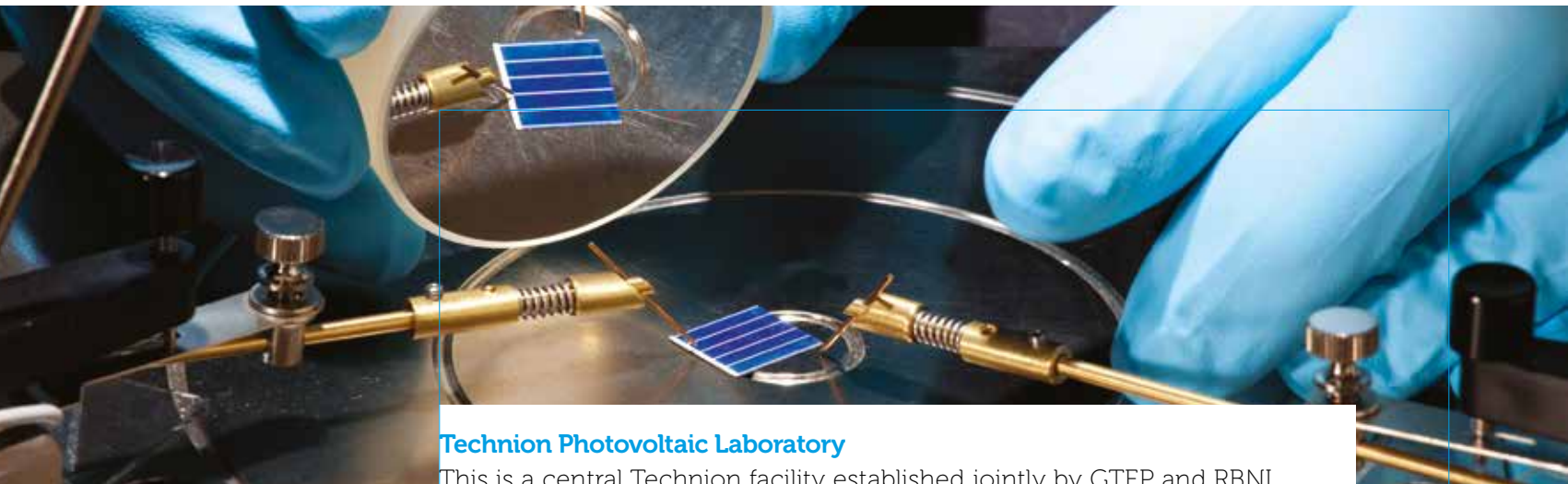
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### Technion Photovoltaic Laboratory

This is a central Technion facility established jointly by GTEP and RBNI to provide advanced tools for the fabrication and characterization of photovoltaic (PV) devices. The Photovoltaic Center comprises two laboratories; one for the fabrication of photovoltaic cells, and the other for the characterization of these cells.

Laboratory personnel offer both technical services and assistance in the design, fabrication, and characterization of organic, inorganic, and hybrid PV devices. The laboratory serves the PV community of the Technion and the broad optoelectronics community in Israeli academia and industry. Professionals from industry come to the Center for the characterization of devices and for support in fabrication.

### Technion Hydrogen Technologies Research Laboratory (HTR)

This is a central Technion facility, established jointly by the Grand Technion Energy Program (GTEP), the ADELIS Foundation and the Solar Fuels I-CORE, to provide basic and advanced tools for developing technologies for low-cost, highly-efficient hydrogen production from diverse renewable sources.

The laboratory personnel offer both technical services and assistance in the design and characterization of hydrogen production technologies. The laboratory serves the general Technion community and Israeli academia and industry. Launched in August 2013, the HTR Laboratory is now fully active.

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hydrogen\\_technologies\\_  
research\\_laboratory.php](http://gtep.technion.ac.il/hydrogen_technologies_research_laboratory.php)



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### **Leona M. and Harry B. Helmsley Charitable Trust Energy Storage Complex**

This complex was established by GTEP as the first academic complex for research into energy storage. Investigations are focused on advanced, rechargeable Li-ion and metal-air battery systems using high energy fuels such as lithium and silicon.

#### **The Energy Storage Complex includes four hubs:**

- ④ Powder Preparation Hub
- ④ Electrochemical/Chemical Laboratory
- ④ Analysis of Hub-battery Discharge and Characterization
- ④ X-ray Diffraction Laboratory

Laboratory personnel offer both technical services and assistance in the design and characterization of energy storage technologies.

### **Satell Family Nitrogen-Hydrogen Alternative Fuels (NAHF) Reaction Research Laboratory**

The Center was established by GTEP to promote the development of non-carbon fuel technologies. Investigations focus on the reactions of nitrogen-based fuels commonly encountered in fertilizers. The challenges are to develop clean, efficient, and environmentally friendly combustion technology of these energetic materials.

#### **The Center includes the following facilities:**

- ④ High-pressure batch reactors
- ④ High-pressure continuous reactors
- ④ Chemical analysis and characterization units of the effluent gases

Laboratory personnel offer both technical services and assistance in measurements of effluent gasses from combustion processes.



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**<http://rbni.technion.ac.il>**

Supported by the Russell Berrie Foundation, the Government of Israel through TELEM, and the Technion; RBNI aims at positioning the Technion and the State of Israel at the forefront of global nanotechnology research and development. Vigorous recruitment of bright new faculty members from research laboratories around the World, extensive investment in infrastructure, new educational programs for training the next generation of scientists and engineers, and nurturing of multidisciplinary collaborations within campus, as well as with industry and other academic institutions, provide the vehicle for achieving the desired impact on the Technion, the State of Israel, and the well-being of humankind.



# **RUSSELL BERRIE NANOTECHNOLOGY INSTITUTE (RBNI)**

1  $\mu\text{m}$



### Industrial Liaison:

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**[http://rbni.technion.  
ac.il/?cmd=infrastructure.395](http://rbni.technion.ac.il/?cmd=infrastructure.395)**

### Industrial Liaison

Dr. Kassel serves as the contact person between industry and RBNI, helping industry to identify contacts within the Technion to solve problems, or suggest use of particular infrastructure.

Dr. Kassel will also help identify RBNI-related research projects that could potentially lead to industrial processes or products.

### Nanotechnology Infrastructure

Electron Microscopy Center (Faculty of Materials Science and Engineering) ➤ Electron Microscopy Center for Soft Matter (Faculty of Chemical Engineering) ➤ Zisapel Nanoelectronics Center (MNFU) - (Faculty of Electrical Engineering) ➤ Center for Nano Photonics (Faculty of Electrical Engineering Fischbach Building) ➤ Joint GTEP and RBNI Technion Photovoltaic Laboratory (Zisapel Building) ➤ Life Sciences and Engineering Infrastructure Unit (Emerson Building) ➤ Smoler Proteomics Center (Faculty of Biology) ➤ Biomechanics and Tissue Engineering Center (Faculty of Bio-Medical Engineering) ➤ Surface Characterization Center (Solid State Institute) ➤ Russell Berrie Nanoparticles and Nanometric Systems, Characterization Center ➤ X-ray and Particle Characterization Facilities (Faculty of Chemical Engineering) ➤ Center for Computational Nanoscience and Nanotechnology (Computer Center) ➤ Technion Center for Structural Biology.

### Focal Technological Area - Nanophotonics for Advanced Light Detection, Imaging, Inspection, Smart Sensors, Energy Conversion

The focus of this activity is light nano-detectors, enhanced by nanophotonic structures and applications, including sensing and ultra-high resolution inspection.

### Cooperation with industry

The photonics-related industry in Israel is expected to be directly transformed by the project's technologies, detectors, sensors, modules, platforms, and systems. While a significant portion of the research outcome is expected to be absorbed in the large industrial entities of defense, detectors, semiconductors, and inspection; in two evolving fields we expect to promote new initiatives and start-up activities: bio-medical optical probing and diagnostics, and solar energy harvesting.

In the medical field many Israeli companies are looking for applications for optical diagnostic probes (optical pathology), and some of the sensing configurations are proposed in the Focal Technology Area (FTA) - a project funded by the government and the Technion under RBNI, and directly applicable to them.

A large segment of the inspection and metrology industry in Israel will be directly up-graded by novel ultra-high-resolution methodologies and technologies.

The field of solar energy harvesting is making its first steps in Israel, but is expected to increase dramatically due to available investments and the type of innovation.

Products expected to emerge from, or to be affected by, technologies developed in the framework of this project, include: pillar-based NIR-SWIR-MIR sensors and imagers; imagers with plasmonics-based smart pixel optics; miniature optical clocks and photonic-based magnetometers; nanophotonic parametric oscillator-based sensors; plasmonic multispectral, polarization diversity functional imagers; extreme resolution inspection systems with emphasis on microelectronics and biomedics; efficient hybrid thin layer solar cells; efficient solar-electrochemical cells; nanophotonic-enhanced medical probes: high-resolution OCT; plasmonic-enhanced medical Raman probes; micro-nano photonic circuit platforms and elements; flexible sensors; and integrated communication transceivers.

Cooperation already exists with SCD, Elbit, and Tower Jazz in novel detectors, 3G Solar in solar cells, and with Rafael in special sensors, amongst others.

Services to industry - except for specific consultations - will be based on the highest quality e-beam lithography (EBL) tool purchased for the project, and will be used by industrial partners for nanopatterning. EBL can be performed on 200 mm wafers with very rapid exposure (50 MHz) and ultra-high resolution - line width 6 nm, and 15 nm adjustment between two layers of patterns. A special feature of this tool is lithography on a non-flat (e.g. curved) substrate.

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# **TECHNION AUTONOMOUS SYSTEMS PROGRAM (TASP)**





Quad-Copter



Snake Robot

Autonomous systems represent the next great step forward in the fusion of machines with sensors, computers, and communication capabilities. The objective is to develop intelligent systems that can interact dynamically with the complexities of the real world. These systems make independent decisions about how to act, even in groups, especially in unplanned, changing, or unexpected conditions. Autonomous system applications include performance-enhanced unmanned aerial vehicles (UAVs); swimming medical micro-robots that can travel through the human body; unmanned vehicles for underwater, land-based, and space exploration; environmental disaster cleanup operations; rescue operations; detection, identification, and neutralization of chemical and biological weapons and explosives; transportation and traffic control systems; communication networks; and a wealth of other applications that drive progress in defense, medicine, and industry. The Technion does research in all these areas

### TASP Centers

- ③ Arlene and Arnold Goldstein UAV and Satellite Center
- ③ Unmanned Ground Systems Center
- ③ Unmanned Marine Systems Center

### Two Centers under construction:

- ③ Autonomous Medical Systems
- ③ Autonomous Agent Systems

### Collaborations:

- ③ Agreement with Israel Aerospace Industries (IAI) for NIS 1 million annual research support.
- ③ Participation in ROBIL, a three-university project to design a humanoid robot, funded by the US Defense Advanced Research Projects Agency (DARPA) and the Israeli Ministry of Defense.

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# TECHNION COMPUTER ENGINEERING CENTER



The TCE Center is designed to lead worldwide computer engineering research and education, and to operate as a focal point for academic and industrial collaboration. Computer Science and Electrical Engineering are two of the Technion's leading faculties. With the TCE Center, these Faculties intend to take a national and international leadership role in cutting-edge research and development. The TCE Center provides the foundation and facilities for computer engineering research and education. Its unique model facilitates an unprecedented platform for industrial-academic partnership, and creates a novel eco-system beneficial to both.



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Research Areas

Applied Computer Engineering domains, such as:

Computer Architecture and Systems ➤ Cloud Computing ➤  
Communication and Networking ➤ Data Bases ➤ Data Processing and  
Data Mining ➤ Machine Learning ➤ Computer Graphics ➤ Computer  
Vision ➤ Cyber Security ➤ Social Networks ➤ Quantum Computer  
Engineering.

Industry-Affiliated Opportunities

A major goal of the TCE Center is to bridge the academia-industry gap by encouraging academic members to contribute knowledge and experience in joint applied research with industry. The Center welcomes part- and full-time visitors from industry, interested in research collaboration or seeking expert help. Visitors may engage in research, education, and innovative projects. In order to create a suitable environment that will accommodate both TCE and industry, TCE has adopted an open IP policy to govern TCE activities, where all results generated in the scope of TCE activities are open to the public, and IP will be dealt with on a per case basis.

TCE members need to sign the TCE Memorandum of Understanding (TCE MOU).

Industry Members

Check Point ➤ Yahoo! Labs ➤ EZChip ➤ HP ➤ IATI- Israel Advanced  
Technology Industries ➤ IBM ➤ Intel ➤ Matrix ➤ Marvell ➤ Mellanox ➤  
Motorola Solutions ➤ Rafael ➤ Ravello Systems ➤ SAP ➤ EMC





Contact:

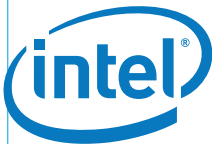
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**Intel Collaborative Research Institute -  
Computational Intelligence (ICRI-CI)**

Intel Laboratories has launched Intel Science and Technology Centers and Intel Collaborative Research Institutes to foster collaboration of Intel and academia. Each research community is Intel-funded, jointly-led, and focused on a specific technology domain, bringing top researchers from academia and Intel together to explore and develop new answers to existing and new questions. The mission is to build global collaborations with academic pioneers to discover and utilize computing to enrich the human experience. The resulting insights are expected to bring in new technologies that will be used by Intel and the industry to build better, more exciting, products, and maintain Israel's leading position.

The Intel Collaboration Research Institute for Computational Intelligence (ICRI-CI) Center was inaugurated on May 22, 2012. It is focused on machine learning, brain-inspired computing, and heterogeneous computer architectures. ICRI-CI's vision is to deliver breakthroughs in architecture, algorithms, and usage models. The center carries out fundamental research in the above domains, as well as developing capabilities in the areas of learning audio/visual systems and intelligent agents.

In Israel the Institute is based at the Technion in Haifa and the Hebrew University of Jerusalem, and also includes researchers from Bar-Ilan University, the Weizmann Institute of Science, and Shenkar College of Engineering and Design. The Center is mainly connected with several Intel business units, in Israel and internationally.

# RESEARCH INSTITUTES



**National Building  
Research Institute**



**TRI**

# NATIONAL BUILDING RESEARCH INSTITUTE (NBRI)



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The National Building Research Institute was established in October 1988, as a joint venture of the Israeli Ministry of Construction and Housing and the Technion, IIT. It is based on the highly respected 50-year-old Building Research Station, and maintains its professional tradition. Its main objective remains advancement of knowledge in the building sciences, solution of long-range problems of the building sector through methodological research, as well as support in solving short-term needs, in areas where expertise is crucial.

NBRI members include the Civil Engineering Faculty, whose research is in the areas of Structural Engineering, Geotechnical Engineering, Building Materials, Performance and Technology and Construction Management and Economics, as well as researchers and graduate students in these areas. NBRI has a large laboratory hall with a massive testing floor and several specific laboratories in these areas.

NBRI has a long-standing collaboration with industry, assisting Israeli manufacturers and builders in the investigation of innovations, and in studying basic issues related to their products or processes. In addition to research collaboration, NBRI provides testing services when other laboratories are not equipped to do so. Reports include detailed description of the test and results. NBRI does not engage in standard testing and certification, or in providing expert opinions.

The price of the testing service includes manpower and use of equipment. It depends on the specific work, and comprises a set-up fee for the specific test plus the price per hour or part of an hour, according to the complexity, manpower, and type of equipment used for testing.



Shaking Table



1000kN compression and tension machine and pulsators

### Testing Hall and Structural Engineering Laboratory

The main testing hall at NBRI includes several testing facilities for material and structural tests, as outlined below, and a strong test floor, which enables versatile arrangement of various set-ups for medium- to large-scale specimens of structural components, such as beams, columns, walls, etc. Part of this floor is dedicated to a permanent special steel frame, with a 500-kN, 150-mm stroke actuator, that enables testing of specimens with a height of up to 2 m. This actuator is connected to an MTS controller that enables testing with stroke control to a variety of static and dynamic loading programs.

#### The specific equipment in this laboratory includes:

- ⌚ **Shaking Tables:** *Large 1-DoF table, 3 x 3 m, up to 50 kN, 1-10 Hz, horizontal sway  $\pm 50$  mm. Small 1-DoF table, 40 x 60 cm, up to 40 N.*
- ⌚ **Compression and Tension Testing Systems:** *Manually controlled machines with capacities of 1, 100, 300, 1000, and 5000 kN*
- ⌚ **Controllable Actuators:** *In compression and tension with capacities of 100 and 500 kN, and in compression with a capacity of 2000 kN*
- ⌚ **Hydraulic Jacks:** *25 jacks and a central control system. Force capacities are 160, 180, 320, 350, 420, and 500 kN, and maximum travels are 60, 100, 150, 380, and 450 mm*
- ⌚ **Static and dynamic measurement laboratory:** *Includes data acquisition systems, and a variety of force, displacement, acceleration and strain transducers, as well as pulsators. Force transducers include compression of 100, 250, 500 and 5000 kN; tension 5 and 50 kN; tension and compression 5 and 50 kN; and hollow 500 kN*





Air Gun

### Impact Laboratory

The Impact Laboratory is built partly below ground. The space of this specially reinforced concrete laboratory comprises a control and operation room with a safety and operational controller, and various electrical, mechanical, and computational facilities. The laboratory is used to test the impact response of structural elements and materials to low velocity and high velocity impact loads, penetration processes in structural and geotechnical systems, and the blast response of structural elements.

The laboratory floor includes two large isolated foundation blocks supporting a gun system and a target holder system. Specially constructed interior reinforced concrete walls provide separation of different safety zones.

#### The specific equipment in this laboratory includes:

- ③ Air-guns *for high-velocity impact, and a moderate-velocity air gun system*
- ③ Low-velocity impact system
- ③ Small caliber shooting system
- ③ High-speed cameras: *A high-speed monitoring system.*
- ③ High-speed velocity measurement system
- ③ Monitoring systems: *For dynamic acceleration, pressure, strain, and displacement*
- ③ Blast shock tube: *Under development*

### Building Materials Laboratory

The laboratory is equipped with various accessories to test chemical, physical and mechanical properties of building materials, such as concrete (in both fresh and hardened states), gypsum, lime, masonry, plaster, grout, natural stone, metals, timber, fiber-reinforced materials, chemical and mineral admixtures for concrete, as well as industrial by-products, such as coal fly ash, chemical gypsum, recycled aggregates, recycled plastics, and rock waste. The laboratory facilities can be used to simulate behavior of various building materials under special environmental and loading conditions, and for testing strength, permeability, durability, shrinkage-induced cracking, corrosion resistance, water/gas/water penetration, sorptivity, resistance to salt attack, UV radiation, and thermal and hygric cycles.



Climactic Chamber

The laboratory is also equipped for non-destructive testing of mechanical properties.

**The specific equipment in this laboratory includes:**

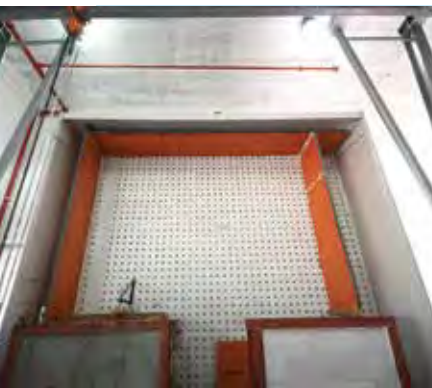
- ③ Climatic Rooms: *Regulated temperature  $\pm 0.5^{\circ}\text{C}$  and humidity  $\pm 5\%$*
- ③ Climatic Chambers: *Temperature range:  $-10$  to  $+150^{\circ}\text{C}$ , RH = 25%-99%*
- ③ Carbon Dioxide Chamber: *up to 5% of  $\text{CO}_2$*
- ③ Ovens: *For drying and heating*
- ③ Mercury Intrusion Porosimeter: *up to 0.4 GPa*
- ③ Thermo-Gravimetric Analyzer TGS-2
- ③ Scanning Electron Microscope (SEM)
- ③ Small Wind Tunnel: *90x60 cm cross-section and 180 cm length, for testing building materials under drying conditions in hot climates*
- ③ Uniaxial Restrained Shrinkage Apparatus: *Closed loop system for measuring strains and stresses in early age concrete*
- ③ Chemical Shrinkage Measuring System
- ③ Adiabatic and Isothermal Calorimeters: *For measuring heat of cement hydration*
- ③ Rheometer: *For measuring rheological properties of fresh concrete mixes*
- ③ Portable Non-Destructive Testing Instruments: *For ultrasonic pulse, rebound, electro-magnetic, electrical conductivity, optical and other measurements*
- ③ Chloride and Water Penetration Measuring Systems
- ③ Set-up for Testing Corrosion of Reinforcement Steel in Concrete

**Thermal and Energy Laboratory**

The Thermal and Energy Laboratory is capable of testing the thermal conductivity of building materials, thermal and energy performance of wall specimens of surface area 1.2x1.2 m, and the air and water permeability and performance under a pressure difference of any vertical building envelope element, such as walls, windows and curtain-walls, with a surface area up to 4x4 m.

**The equipment in this laboratory includes:**

- ③ Guarded hot plate: *Thermal conductivity measurements of specimens up to 5 cm thick in the range  $10^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ .*
- ③ Hot box: *For the investigation of steady-state thermal and energy performance of 1.2x1.2 m wall specimens.*



Air and Water Permeability  
Test Facility

- ④ Air and water permeability test facility: For investigating air and water tightness of vertical elements of up to 4x4 m. The nominal pressure difference capacity is up to 3000 Pa, and the air flow range is 210 m<sup>3</sup> h<sup>-1</sup>.

**Radiation Safety in Construction Laboratory**

The laboratory can assist in measuring natural radionuclides in building materials, radon flux from soils and building materials, and perform continuous as well as long-term average radon monitoring in enclosed spaces.

**The equipment in this laboratory includes:**

- ④ Scintillation gamma-spectrometers for measuring natural radionuclides in building materials
- ④ Beta-spectrometer for measuring radon flux from soils
- ④ Continuous radon monitors and electrets
- ④ Gamma dosimeters
- ④ Radon permeability test installation for testing building materials and radon-barrier materials.
- ④ Radon exhalation testing chambers for measuring radon exhalation of building materials (6.5 and 85 L)

**Seskin Virtual Construction Laboratory**

The primary foci of the Virtual Construction Laboratory (VC Lab) include Building Information Modeling (BIM), Lean Construction, and the synergies between the two. Its computing and virtual reality infrastructure enables tackling a wide range of topics, not only in Construction Management, but in diverse fields such as Architecture and Town Planning, Transport, Design Collaboration, and others.

**The specific equipment in this laboratory includes:**

- ④ A CAVE (CAVE Automated Virtual Environment): the EON Mobile Icube, a reconfigurable 3-wall PC workstation-based immersive environment, in which participants are completely surrounded by virtual imagery and a sound system. The system has a DLP active stereo-projection system, 3D stereo rear-projection screens, a floor-mounted screen structure, EON Professional Software (EON Studio, Visual Effects, RPC, EON CAD, Raptor and Physics

Engine as well as EON Server), a Natural-Point eight-camera wide field of view infrared wireless motion tracking system, and active stereo glasses



- ④ KanBIM™ mobile touch screen workstation: Includes a mounted PC workstation (Intel i7 950 6GB RAM DDR III NVidia GTX 460) and a 42" touch screen monitor (Elo Touch Systems 42" Model ET4200L-AUWA).
- ④ Dual-screen BIM workstations: Five stations with a variety of BIM software tools.



# NORMAN AND HELEN ASHER SPACE RESEARCH INSTITUTE (ASRI)



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The ASRI operates with a broad national perspective. It fosters interdisciplinary work and collaboration of Israeli researchers from all Technion departments, as well as from other universities, agencies, and industry. The ASRI has also established collaborative projects with institutions in other countries.

The ASRI was established in 1984. Its members are professors in eight academic departments of the Technion (Physics, Aerospace, Mechanical, Chemical, Civil and Environmental, and Electrical Engineering, Computer Sciences, and Architecture).

Its research and technical staff are involved in various activities, including research and development of small satellites.

The Asher Space Research Institute has achieved global recognition, having succeeded in bringing space-related research activities to the forefront of science, technology, and academia, both nationally and internationally. The Institute is now regarded one of the most prestigious research centers on campus, and attracts high-profile visitors.

## Laboratories

In addition to its support of space-related research around the campus, ASRI is home to three leading laboratories.



<http://www.technion.ac.il/~dssl>



<http://asri.technion.ac.il/electric-propulsion>



<http://asri.technion.ac.il/space-interferometry>

### **Distributed Space Systems Laboratory (DSSL)**

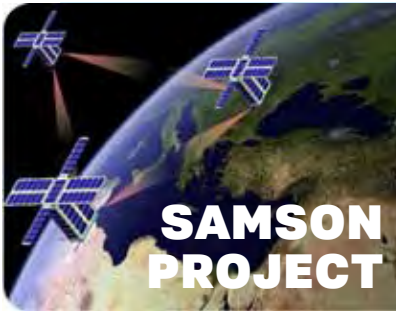
The DSSL was designed and built in the Faculty of Aerospace Engineering, and is located in the Asher Space Research Institute. Research efforts are focused on dynamics and control of multiple spacecraft formation flying, a topic attracting much interest in the United States and Europe. The DSSL also serves as a resource for instruction and education.

### **Electric Propulsion Laboratory**

The present-day stage in the development of worldwide spacecraft technology is characterized by the increasing use of electric propulsion (EP) for solving a broad spectrum of problems; from correction of a spacecraft position in orbit, to a radical change of its flight trajectory, and implementations of interplanetary missions. The application of electric propulsion allows a significant reduction of spacecraft mass as a consequence of propellant saving. This, in turn, provides substantial mission cost savings. ASRI researchers invented the patented CAMILA thruster that is now on track to commercialization.

### **Space Interferometry Laboratory**

The Space Interferometry Laboratory (SILy) seeks novel solutions for improving the angular resolution of telescopes for both astronomical and Earth observations from space. The resolution of a traditional telescopic imaging system is strictly limited by the size of the aperture and the color of light that is observed. Telescopes as large as 30 and 50 m are currently being designed, but in space, limitations on size and weight are severe. The Hubble space telescope, for example, has a mirror diameter of 2.4 m. In order to minimize aberrations, the mirror needs to be thick, which costs valuable space, and more importantly, weight, which the mission needs to launch into space. Telescopes much larger than Hubble, therefore, very quickly become far too heavy and expensive for space missions. Our laboratory is now involved in a project to develop a segmented telescope that will allow the optics to be deployed in space to be larger than the launcher.



**SAMSON Project**

The State of Israel is a proud member of the space club, which comprises fewer than ten nations that design, build, and launch their own satellites. As such, Israel’s space industries are world-renowned, and have achieved their well-respected standing for the satellites they have built, and are building and selling today. In contrast, the research at the Asher Space Research Institute (ASRI) is mostly concerned with Israel’s space technology a decade from now, and beyond.

Small university-scale satellites, such as those of the Technion’s SAMSON mission, are becoming the primary tool for training engineering students on a worldwide basis, as well as for testing novel applications in space before they can be implemented on large, commercial satellites. University space research, by its nature, is too far advanced for industries to immediately turn their concepts and designs into current business. Nevertheless, many industries do have vision, and realize that today’s research is tomorrow’s potential business.

Over the past two years, the Technion has claimed the role of spearheading small-satellite research in Israel, mostly owing to the SAMSON project. Under the leadership of ASRI, we have now built a diverse group of several dozen researchers and engineers from the Technion and collaborating Israeli industries. The industries work pro-bono, as they recognize the technological value of being part of a cutting-edge space mission. In the space business, where customers are few, SAMSON provides a rare opportunity for industry to be part of a novel, yet real, mission through which their people and hardware gain valuable prestige in the space industry.

**Current SAMSON Industry Partners**

The space division of Israel Aerospace Industries – MBT Space – is Israel’s primary space contractor, and the home of Israel’s highly successful Ofeq and Amos satellite lines. Once SAMSON was conceived, MBT Space volunteered to provide systems engineering services to the project, as well as their other expertise in satellite building, attitude and thermal control, thermo-acoustic testing, systems integration, etc. MBT Space has just developed a new “bus” (basic units) for nano-satellites. We are in the process of purchasing three such units for the SAMSON satellites, which will be one of the first test beds for the new bus.

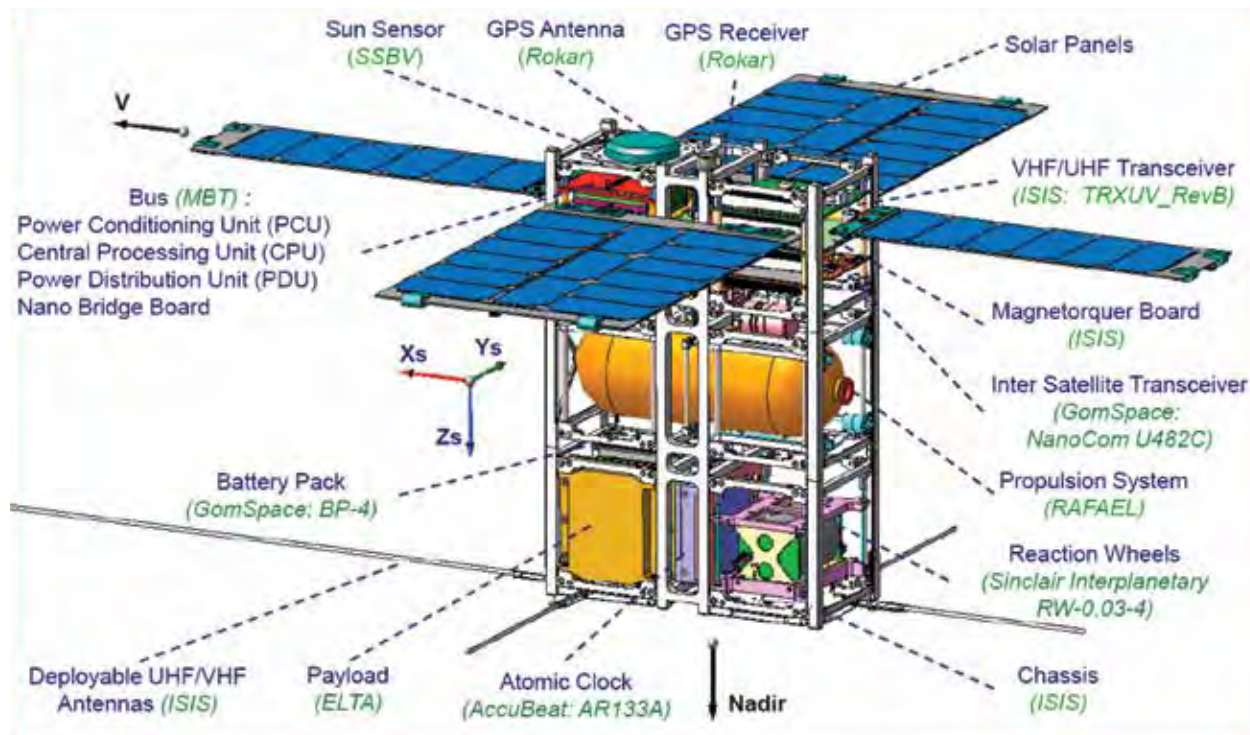


Image courtesy of Dr. Vladimir Balabanov (ASRI)

Rafael Advanced Defense Systems Ltd. is the backbone of Israel's defense industries, and is probably its most profitable member. Rafael designs and builds thrusters and thruster components for most of Israel's satellites. Rafael was part of SAMSON early on, when one of its engineers instructed group student projects. Since SAMSON was conceived in 2011, these projects have been geared towards the SAMSON mission. Under the instruction of engineers from Rafael's Space Directorate, Technion students designed the thruster system of SAMSON that will be the key to the success of its formation flying and the geo-location missions.

ELTA Systems Ltd., a subsidiary of IAI, is one of Israel's leading defense electronics companies. Several Elta engineers are core members of the SAMSON team, and are working closely with the SAMSON team to develop the geo-location payload.

Beyond all the above, several small and medium Israeli enterprises (SMEs) are important members of the SAMSON collaboration:

- ① **Spacecialist** - for its expertise in systems engineering and launch technologies
- ② **BAE Systems** - Rokar - for its GPS flight models
- ③ **Accubeat** - for its atomic clock for high-precision time-keeping that is the key to the geo-location algorithm



# SOLID STATE INSTITUTE (SSI)



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The Solid State Institute is an interdisciplinary research center designated to house and serve scientists from various faculties who are interested in the study of solids and solid interfaces. Pure and applied research projects, some of which may ultimately be of use to industry, are being carried out at the Institute in many individual and/or collaborative research efforts. The physical proximity fosters cooperation between scientists from different disciplines and different faculties that otherwise would not take place.

## Service Laboratories

Ion Implantation Laboratory ➔ Near Field Scanning Optical Microscopy and Raman Spectroscopy Laboratory ➔ Surface Science Laboratory ➔ Ultra-High Vacuum Surface Probe Microscopy Laboratory ➔ X- Ray Laboratory

## Individual Researcher Laboratory Functions

Extreme non-linear optics ➔ Coherent electronic transport ➔ Non-linear optics ➔ Optically-detected magnetic resonance and near-field optics ➔ Quantum optics and time-resolved spectroscopy ➔ Photo-induced infrared spectroscopy ➔ Diamond-film deposition ➔ Electrical characterization, Electro-optical characterization and magneto-optical spectroscopy



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**<http://solid-state.technion.ac.il/labs/labsdisplay.php?name=The%20Nano%20Photonics%20Laboratory>**

## Main service laboratories

### Ion Implantation Laboratory

The Ion Implantation Laboratory was established some 30 years ago. The facility is based on a 350 keV ion implanter, with the ability of utilizing many different ion species for implantation at multiple-charged ion states under different conditions, such as sample temperature, orientation, etc.). It can implant nearly any ion with isotopic resolution. In this respect it is unique in Israel, and is most useful for versatile research applications. The laboratory collaborates with many local industries, as well as worldwide.



Ion Implanter

### Near Field Optical Scanning and Raman Microscopy Laboratory

The Laboratory is based on the Nanonics CryoView 2000™ set-up, purchased in 2007. It introduces integrated microscopy to low-temperature research. It is capable of simultaneous near-field scanning optical microscopy (NSOM) and atomic force microscopy (AFM) or confocal imaging of surfaces in variable temperature environments.

The unit comprises a helium flow cryostat with optical access from above and below the sample. It is capable of simultaneous AFM and NSOM at temperatures down to 10<sup>9</sup>K. It provides high resolution photoluminescence measurements at a lateral scanning range of 50 by 50 μm and heights of about 10 μm.



NSOM apparatus



The UHVSPM apparatus in the VT-UHVSPM lab

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**Variable Temperature, Ultra High Vacuum, Scanning Probe  
Microscope (VT-UHVSPM) Laboratory**

The Laboratory is based on an Omicron Variable Temperature Ultra High Vacuum Scanning Probe Microscope system, purchased in 2005.

It includes an atomic force microscope (AFM) and a scanning force microscope (STM) with the following technical capabilities:

- ⌚ True pico-ampere scanning tunneling microscopy and spectroscopy
- ⌚ Scanning tunneling imaging mode
- ⌚ Contact or non-contact AFM.
- ⌚ Beam deflection AFM
- ⌚ Liquid helium and nitrogen cooling from 25°K to room temperature, and heating up to 1000°K
- ⌚ Indirect and direct current sample heating
- ⌚ Continuous imaging during temperature ramping
- ⌚ Vacuum basis pressure:  $3 \times 10^{-10}$  mbar
- ⌚ Sample introduction through load-lock chamber
- ⌚ Scan size from sub-nano to 8  $\mu\text{m}$
- ⌚ Additional sample characterization and preparation chamber equipped with: Auger electron spectroscopy (AES), low energy electron diffraction (LEED), an argon ion gun for sputter cleaning, in-situ cleavage apparatus, a gas inlet and leak valve for in-situ adsorption experiments, an  $\text{H}_2$  cracker for atomic hydrogen surface treatment, and a valve for analysis and preparation chamber vacuum isolation





**The system has so far been mainly used for the following measurements:**

- ② Visualization of solid surface and nanostructure topography with vertical resolution of less than 0.01 nm and lateral resolution of less than 0.1 nm.
- ② Determination of chemical, electric, magnetic, and mechanical surface properties at atomic scale.
- ② In-situ cleaving and imaging of semiconductor nanostructures down to atomic resolution (interface roughness, atom intermixing).
- ② Direct measurement of local electronic properties (density of states, band gap, Coulomb blockade).
- ② In-situ surface diffusion processes.
- ② Leakage current on high-k dielectric materials.
- ② Local work function measurements.

### Surface Science Laboratory

The Surface Science Laboratory serves as a center for basic and applied research in the areas of surface and thin film physics and chemistry. Since 1980, hundreds of industrial companies have taken advantage of the Laboratory's facilities, and have been given analytical and research services essential for their activities.

**The Laboratory specializes in three surface-sensitive analytical techniques:**

#### X-ray Photoelectron Spectroscopy (XPS) -

Thermo VG Scientific Sigma Probe, England.

XPS provides the chemical composition of solid surfaces with chemical bonding information. The key features of XPS are:

- ② Identification of all elements except hydrogen and helium
- ② Surface sensitivity (probes top 2-10 nm of the material)
- ② Quantitative analysis with 0.1 atomic % sensitivity
- ② Chemical bonding information from core level energy shifts
- ② Depth profiling with good depth resolution
- ② Local surface analysis with a microfocused monochromatic X-ray source (down to 15  $\mu\text{m}$  beam diameter)
- ② Electronic structure information



The XPS apparatus in the surface science laboratory





The TOF-SIMS apparatus in the surface science lab

### **ToF-SIMS - Time of Flight Secondary Ion Mass Spectrometry (TOFSIMS5, ION-TOF GmbH, Germany)**

TOF-SIMS provides elemental and molecular information from the uppermost layer of organic and inorganic surfaces, thin layer depth profiling, and secondary ion chemical imaging.

#### **The key features of TOF-SIMS are:**

- ⊕ Elemental and molecular chemical detection
- ⊕ All element detection, including hydrogen
- ⊕ Surface sensitivity (1 to 3 atomic layers)
- ⊕ Depth profiling capability (from a few nanometers down to a few microns depth)
- ⊕ ppm detection limits
- ⊕ Depth resolution to about 1 nm; spatial resolution in the sub-micron range
- ⊕ High mass resolution ( $M/\Delta M > 8,000$ )
- ⊕ In-situ sample cooling (down to 150°K) or heating (up to 900°K)

### **Scanning Auger Microscopy/Auger Electron Spectroscopy (SAM/AES) Thermo VG Scientific Microlab 350, England**

AES provides information on the solid surface and sub-surface elemental composition.

#### **The key features of SAM/AES are:**

- ⊕ Identification and quantification of all elements except hydrogen and helium
- ⊕ Surface sensitivity (2-10 nm sampling depth, 0.1 atomic % sensitivity)
- ⊕ Sub-micrometer lateral resolution with an electron beam size of less than 10 nm
- ⊕ Depth profiling with good depth resolution
- ⊕ Secondary electron imaging (identical to SEM) and Auger electron elemental mapping
- ⊕ Partial chemical and electronic structure information from line shape analysis

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# STEPHEN AND NANCY GRAND WATER RESEARCH INSTITUTE (GWRI)



STEPHEN AND NANCY GRAND  
WATER RESEARCH INSTITUTE  
(GWRI)

Stephen and Nancy  
Grand Water Research  
Institute

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The Stephen and Nancy Grand Water Research Institute (GWRI) was established in 1993. Its mission is to promote and support research and management of Israel's water resources, maintaining the Technion's leading position and Israel's world leadership in the domain.

The Technion, given its international and regional pre-eminence in science, engineering and technology, relies on the GWRI leadership to continue the line of research excellence that provides solutions to water-related problems.

The GWRI emphasizes advancement of water science, engineering and management tools in Israel, the Middle East, and other water-sensitive regions worldwide. The GWRI focuses on innovative and sustainable approaches, technologies and methods for overcoming water shortage and preserving the quality of water resources at lowest possible cost, while saving energy and diminishing environmental and ecological impact. The GWRI is committed to lead water research in Israel, while maintaining good working relations with the academic, research, and industrial sectors both locally and internationally.

**Research and Development Areas**

**Water treatment, desalination and treatment of wastewater:**

Water treatment (physico-chemical, biological) ➤ Advanced desalination technologies ➤ Membranes: design-synthesis-modifications-testing-modeling ➤ Wastewater treatment: biological, chemo-physical, membranes, nanofiers / nanotubes/nanochannels ➤ Post-treatment of desalinized sea water ➤ Treatment of industrial wastewater ➤ Gray-water recycling and management aspects

**Preservation of water resources, hydrology - source quantity and quality, wastewater reuse and efficient irrigation:**

Hydro-geophysics ➤ Hydrological processes, including climate change effects ➤ Monitoring and modeling at various scales ➤ Fluid dynamics of complex water systems ➤ Development of advanced analytical and monitoring tools ➤ Reuse of reclaimed wastewater for sustainable crop production ➤ Water use efficiency

**Water and environmental microbiology:**

Applied Genomics and Water Microbiology ➤ Pathogen survival in water systems and in plants irrigated with reclaimed wastewater  
➤ Advanced methods for bacterial detection ➤ Microfluidics for advanced bio-sensing

**Management of urban water systems, water resources management and policy:**

Water resource systems analysis ➤ Management of water distribution systems ➤ Multi-objective optimization models ➤ Security and reliability aspects ➤ Water resources under uncertainty and risk ➤ Water-sensitive planning ➤ Enviromatics: utilization of distributed multi-modal sensor networks for water sensing and decision-making

**Interaction with the water industry sector**

GWRI members are deeply involved with the Israeli and international water industry through active participation in R&D projects, scientific/professional meetings, consulting to industry, and involvement in professional steering committees.

Research projects are conducted by GWRI researchers sponsored directly by various water industries, including SANOFI; Mekorot-Israel National Water Co.; Haifa Chemicals Ltd.; Maccabi Carasso Ltd; Agat Engineering Consulting and Design 2000 Ltd; Israel Electric Corporation; Hydranautics Inc.; and Oil Refineries Ltd.

A significant portion of the research projects are funded by leading, competitive and prestigious local and international funding agencies (e.g., BSF, ISF, BARD, BMBF and DKFZ, Technion-Niedersachsen fund [Germany], US-AID/MERC, FP-7 [EU]).

**Involvement and Interaction with Governmental Offices/Authorities**

GWRI as an institute, as well as its individual members, are deeply involved with Israeli governmental offices and authorities. This activity includes interaction with: the Israeli Water Authority at various levels; and participation and/or chairing of Professional/Steering Committees at the Ministry of Infrastructures - Water and Energy, the Ministry of Environmental Protection, the Ministry of Science, and the Ministry



of Agriculture. GWRI members also contribute to, amongst others, Israel's Institute of Standards and Water and Wastewater Corporations.

Research projects conducted by GWRI researchers are funded directly by governmental agencies/ministries, such as the Ministry of Industry, Trade and Labor, the Water Authority, the Ministry of Environmental Protection, the Ministry of Science, the Ministry of Agriculture, and the Standards Institution of Israel.

The GWRI jointly organizes with the Samuel Neaman Institute for Advanced Studies in Science and Technology and the Water Authority "The Water Forum", with more than 100 participants, including leading researchers, water specialists, government officials and the Water and Energy Office of the Minister of Infrastructures. The forum's aim is to discuss and analyze key issues of Israel's water-related management problems in annual workshops.

GWRI members are also deeply involved in leading/chairing or participating as members of steering committees of the following professional societies: the Israeli Desalination Society - IDS, the Israeli Society of Soil Science - ISSS, the Israel Agricultural Engineering Society, the Israel Society of Ecology and Environmental Sciences, and the Israel Analytical Chemistry Society.

**Blumenstein Family Information Center (BFIC)**

The GWRI's Blumenstein Family Information Center (BFIC) is unofficially recognized as Israel's national water-related information center, and is a gateway to a variety of local and international databases, providing speedy access to water-related topics. The BFIC assembles, archives, summarizes, and makes accessible, publications on Israel's water issues through an organized database. The BFIC database contains approximately 50,000 items related to water, with thousands of new items added annually. It also contains the "Who's Who in the Israel Water Sector," which lists more than 2,000 individuals and organizations.

A team of information specialists is on hand to assist researchers, planners, engineers, students, decision-makers, and the general public, in locating the required information.



**Blumenstein Family Water Information Center**

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# TRANSPORTATION RESEARCH INSTITUTE



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**<http://tri.technion.ac.il>**

The Transportation Research Institute (TRI) began its operations in October 1977. It serves as a center and framework of cooperation for faculty members from various Technion units whose research covers a wide spectrum of transportation subjects. This research, largely financed by state funds, is primarily directed at solving problems of crucial national importance: road safety, traffic congestion, energy and environmental issues, transportation planning, transportation systems analysis, and road maintenance.

The Institute has gained recognition in Israel and abroad as leading in the transportation research areas of its expertise. The main achievements and accumulated benefits from the research projects have yielded significant results in improving road safety, transport infrastructure, traffic control, and environmental quality. In recent years the Institute has set itself as an important goal of raising public understanding and awareness of the fields of transportation and road safety, using the capabilities of the Institute's researchers.

## Research Areas

Road Safety ➔ Traffic Engineering and Control ➔ Vehicle, Energy and Environmental Engineering ➔ Transportation Planning, Urban planning and Land Use ➔ Road and Pavement Engineering



<http://tri.technion.ac.il/Transportation/Templates/ShowPage.asp?DBID=15LNGID=15TMID=84&FID=287>

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Traffic Management Research Center

The Traffic Management Research Center (TMRC) was founded in 1994 as part of the Transportation Research Institute. The Center specializes in developing algorithms, methodologies, and systems for promoting sustainable urban mobility.

TMRC conducts multidisciplinary research, based on know-how and expertise in Transportation Engineering, Industrial and Management Engineering, Operations Research, Economics, Statistics, System Analysis, and Software Engineering.

TMRC works in close cooperation with all the major transport authorities in Israel, as well as with high-tech companies. Alongside the local cooperation, TMRC is also involved in international research projects through various research frameworks, such as the EU R&D Framework Program.

R&D examples

INBAR

INBAR is a signal-program planning system developed by the TMRC for the Ministry of Transport, and constitutes the standard system for signal-program design in Israel.

A systematic approach composed of both mathematical models and engineering considerations is implemented in INBAR. This approach enables us to meet the challenge of integrating quantitative data and qualitative requirements.

Various self-developed algorithms for signal program design, planning, and quality assurance are embedded in INBAR, such as: splitting a signal-state graph into fundamental entities; the stage transition optimization algorithm; automatic identification of illegal stage sequence based on safety constraints; public transport trajectory based on car-following models; and an optimization model for staggered junction design.

The models and algorithms embedded in INBAR serve as a decision support tool for transportation engineers, and reflect general traffic engineering methodologies, combined with Israeli guidelines for signal planning.

**AVIVIM**

AVIVIM is the Traffic Management and Control System of the metropolitan area of Tel-Aviv. AVIVIM follows the classical approach of management and operational layers. TMRC has conducted research focusing on decision-support traffic management methodologies since 1994, funded by the Municipality of Tel Aviv, with the support of the Israeli Ministry of Transport.

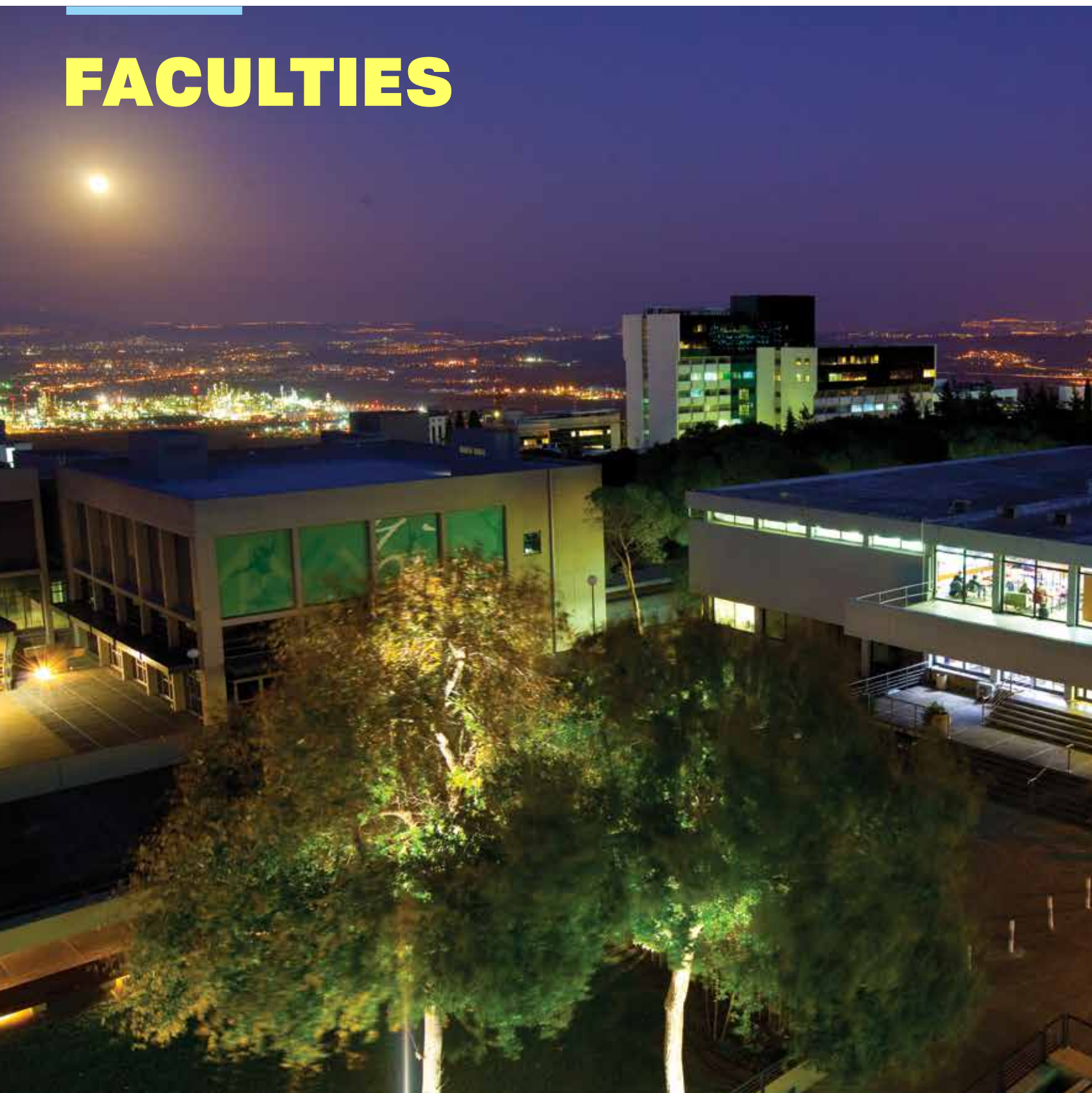
The research in this area continues to address the ever-growing mobility needs of public transit users, private vehicle users, bicycle riders, and pedestrians, and is reflected in new methodologies incorporated into AVIVIM.

The Municipality of Tel Aviv has chosen to present AVIVIM as the municipal state-of-the-art system in several benchmarking projects. As a result of the success of the implementation of AVIVIM in Tel Aviv, it was adopted by the municipality of Haifa in 2006.





# FACULTIES





# FACULTY OF AEROSPACE ENGINEERING



<http://ae-www.technion.ac.il>

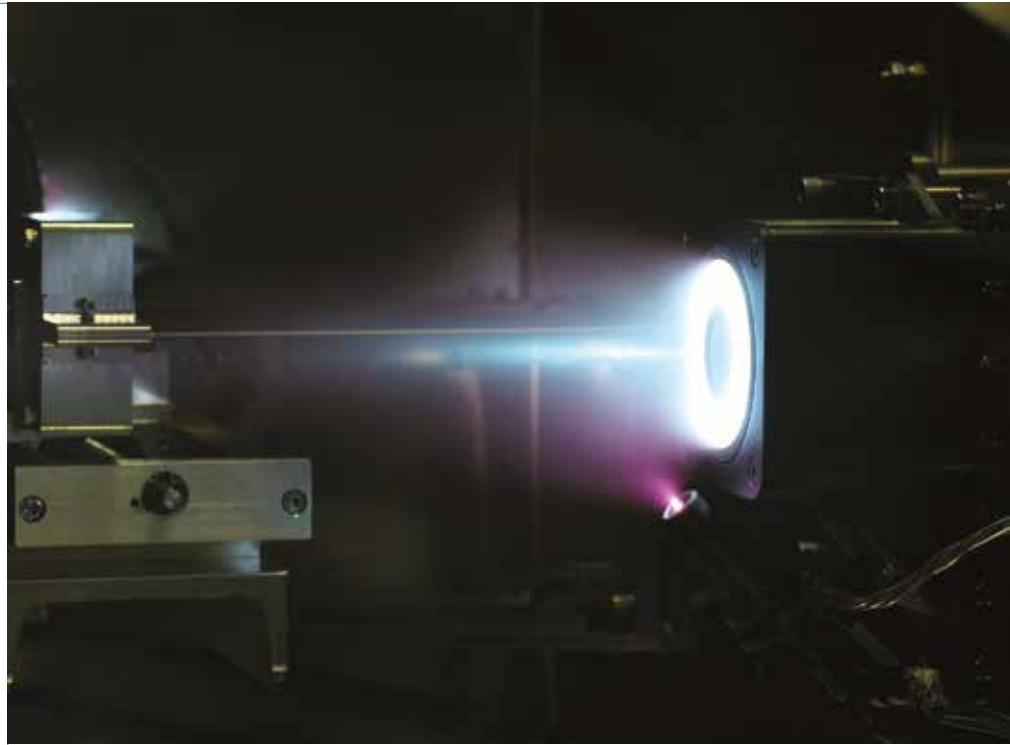
## Faculty of Aerospace Engineering

The Faculty of Aerospace Engineering is the sole source of aerospace engineers in Israel. Faculty members conduct world-class (mostly sponsored) research, provide consultancy services to the Israeli aerospace industry in innovative technologies and challenging problems, and teach a wide range of aerospace disciplines. The Faculty's research laboratories include: the Wind Tunnel Laboratory complex (comprising supersonic, transonic, subsonic, and turbulence laboratories), the Aerospace Structures Laboratory, the Combustion and Rocket Propulsion Laboratory, the Turbo and Jet Engine Laboratory, the Flight Control Laboratory, the Distributed Space Systems Laboratory, the Cooperative Autonomous Systems Laboratory, and the Design for Manufacturing Laboratory.

During its 60 years of existence, constant efforts have been made to maintain and strengthen the Faculty's excellence in research. The high quality of the academic work performed by Faculty members and graduate students is reflected, first and foremost, by the quality and number of scientific articles published in the best academic venues, but also in the appointments of these Faculty members to Israeli, American, and other international academies; their election to governing bodies of national and international professional associations, and their memberships on editorial boards of prestigious scientific journals. Thus far, three Faculty members have received the prestigious Israel Prize, the highest national award, for their lifetime achievements in aerospace sciences research.

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Turbo and Jet Engine Research Center

Exceptionally close ties are maintained with the world-leading Israeli aerospace industry, including companies, such as Israel Aerospace Industries Ltd. (IAI), Rafael Advanced Defense Systems Ltd. and Elbit Systems Ltd, the research agencies of the Ministry of Defense, and various technological army and air-force units.

#### **Research and Consultancy Areas**

- ④ Fluid mechanics and aerodynamics
- ④ Aerospace structures
- ④ Guidance, navigation and control
- ④ Design theory
- ④ Jet and rocket propulsion and combustion
- ④ Interdisciplinary topics (aeroservoelasticity, multidisciplinary optimization, flow control)



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**Research Laboratories****Aerodynamics Laboratory**

The Wind Tunnel Complex in the Faculty of Aerospace Engineering consists of four tunnels: two in the incompressible subsonic range ( $Mach < 0.3$ ), one in the compressible transonic range ( $0.35 < Mach < 1.1$ ), and one in the compressible supersonic range ( $1.6 < Mach < 3.5$ ). In addition, the complex includes the Turbulence Laboratory, the water-tunnel facility and a transonic jet. While numerous incompressible subsonic wind tunnels can be found in the academic environment, the Technion is one of few universities in the world with such facilities. The wind tunnels are used for aerodynamic experimental research carried out by faculty members, graduate students and joint projects with the industry as well as for teaching undergraduate laboratory courses.

**Computational Laboratory for Aerospace Structures**

The lab has three HP DL585 G7 servers, with 48 processors each, intended for CPU-intensive High Performance Computing (HPC). The research is numerical and involves, mainly, aerodynamic and aeroelastic simulations in designated codes.

**Cooperative Autonomous Systems Laboratory**

The research performed in the Cooperative Autonomous SYstems (CASY) lab is in the general area of guidance of autonomous (especially aerial) vehicles operating individually or as a team. The scope of the research spans from the high-level cooperative team mission planning (task assignment), to motion planning (guidance) with regard to optimizing trajectories for the dynamical systems, to the problem of trajectory-following, and lastly to the low-level control of a single vehicle. In our research and experiments we seek to devise new algorithms and strategies for performing these cooperative or individual tasks and to gain insight into the interactions between the different levels of planning and control. The lab operates an indoor test-bed emulating real world complexities and constraints. It is composed of a motion capture system, providing in real-time 6-DOF estimates for tracked vehicles that include quadrotors and ground vehicles. CASY's architecture allows for the addition of vehicles in a short time at a low cost, since no embedded hardware is installed in the vehicles. This enables us to avoid being overly conservative during flight testing. Research performed in CASY is currently mainly



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supported by the Israel Science Foundation, the Israeli MOD, and by the Technion's Autonomous Systems Program.

Distributed Space Systems Laboratory

Distributed Space Systems Lab (DSSL) is a research laboratory at the Technion, led by Professor Pini Gurfil and comprising an interdisciplinary group of faculty, staff, and graduate students from Aerospace Engineering, Physics, Computer Science, Autonomous Systems Program and other departments.

DSSL's vision is to generate knowledge and experience that will enable the launch of a multiple satellite formation flying mission into a low Earth orbit within the next 3 years. DSSL is committed to performing groundbreaking research in astrodynamics, navigation and data processing of multiple satellite systems, as well as related disciplines. DSSL's experimental facilities include a 4x4 meter air-bearing table, nanosatellite models, sensors, and optical telescopes.

Philadelphia Flight Control Laboratory

Description of activities:

**Advanced Flight Displays:** Lately this activity was focused on advanced integrated forward-looking flight displays for low or zero visibility Nap-of-the-Earth flight and hovering flight but this philosophy has also been applied to perspective display formats for air-traffic control. An additional development based on natural predictive information has been an orbital maneuvering planning display for executing fuel-efficient maneuvers about the space station.

**Pilot-vehicle modelling:** A core predictor symbology theory has been developed that has been applied to a wide variety of display designs. Models for visual field information based on optical flow have provided thorough insight in the visual field information of the pilot in low-altitude visual flight and have been instrumental in the development of the first tunnel-in-the-sky display.

**Active manipulators:** This type of actuator provides force feedback to the pilot. In the past, the laboratory has investigated kinesthetic feedback both for aircraft and road vehicles, the latter one for skid prevention and recovery.

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**Guidance and control systems for small unmanned indoors flight**

**vehicles:** In the absence of GPS it is based on combined inertial and electro-optical sensors that are used to track features in the visual field. The displacement of these features on the image is able to reconstruct both the motion of the vehicle as well as the internal structure of the building in which it is located. The inertial sensors are required to adequately track these features and both inertial and optical sensor information complement each other in this estimation process.

**Krumbein Aircraft Structures Laboratory****Lab Equipment:****MTS Servo-Hydraulic Machine:**

Three loading rigs, with capabilities of 100, 250, 500 kN, each able to dictate a displacement up to 150 mm, and testing of structures up to 2 m.

All the three systems can be controlled by force, strain or displacement of the hydraulic piston. The control is either manual or computerized and can include various types of functions like, random, continuously up to 20 Hz, etc.

During the tests, the data in the form of forces, strains, displacements and temperatures can be stored for later use.

**Large Scale Test Servo-Hydraulic Machine:** Another MTS type system is solely dedicated to special projects, which has special testing need and has to be clamped to the floor of the lab. The maximum applied load is: 100 kN.

**Impact Test Machine:** Impact testing of structures for damage / destruction by shooting steel spheres having the diameter of 9 or 13 mm, with velocities up to 150 m/sec.

**Capabilities:** FE simulations - NASTRAN, ANSYS, ABAQUS; Design and Performance of Structural Tests; Dynamic Loading; Static Loading; Impact Loading; Thermal Loading; Vibrations.

**Sylvia and David I.A. Fine Rocket Propulsion Center**

The Fine Rocket Propulsion Center accommodates research activities in rocket and ramjet propulsion and related areas and derivatives (e.g., combustion, gel fuels and propellants, energetic materials,

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energy, two phase flows, and marine propulsion). It includes two faculty members, four scientists, some 10 graduate students, and technical personnel. It hosts Visiting Professors, Visiting Scientists, Post-Doc Fellows, as well as foreign and Technion undergraduate research students. The Center has a number of reinforced test cells, specially built for static firing tests and for high pressure experiments, high pressure air and gas supply, high and low speed video cameras, computerized data acquisition systems, a Malvern spray size measurement system, a DSC-TGA thermal analysis system, and a number of specific setups such as a water tank for marine propulsion and bubbly flow research.

**Turbo and Jet-Engine Laboratory**

Development of low NOx Jet engine combustor, improving stability of gas turbine combustion system, the use of methanol as an alternative fuel, biofuels for aviation, development of acousto-optic interface for autonomous maritime vehicles, optimization of small wind turbines for urban environment, control system for small engines, compressor dynamics & aerodynamics, development of optical diagnostics, sensors design.

**Turbomachinery and Heat Transfer Laboratory**

Turbomachinery and Heat Transfer Laboratory, supervised by Dr. Cukurel, is envisioned to be the main Israeli academic entity for aero-thermal research and advanced development in the field of turbomachinery applications. The center mainly focuses its effort on the hot gas section of a gas turbine, consisting of the high pressure turbine. The scientific contributions are primarily applicable towards small scale engines, which are commonly used in distributed power generation, business jets, unmanned air vehicles, auxiliary power units etc. In light of more stringent emission requirements, demand for increased power to weight ratio, the progressively augmenting durability requisites, and critical necessity to improve cycle efficiency, the laboratory develops technology at the frontiers of the current knowledge with advances in:

- ⌚ Turbine Cooling in Mini and Micro Jet Engines
- ⌚ Heat Transfer Enhancement in Hot Gas Section Coolant Coverage
- ⌚ Thermal Management
- ⌚ Aerodynamic - Thermal Coupling in High Speed Flows
- ⌚ Novel Experimental Measurement Technique Development

**Ties with Industry**

- ② Faculty members and their supervised graduate students perform industry-sponsored applied research.
- ② Faculty members provide consultancy services on a personal basis to the industry in their areas of expertise.
- ② Industry seminars are delivered by industry representatives as part of the Faculty seminar series.
- ② Leading experts from the industry supervise and mentor undergraduate final-year comprehensive student projects.
- ② Industry experts collaborate with Faculty members in advising MSc and PhD students.
- ② Industry and Faculty collaborate in organizing conferences and symposia in various fields of aerospace sciences.
- ② The Faculty's Research Laboratories provide various testing services to aerospace industries.





# FACULTY OF ARCHITECTURE AND TOWN PLANNING



<http://architecture.technion.ac.il>

The goal of the Faculty of Architecture, since it was established in 1924, has been to be the foremost professional body shaping the built image of Israel. Through education, research, and design leadership, the Faculty has successfully upheld this goal for the past 90 years, graduating thousands of professionals who literally designed and built the State of Israel. Led by a dedicated, fully-qualified, teaching staff of researchers and practitioners, the Faculty houses about 900 students (350 of whom are graduate students) in the fields of architecture, landscape architecture, planning, and industrial design. In addition, through its three research centers, the Faculty is also the primary locus of research and the generator of new design and planning knowledge in Israel. The Faculty offers post-professional, mid-career, and advanced degree programs in architecture, environmental design, industrial design, conservation of the built heritage, and real estate. In 2014, in collaboration with the Faculty of Civil and Environmental Engineering, the Faculty will inaugurate a new master's program in urban engineering.

## Research Areas

**Architecture:** Digital Architecture/Computer-Aided Architectural Design (CAAD) ➔ Design Research and Design Theory ➔ Sustainable Architectural Design ➔ Intelligent Buildings ➔ Computer-Aided Architectural Fabrication ➔ Urban Design ➔ Architectural Philosophy ➔ Architectural Education ➔ Design with Communities ➔ Art ➔ Architecture Theory and Criticism ➔ Deployable Structures, Spatial Structures and Shells | Design Research, Design Theory, Design Studies ➔ History, Theory and Criticism ➔ Biomimicry in Architecture ➔ GIS

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<http://architecture.technion.ac.il/Affiliates>

**Urban and Regional Planning:** Housing and Urban Regeneration • Social and Cultural Aspects of Planning • Spatial Development and Planning • Economic Aspects of Planning • Planning Law and Property Rights • Infrastructure • Environment and Planning

**Industrial Design:** Design and Human Factors in Healthcare • Personalized Design, Design for All (Inclusive Design) • Human Factors and Design in Extreme Environments • Evidence- Based Design (EBD) Methodologies • Computer-Aided Architectural Fabrication • Interactive Design and Responsive Environments • Sustainable Materials

**Landscape Architecture:** History, Theory and Criticism of Landscape Architecture in Israel • Cultural Landscapes • Sacred and Symbolic Landscapes: Natural, Cultural and Visual Components

### Architecture and Town Planning Affiliates Program (ARAP)

The Architecture and Town Planning Affiliates Program (ARAP), established in 2013, is dedicated to the creation of cooperation between academia and leading industrial companies in Israel and worldwide. We believe that by establishing strong long-term relations between academia and industry we can promote important values, focusing on knowledge, development, innovation, leadership, and excellence. The ARAP stimulates and supports the needs of business, industry, and academia in applied research and development, teaching, human resources, public relations, and advertising.

### Research and Development:

- ③ Professional interaction with Faculty researchers.
- ③ Students' Final Project Course: subjecting proposals and assistant mentors provided by company for special student projects.
- ③ Carrying out joint projects with research centers and laboratories.
- ③ Use of Faculty Laboratories - Fabrication, Visualization, GIS, Climate and Energy, Experimental Art and Architecture.
- ③ Identifying partners for joint research proposals to the Chief Scientist of the Ministry of Economy and the European Union.

### Teaching

- ③ Workshops, Seminars and Guest Lectures presented within the Faculty by representatives of suitable companies.
- ③ Student competition themes by companies.



- ③ Mini-courses, seminars, summer courses and professional graduate programs presented in the Faculty by Faculty researchers to company employees.
- ③ Free Auditing: option for company employees to choose specified faculty courses.
- ③ Industrial Advisory Board held once or twice a year to discuss teaching programs, research projects, laboratories, and Faculty equipment.
- ③ Library Services: limited.
- ③ Guided Tours: opportunity for students to have a guided tour of the company's facilities.

Human Resources

- ③ Classified ad distribution by direct mailing, monthly Faculty newsletter, Faculty website and bulletin boards and plasmas.
- ③ Announcements via professional conferences, seminars, awards, scholarships, and recruiting days.
- ③ Student employment during summer projects, and hosting summer interns.

Public Relations and Advertising

- ③ Increasing company's visibility: Company's name and logo presentation at the Faculty Academia Industry Affiliates program web page linked by the official Faculty website.
- ③ Sponsorship opportunity for affiliate's conferences, seminars, competitions, projects, etc.
- ③ Sponsorship advertising announcement in the Faculty newsletter, distributed to alumni, industry personnel, Faculty staff, and students.
- ③ Advertising firms' activities/events: monthly Faculty newsletter, Faculty website, bulletin boards and plasmas.
- ③ Exhibition presentations: in Faculty building.
- ③ Links for selected web pages/company presentations to the Faculty Academia Industry Affiliates program web page.

Visualization Laboratory (VizLab)

The Visualization Laboratory (VizLab) was established in the Fall of 2013. The centerpiece of the Laboratory is a 3D immersive theater, consisting of a 2.4 x 7.0 m screen with a 75° field of view and three high-definition Projectiondesign® projectors. The laboratory was designed and installed by Antycip Simulation®. 3D capacities are enabled by VizTech XL software, which produces 3D images from software, including Rhino 3D,



3D Max//Vrml, Virtools, SketchUp, Google Earth, AutoCad, and ArcGIS. VizLab can host up to 20 people simultaneously for a 3D experience in which one participant, followed by tracking cameras, can “move” through the image, or manipulate a 3D object on the screen. VizLab is also equipped with a state-of-the-art sound system and advanced photography equipment.

The VizLab is available to users throughout the Technion and beyond.

**The Laboratory serves a broad diversity of uses including:**

- ③ Investigating user experience in coastal environments under diverse physical and social conditions.
- ③ Examining human behavior in interactive built environments (including historical settings).
- ③ Stimulating dialogue and community participation in the future of their physical environment.
- ③ Studying human cognition and perception during navigation and way-finding in urban environments and large internal spaces.
- ③ Assessing the ecological, aesthetic and tourist value of open and forested landscapes.
- ③ Empowering community stakeholders through the use of 3D visualization of urban development and architectural scenarios, thereby eliminating the gap between professional jargon and popular perceptions of development possibilities.
- ③ Testing movement patterns in urban environments at different times.
- ③ Participatory land use planning and architecture.
- ③ 3-D study and design of objects, from as small as a pin to as large as a building, and from inanimate objects to complex living organisms
- ③ Virtual tours of buildings and neighborhoods
- ③ Land use and architectural scenario analysis

**Contact**

**Asst. Prof. Dafna Fisher-Gwartzman**

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ardafna@tx.technion.ac.il

VizLab users receive the support of trained student technicians who accompany the user from data preparation to actual use within VizLab.





<http://tcode.net.technion.ac.il>

### Contact

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Grobman**

Tel: +972-829-4041  
[yasha@technion.ac.il](mailto:yasha@technion.ac.il)

### Technion Computer Oriented Design and Manufacturing Laboratory (T\_CODE)

The T\_CODE is an experimental computer-oriented design research laboratory, which supports research and education in design computation and fabrication of new media and architecture. It includes a full spectrum of leading digital design and fabrication tools, such as 3D scanning, 3D printing, laser cutting, and a CNC milling machine. It supports design, rationalization, and preparation for fabrication of complex geometry, as well as 3D scanning and fabrication in various types of materials. It allows researchers and students to comprehend their designs more fully, as well as to conceive forms they would be unable to build on their own, thus unlocking their design creativity and productivity.

### Center for Architectural Research and Development

The Center for Architectural Research and Development (CARD) was established in the 1970s as the research arm of the Faculty of Architecture and Town Planning in areas including Sustainable Architecture (focusing on energy and lighting in buildings), Computational Design Methods, Digital Technologies, Advanced Building Simulation, Environmental Control, Urban Design, Housing, Morphology, Architectural Theory, Construction Technology, Building Technology, Re-Use of Buildings, and Work with the Community. Some 20 Faculty members and graduate students are affiliated with the Center, engaged in both basic and applied research. Examples of research performed at the CARD include development of the Israeli Standard for Energy Rating of Buildings (IS5282), which was adopted as part of the Israeli Standard for Green Buildings (IS5281). It will significantly help to reduce the energy consumption for air-conditioning and heating buildings, and will help reduce the dependence of Israel on imported energy resources. At the urban scale, many studies have been performed to develop design guidelines for solar and wind rights. The guidelines have been implemented in the curriculum, and published in books and papers available to the professional community. CARD researchers have developed novel tools, recognized nationally and internationally, for simulating future building behavior, which can forecast many performance aspects, including thermal comfort, lighting, heating, cooling, and people's behavior in buildings.

### Center for Urban and Regional Studies (CURS)

The Center for Urban and Regional Studies (CURS) has traditionally been deeply involved in the planning field. The planning field is basically public, but involves numerous agencies and organizations,

governmental and non-governmental; as well as private firms and a range of supporting services. CURS has made a major contribution over many years to the development of planning methodologies and tools for industry. In fact, CURS has been highly influential in the development of plans and planning policies at the national, regional, and local levels. CURS and the Faculty of Architecture and Town Planning have frequently initiated and coordinated major national planning efforts, including the 2020 Master Plan for Israel, the Northern District Outline Plan, local outline plans, and many policy documents dealing with tall buildings, affordable housing, and water conservation. Its extensive research in planning and land legislation has been widely referred to in Supreme Court decisions and rulings, and has led to new legislation. CURS is now leading the preparation of the Marine Spatial Plan for Israel's Mediterranean Exclusive Economic Zone.

As a leading practice-oriented research center in the applied science of planning, CURS is a hub for professional discourse and innovation. It hosted the 2011 Annual Conference of the Israel Planners Association, and many professional seminars and symposia.

Members of CURS often serve on public committees, both national and local. Their leading role as members in the National Council for Planning and Building has had a major impact on its decisions for many years.

### **Architectural Heritage Research Center**

The Architectural Heritage Research Center was established by Professor Gilbert Herbert in the 1980s. This Center was the first architectural archive in Israel, founded in order to establish a national basis for architectural research. Research in architecture is typological by nature, being based mostly on precedents.

The Center allows in-depth research of the roles that architecture, landscape architecture, and urban design have played in the evolution of the modern State of Israel. Far from being the site of dusty papers and scholars deprived of daylight, the Center offers researchers from Israel and abroad welcoming surroundings in which to examine the nature of the built environment and the ideas that underlie Israeli architecture. At the Center they find active elements of the past and the present that continue to inform and stimulate our built reality and to provide new directions in contemporary architectural practice.



# FACULTY OF BIOLOGY



<http://biology.technion.ac.il>

## Dean's Office

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## Industrial Relations Coordinator

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Dean  
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The Faculty of Biology started as a small department that split from the Faculty of Chemistry in 1971. During the first 25 years the Faculty of Biology developed slowly in terms of quality and quantity, focusing primarily on molecular and cellular biology research. After it became a Faculty, biology was not as dominant on campus as the biology departments at other universities. About ten years ago, the Technion management decided to establish strong and leading Life Science activities on the Technion campus by upgrading the Faculty of Biology to serve as the focal point for research into modern Life Sciences and teaching efforts. One of the tools for implementing this decision was the establishment of the of the Lorry I. Lokey Center for Life Sciences and Engineering, founded by Distinguished Professor and 2004 Nobel Prize laureate, Aaron Ciechanover. As head of this Center, Professor Ciechanover collected and implemented the essential resources and funds for the J. Steven and Rita Emerson Life Sciences Building adjacent to the Faculty of Biology to house modern infrastructure, technologies and facilities in Biology and Life Sciences.

## Research Areas

Biochemistry ➤ Biophysics ➤ Biotechnology ➤ Cancer ➤ Cell Biology ➤ Computational Biology ➤ Development ➤ Drug Discovery ➤ Ecology ➤ Endocrinology ➤ Epigenetics ➤ Evolution ➤ Gene Regulation ➤ Genetics ➤ Genomics ➤ Immunology ➤ Microbiology ➤ Physiology ➤ Plant Biology ➤ Structural Biology ➤ Systems Biology ➤ Virology ➤ Zoology



<http://proteomics.net.technion.ac.il>

### Contact

**Prof. Arie Admon**

Head

**Dr. Tamar Ziv**

Manager

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tamarz@tx.technion.ac.il

**Price list:**



<http://proteomics.net.technion.ac.il>

### Smoler Proteomics Center

The Smoler Proteomics Center is the national infrastructure hub for proteome analysis. It was established by the Technion and the Ministry of Science to facilitate direct access to state-of-the-art technologies, instrumentation and knowhow in the fields of protein purification and analysis to researchers from universities, research institutes, hospitals, and biotechnology companies, from Israel and worldwide.

Activities in the Center range from identifying and quantifying proteins, to large-scale comparisons of proteins and their post-translational modifications in healthy and diseased states. The Center offers direct access to its technology and expertise, including protein and peptide mass spectrometry, micro-chromatography, two-dimensional chromatography, and electrophoresis, as well as in analyzing minute amounts of proteins. Three mass spectrometers are currently functional in the Center: Orbitrap, Orbitrap XL, and Q-exactive. All three are high-resolution, high-accuracy instruments enabling advanced proteomics. The mass spectrometers are fitted with nano-capillary HPLC, which enables the performance of very high-pressure and high-resolution chromatography.

The Center provides services on a first-come, first-served basis, and also for research collaborations for complex projects. Services to biotechnology companies are performed both during the research and development phases, as well as the quality-control phase, and include consultation throughout the project.

### Quality Control

- ② Analyses of synthetic peptides - sequence validation and contamination analysis
- ② Protein identification
- ② Characterization of contaminated peptide
- ② Analyzing changes in a protein (company product)
- ② Stability tests of peptides and proteins
- ② Comparison of product purification in different production stages
- ② Comparison between different lots of products

### Research and Development

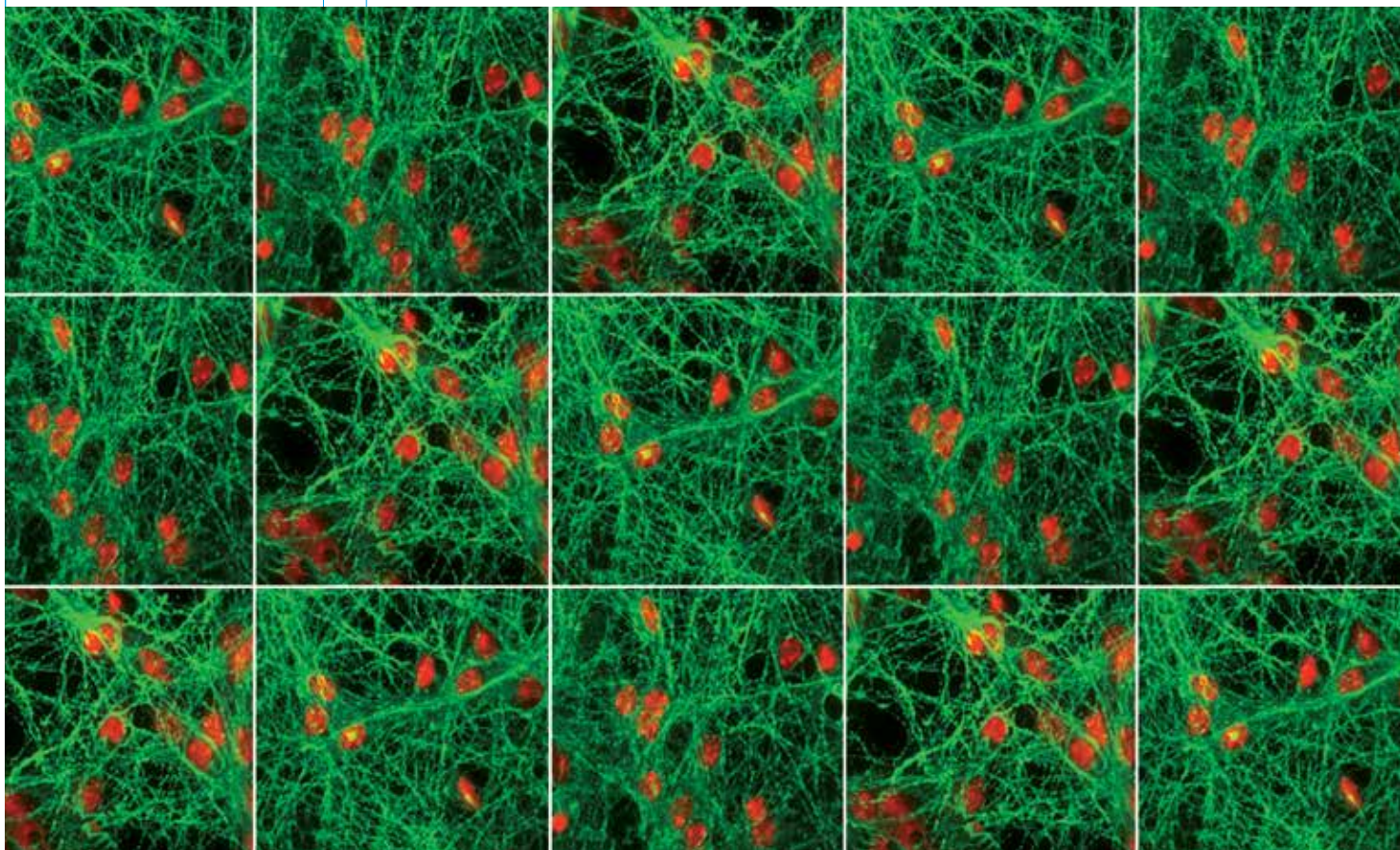
- ② Identification of the full repertoires of proteins (full proteomes, including many thousands of proteins) present in samples, such as cell lines, tissues, or microorganism cultures.
- ② Quantitative proteomics - definition of the relative levels of these



protein repertoires in different cell types, and following the changes in these levels in response to treatments or mutations.

- ② Analysis of protein complexes - characterization of the interactions between different cellular proteins, and determination of their sub-cellular locations.
- ② Modifications - determination of post-translational modification patterns (including phosphorylation, ubiquitination, acetylation, etc.).
- ② Variations - determination of the differences between similar proteins.

In recent years more than 50 biotech companies, pharmaceutical companies, and startups have worked successfully with the Proteomics Center.



# FACULTY OF BIOMEDICAL ENGINEERING



<http://www.bm.technion.ac.il>

## Dean's Office

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[http://www.bm.technion.ac.il/  
Labs/Pages/Default.aspx](http://www.bm.technion.ac.il/Labs/Pages/Default.aspx)

Biomedical Engineering (BME) at the Technion began as early as the mid-1940s, when the body's bio-electric phenomena were studied in the Department of Electrical Engineering. The interest and enthusiasm generated by this new field of studies grew so rapidly that by 1968 over 40 ongoing biomedical projects were under way at various Technion departments. In 1969, the Julius Silver Institute was set up to house all the Technion's biomedical engineering research, and the interdisciplinary Department of Medical and Biological Engineering was formally established, with the mission of developing a program for graduate studies. Today, the Faculty of Biomedical Engineering is involved in wide-ranging research, both basic and applied. The varied novel engineering techniques and state-of-the-art technological, scientific and medical know-how generated by the Department have, over the years, proved both useful and beneficial to Israel's medical community.

## Research Laboratories

Biomaterials ➤ Biomechanics of ultrasound interaction with cell and tissue ➤ Biomedical Optics Laboratory ➤ Cellular Biomechanics and Bio-rheology ➤ Cartilage and Joint Diseases Laboratory ➤ Stem Cells Tissue Engineering Laboratory ➤ Laboratory for Ultrasound Signals and Image Processing and Modeling ➤ Laboratory of Vision Research ➤ Medical Imaging Laboratory ➤ Meller Group ➤ Molecular Cardiology Laboratory ➤ Neural Interface Engineering Laboratory ➤ Orthopedic and Rehabilitation Engineering Laboratory ➤ Technion Biofluids Laboratory ➤ Laboratory for the Mechanics and Function of Organs, Tissues and Cells ➤ Tissue Engineering and Biomaterials Laboratory.





<http://www.bm.technion.ac.il/Labs/stem/default.aspx>

### Contact

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### Industrial Affiliates Program - IAP

The Technion Biomedical Faculty's Industrial Affiliates Program (IAP) is one of the Faculty's flagship development projects for the coming year. The program's goal is to promote excellence and long-term affiliations and collaboration between academia and leading companies in industry in research and development, human resources and employment, marketing and public relations, education, and instruction. Any company, large or small, in the Industrial Affiliates Program has access to the Faculty's resources, and can expose the company's operations at all levels to students studying all degrees and programs, as well as to academic, administrative, and technical Faculty members.

### Lorry I. Lokey Tissue Regeneration Group in the Biomedical Engineering Laboratories

The Levenberg Tissue Engineering Laboratory can contribute proven methodology and expertise in the fields of engineering vascularized cardiac / pancreatic / muscle tissue, flow-induced vascularization in engineered tissue, cell mechanics in 3D constructs, spinal cord injury regeneration and droplet-based microfluidics.

The Laboratory can assist in feasibility research in order to assess the possibility of using technologies for new product development, as well as developing assays to support product development. The Laboratory provides histology services for tissues and engineered tissues. It can also assist in testing mechanical properties of tissues and scaffolds.

The Laboratory is equipped with advanced equipment, and uses state-of-the-art assays for research in tissue engineering, 3D cultures, bioreactors, molecular biology, microscopy, and biochemistry.



# FACULTY OF BIOTECHNOLOGY AND FOOD ENGINEERING



<http://biotech.technion.ac.il/en>

The Faculty of Biotechnology and Food Engineering is unique in Israel, providing the highly skilled engineers needed for the country's expanding biotechnology and food industries. It offers a unique interdisciplinary blend of courses in engineering, food science and technology, life sciences, and biotechnology engineering. The Faculty has been transformed since a decision was made during the mid-1980s to focus on biotechnology. Accordingly, new Faculty members specializing in various aspects of biotechnology were recruited, and the teaching programs were revised to include a biotechnology specialization program, in addition to the existing food engineering specialization program. The integration is based on the biological material common to both fields, and fits well with the many changes in the traditional food industry, which is becoming more and more biotech-oriented. The Faculty's objectives are:

- ④ To enhance and maintain the leadership status of the Faculty of Biotechnology and Food Engineering in Israel and among the World's top faculties in these fields.
- ④ To attract the best Faculty members and students.
- ④ To educate top-level engineers and scientists for the modern biotechnology and food industries.
- ④ To maintain cutting-edge research, integrating scientific and engineering aspects related to biotechnology and food.

These objectives are in line with the Technion's vision of becoming one of the World's top ten universities.

The diverse activities of the Faculty of Biotechnology and Food Engineering combine a unique blend of engineering-technology research and aspects of life sciences and nanotechnology.

## Dean's Office

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<http://biotech.technion.ac.il/en/research-labs>

Contact

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Asst. Prof. Uri Lesmes  
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Tel: +972-77-887-1869  
lesmesu@tx.technion.ac.il



Research Laboratories

Synthetic Biology Laboratory

**Research Topics:**  
Decipherment of the regulatory and transcriptome codes using synthetic biology approaches, single molecule diagnostics.

Nanostructured Molecular Assemblies Laboratory

**Research Topics:**  
Nanoencapsulation and drug delivery, physical chemistry of soft matter, lipids and vesicles, self-assembly and nanostructure of complex fluids, cryo-TEM: development and application.

Molecular and Applied Biocatalysis Laboratory

**Research Topics:**  
Engineering of enzymes for their use in the synthesis of chiral compounds and food ingredients, structure-function correlations of enzymes, enzymes in non-aqueous media.

Applied Genomics and Food Microbiology Laboratory

**Research Topics:**  
Food and environmental microbiology, rapid detection of pathogens, typing of probiotics and pathogens, genome evolution, evolution of microsatellite DNA.

Chemistry of Foods and Bioactive Ingredients Laboratory

**Research Topics:**  
Physicochemical basis of human digestion, food hydrocolloids, chemometrics and food personalization.

## Contact

**Prof. Ben-Zion Levi, Head**  
Tel: +972-4-829-3345  
blevi@tx.technion.ac.il

### Mammalian Cell Technology Laboratory

#### Research Topics:

Gene regulation in innate immunity, myeloid-leukemia, host-pathogen interactions

**Assoc. Prof. Yoav D. Livney**  
Head  
Tel: +972-4-829-4225  
livney@tx.technion.ac.il

### Biopolymers and Food Nano-Biotechnology Laboratory

#### Research Topics:

Physical chemistry of macromolecules in food and other biotechnological systems, nano-delivery systems for health-promoting compounds.

**Prof. Marcelle Machluf, Head**  
Tel: +972-4-829-4916  
machlufm@tx.technion.ac.il

### Cancer Drug Delivery and Tissue Engineering Laboratory

#### Research Topics:

Tissue engineering based ECM platforms, cell encapsulation and drug delivery systems, ultrasound technology for DNA delivery to cells and tissues.

**Asst. Prof. Esther Meyron-Holtz**  
Head  
Tel: +972-4-829-3348/9  
meyron@tx.technion.ac.il

### Molecular Nutrition Laboratory

#### Research Topics:

Mechanisms and regulation of systemic and cellular iron distribution in mammals, in health and disease.

**Prof. Emeritus Joseph Miltz**  
Head  
Tel: +972-4-829-2451  
jmiltz@tx.technion.ac.il

### Goldstein Packaging Laboratory

#### Research Topics:

Packaging (Active and Modified Atmosphere), suitability of packages for contact with food, suitability for dangerous materials and for fragile products, evaluation of gas (oxygen, water vapor and other gases) permeability, evaluation of mechanical and physical properties of packages and packaging materials.

**Asst. Prof. Boaz Mizrahi, Head**  
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bmizrahi@technion.ac.il

### Biomaterials Laboratory

#### Research Topics:

Biologically inspired materials for reparative medicine, for improved bioavailability of drugs and food additives, and for separation processes, and the relationship between the molecular structure and functionality.

<b>Contact</b> <b>Prof. Amram Mor, Head</b> Tel: +972-4-829-3340 amor@tx.technion.ac.il	<b>Host Defense Peptides Laboratory</b> <b>Research Topics:</b> Peptide-based drug design and delivery; non-specific mechanisms of action; structure-activity relationships.
<b>Assoc. Prof. Ester Segal, Head</b> Tel: +972-4-829-3349 meyron@tx.technion.ac.il	<b>Functional Nanomaterials, Biosensors, and Sensors Laboratory</b> <b>Research Topics:</b> Development of multifunctional nano-materials for sensing/ biosensing, drug delivery systems, intelligent and active packaging.
<b>Prof. Yuval Shoham, Head</b> Tel: +972-4-829-3072 yshoham@tx.technion.ac.il	<b>Protein and Enzyme Engineering Laboratory</b> <b>Research Topics:</b> Gene regulation in clostridium thermocellum and geobacillus stearothermophilus, catalytic mechanism and structure function relationship of glycoside hydrolases.
<b>Prof. Assoc. Prof. Sima Yaron Head</b> Tel: +972-4-829-2940 simay@tx.technion.ac.il	<b>Molecular Biology of Pathogens Laboratory</b> <b>Research Topics:</b> Food safety, molecular microbiology of food-borne pathogens, host-pathogen interactions, bacterial biofilms, gut microflora.
<b>Prof. Yeshayahu Talmon</b> Tel: +972-4-829-2007 ishi@technion.ac.il  <b>Assoc. Prof. Dganit Danino</b> Tel: +972-4-829-2143 dganitd@tx.technion.ac.il	<b>Electron Microscopy Laboratory for Soft Matter</b> The Electron Microscopy Laboratory for Soft Matter was established in 1998 to provide the tools and methodology to image nanostructured liquid and semi-liquid systems directly. It includes two dedicated cryo-TEMs, a Philips CM120, and an FEI T12, which was acquired in 2004. In 2008, we added a Zeiss high-resolution scanning electron microscope (HR-SEM). We have all the facilities necessary for specimen preparation. These include an in-house system developed and built for direct imaging of vitrified specimens, and a new Leica (Bal-Tec) BAF 060 instrument for freeze-fracture-replication and cryo-SEM specimen preparation. We also have an image-processing and archiving room. This unique facility has proven to be most useful for a wide range of projects (room temperature work is also done on our instruments), and attracts users and collaborators from the campus, and from other Israeli and foreign universities and industries.
	In addition to the in-house-built controlled environment vitrification system (CEVS) used for both cryo-TEM and cryo-SEM specimen

	<p>preparation under controlled conditions, the Laboratory also has a commercial Vitrobot system for cryo-TEM specimen preparation. Also available is a Leica UC6 ultramicrotome equipped with an FC6 cryo-system for cryo-sectioning of biological and polymeric specimens for TEM.</p> <p>Electron microscopy is augmented by a digital light microscopy system based on an Olympus BHT-2 microscope with an Optronics LED digital camera system. We have differential interference contrast (Nomarski) and polarized light cross-polarizer optics with this microscope, as well as a hot stage.</p>	
CONTACT	EQUIPMENT	ITEM DESCRIPTION
<b>Assoc. Prof. Dganit Danino</b> Tel: +972-4-829-2143 dganitd@tx.technion.ac.il	CEVS	Manual system for cryo-TEM sample preparation in a controlled environment (temperature, humidity, vapor saturation)
	VITROBOT	Automatic system for cryo-TEM sample preparation in a controlled environment (temperature, humidity, vapor saturation)
	Slice sample for microtome	System for thin slice preparation of liquid samples in the vitrified state for Cryo-TEM and Cryo-SEM
<b>Assoc. Prof. Sima Yaron</b> Tel: +972-4-829-2940 simay@tx.technion.ac.il	PERKIN ALMOR VICTOR	Fluorescence and luminescence plate reader
	BLOTEK	Fluorescence plate reader
	RT-PCR	Real-time PCR
<b>Prof. Ben-Zion Levi</b> Tel: +972-4-829-3345 blevi@tx.technion.ac.il	Gel imager	Imaging lengths of DNA and RNA molecules
	Inverted fluorescence microscope	
	Nanodrop	
	Luminometer	
<b>Asst. Prof. Uri Lesmes</b> Tel: +972-77-887-1869 lesmesu@tx.technion.ac.il	LumiSizer LUM GmbH	Analytical centrifugation for analysis of stability and size of suspension and emulsions
	Titrand 902+TIAMO control software	Computer-controlled dual auto-titration unit
	Applikon MiniBioreactors and SCADA control software	Computer-controlled fermenters
	Bioreactors and Fermac peristaltic controllers	Simulated human colon fermentation
	Stomacker	Paddle homogenizer



CONTACT	EQUIPMENT	ITEM DESCRIPTION
<b>Assoc. Prof. Yoav D. Livney</b> Tel: +972-4-829-4225 livney@tx.technion.ac.il	HPLC: Akta Basic (GE Healthcare)	Size exclusion, reversed phase
	MALLS: Dawn EOS (Wyatt Technologies)	Molecular weight distribution
	RI detector: OPTI LAB (Wyatt Technologies)	Absolute and differential refractive index; concentration
	DLS/Zeta: Nicomp 380 (PSS)	Nanoparticle size and zeta potential
<b>Prof. Amram Mor</b> Tel: +972-4-829-3340 amor@tx.technion.ac.il	Peptide synthesizer	Peptide synthesizer AB433A
	HPLC	Waters separation module Alliance
	Biotec Synergy	Biotec Synergy
<b>Prof. Marcelle Machluf</b> Tel: +972-4-829-4916 machlufm@tx.technion.ac.il	Cell counter	
	FACS	
	Nikon T-2000E ECLIPSE epifluorescence inverted microscope with incubator setup for time-lapse imaging.	
<b>Asst. Prof. Ester Segal</b> Tel: +972-4-829-3349 meyron@tx.technion.ac.il	DSC- differential scanning-calorimeter	<a href="http://segallab.technion.ac.il">http://segallab.technion.ac.il</a> - used for thermal characterization of materials, mainly polymers
	TGA Thermal gravimetric analyzer	<a href="http://segallab.technion.ac.il">http://segallab.technion.ac.il</a> - used for thermal analysis of materials
	FTIR - Fourier Transform IR Spectrometer	<a href="http://segallab.technion.ac.il">http://segallab.technion.ac.il</a> - spectroscopic technique to identify and study chemical composition
<b>Asst. Prof. Roei Amit</b> Tel: +972-77-887-1895 roeeamit@tx.technion.ac.il	Optosplit	Splits microscope image for simultaneous imaging of different fluorescent channels
	Oscilloscope	Measurement and generation of voltage signals
	Fluorescence microscope	Measurement of microscopic samples (bacteria) that emit fluorescence
	Gel imager	Imaging lengths of DNA molecules
	Nanovue	Measures concentration of DNA in suspension

CONTACT	EQUIPMENT	ITEM DESCRIPTION
<b>Assoc. Prof. Ayelet Fishman</b> Tel: +972-4-829-5898 afishman@tx.technion.ac.il	2 Bioreactors (200 ml) - Applikon	Controlled growth of microorganisms
	HPLC-DAD and HPLC-UV (Agilent), HPLC -DAD (Dionex)	Separation of small non-volatile molecules
	GC-MS (Agilent)	Separation and identification of small volatile molecules based on their mass
	GC-FID (Agilent)	Separation of small and volatile organic molecules
	GC HEAD SPACE (THERMO)	Separation of small volatile organic molecules from liquid or head space
	EpMotion 5070 robotic system (Eppendorf)	Liquid handling system for 96-well plates
<b>Assoc. Prof. Yechezkel Kashi</b> Tel: +972-4-829-3074 kashi@tx.technion.ac.il	3130 Genetic Analyzer - Applied Biosystems	DNA sequencing and genotyping - size determination of fluorenyl labeled products
	Microplate spectrophotometer Eon-BioTek	Absorbance microplate reader under temperature control at selected wavelength (200-999 nm)
	Microplate reader Synergy HT - BioTek	Absorbance, fluorescence and luminescence measurements in microplate
	Step One Plus REAL TIME PCR- Applied Biosystems	Quantification and detection of DNA and RNA, gene expression analysis
	Nanovue plus	Determining DNA and RNA concentration
	Eclipse 50i - Microscope and micromanipulator - Nikon	Yeast tetratide dissection
<b>Prof. Yuval Shoham</b> Tel: +972-4-829-3072 yshoham@tx.technion.ac.il	Dionex-Thermo Scientific Dionex Corporation	Chromatography
	GC-HP-GC 6890	Gas chromatograph
	HPLC-HP 1100	Liquid chromatograph
	Stopflow- Applied Photo Physics p*-180	Spectrometer for nanosecond kinetics and CD-circular dichroism for protein studies; characterization, stability, formulation, structure, and more.
	Akta Explorer- Pharmacia LKB (GE)	Protein chromatography system
	Akta Basic- Pharmacia LKB (GE)	Protein chromatography system
	Akta Avant - Pharmacia LKB (GE)	Protein chromatography system
	ITC- VP-ITC Microcal	Microcalorimeter
	DSC- VP-DSC Microcal	Microcalorimeter
	2-, 10-, and 50-L fermenters (BRAUN-BIOSTAT MD)	Fermenter

CONTACT	EQUIPMENT	ITEM DESCRIPTION
<b>Prof. Yuval Shoham</b> Tel: +972-4-829-3072 yshoham@tx.technion.ac.il	French Press-SPECTRONIC INSTRUMENTS	Cell homogenizer
	Anaerobic hood COY Laboratory Products Inc.	Anaerobic bacterial growth
	EMULSIFLEX C3-AVESTIN	Cell homogenizer
	BioTek- Synergy HT	Plate reader
<b>Pilot Plant (Food Technology)</b> Tel: +972-4-829-2453 shazman@tx.technion.ac.il	Spray dryer (Niro; 10 kg/hr)	
	Drum dryer (Escher Wyss; 50 kg/hr)	
	Fluid Bed dryer (Aeromatic; 4 kg batch)	
	Tunnel dryer (up to 15 kg/batch)	
	Freeze dryer (Grenco; up to 15 kg/batch)	
	Agitated falling fFilm evaporator (Luwa; 25 L/hr batch type)	Boiling vacuum concentrator for viscous liquids
	Falling film evaporator (Niro; 50 L/hr continuous)	Boiling vacuum concentrator for liquids
	Centri Term evaporator (Alfalaval; 30 L/hr batch type)	Up to 2000 bar
	Kugel vacuum evaporator (up to 40 L)	Boiling vacuum concentrator reactor
	2 Plate heat exchangers (Alfalaval and Niro; up to 6 L/min)	Pasteurization of liquids
	Still autoclave (Stork; with temperature and in package monitoring equipment) 50 L	
	Rotating autoclave (with temperature and in package monitoring equipment) 50 L	
	Blast freezer tunnel 80 L	
	Scraped surface freezer (Votator; 10 kg/hr continuous) 8	
	Tweedy mixer for dough (up to 15 kg)	
	Controlled baking oven	
	Smoking cabinet	

CONTACT	EQUIPMENT	ITEM DESCRIPTION
<b>Pilot Plant (Food Technology)</b> Tel: +972-4-829-2453 shazman@tx.technion.ac.il	Stephan mixer	
	2 Step Nozzle homogenizer (2 L/min)	Up to 300 bar
	Vacuum homogenizer (Herbot; 15 L batch)	
	Various high and low shear mixers and blenders	
	Various centrifuges(5 L/min)	
	Various grinders, crushers and Millers	
	Various screeners, sifters, filters	
	U.F filtration (0.54 square meter membrane)	
	FMC In-line-juice extractor	
<b>Industrial Relations Coordinator</b> <b>Prof. Yuval Shoham</b> Tel: +972-4-829-3072 yshoham@tx.technion.ac.il	<b>Relations with Industry</b> The Faculty of Biotechnology and Food Engineering is dedicated to the creation of mutual cooperation between academia and leading industrial companies, as part of our mission to promote mutually important values and needs of industry and academia focusing on knowledge, development, innovation, and excellence.	
	<b>Research and Development</b> <ul style="list-style-type: none"> <li>③ Professional interaction with Faculty researchers.</li> <li>③ Students' Final Project Course: topic proposals and mentors are provided by companies for 4th-year students.</li> <li>③ Joint Projects: laboratory services are provided by Faculty members and their research facilities for the food industry and for the biotech / biomedical companies.</li> <li>③ The Goldstein Packaging Pilot Plant Laboratory offers unique instruments for assessing and designing packaging systems.</li> </ul>	
	<b>Teaching</b> <ul style="list-style-type: none"> <li>③ Workshops, seminars, and guest lecturers</li> <li>③ Free Auditor: options for company employees to choose specified Faculty courses.</li> <li>③ Industrial Advisory Board: held once a year to discuss teaching programs, research projects, laboratories, and faculty equipment.</li> </ul>	



	<div>Human Resource</div> <div><ul style="list-style-type: none"><li>⊕ Recruiting day: an opportunity to hold an exclusive student-recruiting day.</li><li>⊕ Announcements via professional conferences, seminars, awards, scholarships, and recruiting days.</li><li>⊕ Student employment during summer projects and hosting summer interns.</li></ul></div> <div>Public Relations and Advertising</div> <div><ul style="list-style-type: none"><li>⊕ Increasing companies' visibility: companies' names and logo presentations on the Faculty web page</li><li>⊕ Sponsorship opportunity for alumni conferences, seminars, competitions, projects, etc.</li></ul></div>
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# FACULTY OF CHEMICAL ENGINEERING

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<http://chemeng.technion.ac.il/en>

The Faculty of Chemical Engineering developed in parallel with the development of the academic profession in the Western World. The Faculty experienced all the developments in the field typical of the last few decades. Over the years the Faculty developed into a modern chemical engineering department that combines core 'classical' chemical engineering with the modern aspects of the discipline, namely, nanotechnology, advanced materials, and biotechnology.

## Research areas covered by the Faculty include:

catalysis and transport phenomena, colloids, interfaces and complex liquids, polymer science and technology, advanced materials, water desalination, biosystems, and design and control.

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The Faculty members are closely connected to the Israeli and international scientific and industrial communities through active participation in scientific meetings, involvement in professional societies, scientific exchange programs, consulting to industry, and membership of editorial boards of scientific periodicals. The Faculty takes pride in its alumni, many of whom have reached top positions in industry, government, and academia.



<http://ceweb.technion.ac.il/research-labs>

#### Contact:

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## Research Groups

### Interfacial Phenomena

**Research topics:** Colloid and interface science

**Researchers:** Abraham Marmur • Yael Katsir • Elena Vinnik  
• Michal Yarom

**Labs:** Interfacial Phenomena Laboratory

### Complex Liquids, Nanostructure and Macromolecules

**Staff Researchers:** Berta Shdemati • Yehudit Schmidt

• Ellina Kessleman

**Research topics:** Complex Liquids • Nanostructured Biosystem  
• Advanced Materials • Colloid and Interface Science

**Facilities:** FEI T12 and Philips CM 120 TEMs, Zeiss Ultra-Plus HR-SEM, specimen preparation equipment

### Polymers and plastics

**Researchers:** Roza Tchoudakov • Ron Rahman • Guy Mechrez

**Research topics:** Polymer science and technology

**Labs:** Injection Molding Extruder

### Multiphase dispersed fluid systems

**Researchers:** Olga Lavrenteva • Irina Smagin • Jai Prakash

**Research topics:** Mechanics and transport phenomena

### Advanced Ceramics and non-carbon fuels for Energy Applications

**Researchers:** Gennady Shter • Vladimir Gelman

**Research topics:** Advanced materials

### Polymeric biomaterials: Structure - function relations

**Researchers:** Hadas Hecht • Irit Ventura • Ortal Yom Tov

• Elinor Joseph Albert • Tal Eshal • Iris Barsht • Keren Delmar

**Research topics:** Biosystems

**Labs:** Laser Light Scattering

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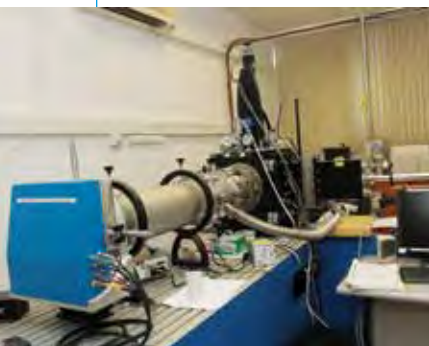
<p><b>Contact:</b>  <b>Prof. Hossam Haick</b>, Head          Tel: +972-4-829-3087  <a href="mailto:hhossam@technion.technion.ac.il">hhossam@technion.technion.ac.il</a></p>	<p><b>Laboratory for Nonmaterial Based Devices (LNBD)</b>  <b>Researchers:</b> Orna Barash ➔ Manal Abud ➔ Nadav Bachar ➔ Alona Bein ➔ Yoav Broza ➔ Rawi Dirawi ➔ Rotem Ermanok ➔ Allaa Garaa ➔ Sagi Gliksman ➔ Amal Haitham ➔ Nicole Kahn ➔ Gad Konvalina ➔ Morad Nakhleh ➔ Nisreen Shehada ➔ Miriam Tisch ➔ Bin Wang  <b>Research topics:</b> Advanced materials</p>
<p><b>Assoc. Prof. Alexander Leshanksy</b>, Head          Tel: +972-4-829-3502  <a href="mailto:lisha@tx.technion.ac.il">lisha@tx.technion.ac.il</a></p>	<p><b>Complex Fluids and Microflows</b>  <b>Researcher:</b> Stanislav Levchenko  <b>Research topics:</b> Catalysis and transport phenomena ➔ Colloid and interface science</p>
<p><b>Prof. Raphael Semiat</b>, Head          Tel: +972-4-829-2009  <a href="mailto:cesemiat@tx.technion.ac.il">cesemiat@tx.technion.ac.il</a></p>	<p><b>Desalination and water treatment</b>  <b>Researchers:</b> David Hasson ➔ Abraham Sagiv ➔ Hilla Shemer ➔ Grigorie Zelmanov  <b>Research topics:</b> Desalination and water treatment  <b>Laboratories:</b> Rabin Laboratory - Desalination and Water Treatment</p>
<p><b>Assoc. Prof. Yaron Paz</b>, Head          Tel: +972-4-829-2486  <a href="mailto:paz@tx.technion.ac.il">paz@tx.technion.ac.il</a>  <a href="http://pygroup.net.technion.ac.il">http://pygroup.net.technion.ac.il</a></p>	<p><b>Photo Catalysis and Thin films</b>  <b>Researchers:</b> Nurit Shacham-Waldman ➔ Sagi Pasternak ➔ Hadas Cherniak ➔ Zach Shidlovski ➔ Malka Rohkind  <b>Research topics:</b> Photocatalysis ➔ Advanced materials ➔ Environment, water and alternative energy ➔ Thin film  <b>Labs:</b> Photocatalysis and Thin Film Laboratory</p>
	<p><b>Relations with the Chemical Industry</b>          The researchers of the Faculty of Chemical Engineering are involved in various ways and in all aspects with the Israeli chemical industry, and also with companies abroad. The cooperation includes research programs in direct cooperation with a wide range of companies, indirectly with the help of governmental institutions, start-up companies that were founded by our Faculty members, services based on available equipment, and consulting on a personal basis by individuals. The range of companies involved is wide, and includes companies in the petrochemical and polymer industries, minerals, energy, agrochemical and fine chemicals, pharmaceuticals, biotechnology and biomedicine, water and desalination, electronics and advanced materials, and the security industry. Our former students are active in all these industries.</p>



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**Research Infrastructure**

The development of the Faculty's infrastructure reflects the evolving directions of research, and the growing need for sophisticated, large-scale and expensive equipment to meet the needs of the research activities of our Faculty members. Some of the larger items of equipment, experimental systems and computer infrastructure are described below.

**Experimental Equipment****Small and Wide-Angle X-ray Scattering (SAXS/WAXS)**

Our Faculty is equipped with state-of-the art equipment for X-ray scattering, operating as an infrastructure center. It allows for simultaneous diffraction measurements at small and wide angles with enhanced flux, and is useful for a broad range of systems, ranging from complex fluids, such as self-assembled polymer and surfactant solutions, biopolymers in their natural state, synthetic and natural gels and colloids, nanoparticle dispersions, to solid materials such as fibers, composite materials and metal alloys. It was acquired from JJ-Xray Instruments (Denmark), based on a design by Molecular Metrology Inc. (now part of Rigaku US). It consists of a Microfocus Plus sealed-tube generator (Philips), graded multilayer optics (Osmic), and a three-pinhole collimation for a bright and well-collimated beam. Sample holders are available for liquids and solids, with temperature control by circulating liquid or resistive heating, as well as a goniometer stage suitable for grazing incidence of thin films. Two-dimensional detectors are based on a multi-wire array (Gabriel) for small angles and an image plate (Fuji) for wide angles.

**Electron Microscopy Laboratory for Soft Matter**

The Electron Microscopy Laboratory for Soft Matter was established in 1998 to provide the tools and methodology to direct image nanostructured liquid and semi-liquid systems. It includes two dedicated cryo-TEMs, a Philips CM120, and an FEI T12, which was acquired in 2004. In 2008, we added a Zeiss high-resolution scanning electron microscope (HR-SEM). We have all the facilities necessary for specimen preparation. These include an in-house system developed and built for direct imaging of vitrified specimens, and a new Leica (Bal-Tec) BAF 060 instrument for freeze-fracture-replication and cryo-SEM specimen preparation. We also have an image-processing and archiving room. This unique facility has proven to be most useful for a wide range of projects (room temperature work is also done on our instruments),

and attracts users and collaborators from the campus, and from other Israeli and foreign universities and industries.

In addition to the home-built controlled environment vitrification system (CEVS) used for both cryo-TEM and cryo-SEM specimen preparation under controlled conditions, the Laboratory also has a commercial Vitrobot system for cryo-TEM specimen preparation. Also available is a Leica UC6 ultramicrotome equipped with an FC6 cryo-system for cryo-sectioning of biological and polymeric specimens for TEM.

Electron microscopy is augmented by a digital light microscopy system based on an Olympus BHT-2 microscope with an Optronics LED digital camera system. We have differential interference contrast (Nomarski) and polarized light cross-polarizer optics with this microscope, as well as a hot stage.

### Material Characterization

Investments were made in equipment for rheological and mechanical property measurement. A Rheometric Sciences ARES system optimized for low-viscosity systems is available in the laboratories of the Talmon group. The Narkis Laboratory hosts an Instron 5568 universal testing machine, a TA, TGA 2050 Thermogravimetric Analyzer (TGA), a Perkin Elmer, DMTA 7e Dynamic Mechanical Thermal Analyzer (DMTA), and other sophisticated equipment for polymer testing, FTIR (under vacuum) Vertex 70V (Bruker)

Sophisticated equipment for materials characterization over a wide temperature range is also available in several research groups of the Faculty.

### Examples:

- ③ Setaram TG-92 TGA/DTA (operating temperature 20-2,200°C), coupled with a mass spectrometer for thermal analysis
- ③ Altamira model AMI-200 for temperature-programmed desorption, oxidation and reduction measurements
- ③ Micromeritics ASAP-2010 pore structure analyzer by BET measurement (Grader)
- ③ HP GCMS gas chromatograph/mass spectrometer
- ③ Inframetrics 900 IR thermography imager (Sheintuch)
- ③ Setaram Labsys TGA/DSC/DTA coupled to mass spectrometer (operating range RT-1200°C) (Gazit)
- ③ Micromeritics ASAP-2020 physisorption full analysis of porous materials (Gazit)



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- ③ Micromeritics ASAP-2920 chemisorption TPD/TPR/TPO coupled to mass spectrometer. Surface analysis of heterogeneous catalysts. (Gazit)
- ③ FTIR in-situ analysis of heterogeneous catalysts under operando conditions high temperature high pressure. (Gazit)

**The Paz group has a variety of characterization tools including:**

SPM (Pico+, Molecular Imaging) ➔ FTIR (IFS55, Bruker) with almost any type of existing accessories (microprobe, ATR, diffuse reflectance, specular reflectance, photoacoustic detector, etc.) ➔ UV-vis spectrophotometer (Perkin Elmer) ➔ HPLC (Agilent) ➔ GC-MS (HP6890/5973) ➔ home-built SPR machine ➔ polarimeter

There is also a well-equipped preparative laboratory that contains standard hoods, a clean laminar hood, a glove box, a spin coater, a plasma cleaning device, a UV-ozone device, a high-pressure high-temperature reactor, furnaces, a centrifuge, etc.

**Electronic Device Fabrication and Analysis**

Upon joining the Faculty in 2006, Professor Haick established wet facilities for the synthesis and purification of functionalized nanomaterials.

**These include:**

Glove boxes (<1 ppm O<sub>2</sub> and <1 ppm H<sub>2</sub>O) in conjugation with an e-beam evaporator;

Two probe stations and device analyzers for probing electrical characteristics of solid-state devices, with a resolution of aF (atto-Farad) in capacitance measurements and aA (atto-Ampere) in conductance measurements;

Six stations for characterizing sensor arrays under different conditions of exposure to simulated biomarkers (e.g., flow rate, concentration, humidity, etc.) or real breath samples;

A GC-MS system in conjugation with pre-concentration techniques (e.g., SPME) for chemical analysis of, for example, real and simulated breath samples;

A Langmuir-Blodgett trough for the deposition of low-defect films of organic materials and nanomaterials on solid-state substrates (The same



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system can also be used for controlling the distance between adjacent nano-species deposited on solid surfaces);

A Kelvin probe for investigating fundamental processes on the surfaces of nanomaterial-based films and for understanding the electrical processes involved in the operation of sensors;

A spectroscopic ellipsometer for measuring thickness and dielectric constant of thin films; and a quartz crystal microbalance (QCM) for measuring adsorption (or weight) of analytes in thin films.

**Thin Film Characterization**

The diverse demands of thin film characterization are met by an M-2000U line spectroscopic ellipsometer. The M-2000U delivers both speed and accuracy. Haick patented RCE technology combines rotating compensator ellipsometry with high-speed CCD detection to collect data from the entire spectrum (about 700 wavelengths) in a fraction of a second with a wide array of configurations. The primary application of the M-200U ellipsometer in our Faculty is to characterize film thickness and optical constants. The M-2000 excels at both. It measures films from sub-nanometer thickness up to tens of microns, and the optical properties from transparent to absorbing materials. It is a flexible instrument that can characterize any type of thin film: including dielectrics, organics, semiconductors, and metals. A wide spectral range and variable angle allow the M-2000 to diagnose many multi-layered structures. The M-2000U ellipsometer is equipped with a liquid cell that enables monitoring liquid-solid interface in real time to study, for example, adsorption kinetics of (bio)molecules from liquid or gas phases onto solid-state substrates, and sensing properties of nanomaterial-based films.

**Particle Sizing and More**

This may be performed using a Malvern Mastersizer particle size analyzer in the 40 nm to 2 mm range and Malvern Zetasizer for 0.6 nm to 5  $\mu$ m range (Semi-AT), or by a Brookhaven Instruments Corporation Zeta PALS zeta-potential and particle size analysis system for a particle size range of 3 nm to 5  $\mu$ m and zeta-potential measurement (TSUR). A surface potential analyzer (SurPASS, Anton Paar) is also available for measuring streaming and zeta-potential of flat surfaces and membranes as a function of pH (Freger). Also available is a Bruker IFS-55 FTIR system (Paz) for molecular identification on surfaces and in liquids and gases.





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An advanced FTIR-Raman system (Nikolet 8700) equipped with ATR and PM-IRRAS attachments (Freger) is used for chemical analysis of surfaces and thin composite films and for partitioning, sorption, and orientation of various solutes in thin surface layers; a TA Q10 DSC Bähr 801 dilatometer for the temperature range of -190°C to 1,500°C; and an impedance spectroscopy laboratory for the range of 1 mHz to 100 MHz (Tsur). The analysis of impedance spectroscopy results can be done using a unique program based on evolutionary programming that has been developed in Tsur's lab. It finds a functional form of the underlying distribution of relaxation times in the sample, hence aids the user in developing understanding about the physical processes that are present.

**Water and Desalination Laboratory**

The Rabin Desalination Laboratory is based on five RO/NF units, two UF/MF units, EDR, and a set of fabrication equipment for sand filtration, crystallization, stripping, fluidization, and laboratory equipment. For measuring the performance of membrane units, state-of-the-art membranes and related materials and processes, TOC/TNC (Semiat, Hasson) and HPLC (Freger) are available. Freger's group has a range of advanced instruments for surface characterization and examination of membranes, including an AFM (Innova, Bruker), a surface potential analyzer (SurPASS, Anton Paar), a FTIR-Raman spectrometer (8700, Nikolet) with ATR and PM-IRRAS attachments and potentiostat/ZRA (SP-300 Biologic). Dedicated equipment is also available for filtration (high-pressure stirred dead-end and flow cells), preparation of well-defined modified surfaces (laminar cabinet, spin-coater) and biofouling and bacteria/particle deposition studies (laminar cabinet, incubator, centrifuge, microscope with fluorescence attachment).

**Micro Fluids Laboratory**

Prof. Manor's laboratory, set up in 2013, is expected to acquire three groups of equipment: device fabrication equipment, device characterization equipment, and flow measurement equipment. The device fabrication equipment, in addition to the Technion's clean room facility, is for microfluidic platform fabrication and assembly. This equipment includes a spin coater, a plasma chamber, and supporting equipment. The device characterization equipment will include an impedance analyzer and a laser Doppler vibrometer for electrical and mechanical characterization of piezoelectric devices and mechanical vibrations of solids in general. The laser Doppler vibrometer will be

accompanied by a signal amplifier and oscilloscope for amplifying and characterizing electrical signals sent to the piezoelectric device. The flow measurement equipment will measure steady and dynamic flow fields, suspension and emulsion structures, and wetting effects of liquids on piezoelectric-based microfluidic platforms. Flow measurements will be assisted with a signal generator, a signal amplifier and an oscilloscope for actuating and controlling the piezoelectric device on which the flow is excited. Flow fields and other dynamic and static effects will be captured using an epi-fluorescence microscope equipped with a 3D motorized stage designed to capture consecutive 2D slices of flow patterns to reconstruct 3D flow fields that exceed the microscope plane in size and depth of view. The images will be taken using a high frame rate, high resolution and flexible cameras to span the different time and length scales associated with acoustic streaming-related phenomena.

### Computer Infrastructure

The research groups whose research is based computationally rely on a number of systems, many of them networked. The following describes the systems in place, organized by research group.

Professor Brandon's group carries out continuum, as well as molecular, analysis of thermodynamics and transport phenomena related to various fundamental and applied problems, such as those stemming from crystal growth systems and wetting phenomena, which are analyzed using in-house-designed as well as public domain and commercial software. Computer platforms include a new 1056 core Technion computer (called TAMNUN), as well as a number of standard desktop computers operating under LINUX and an in-house 16-core Silicon Graphics machine (also operating under LINUX).

The groups of Professors Sheintuch, Pisman, Nir, Brenner, and Srebnik rely mainly on PC computers and workstations, and also on the TAMNUN cluster maintained by Technion Computer Center staff, which is available for high-performance calculations.

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# FACULTY OF CHEMISTRY



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## Industrial Relations Coordinator

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The Faculty of Chemistry is a vibrant academic unit, with dynamic research and teaching programs, active Faculty members, and modern research laboratories and facilities. It spans the full spectrum of disciplines within chemistry – physical, analytical, inorganic, organic, biochemical, and theoretical; and overlaps the associated fields of physics, materials sciences, biology, medicine, electronics, and nanotechnology.

## The Faculty is divided in two divisions:

**The Division of Organic and Inorganic Chemistry** comprises 11 research groups. Their scientific interests and activities encompass general fields of organic, inorganic, bio-organic, bio-inorganic, catalytic, theoretical, supramolecular, polymer, and materials chemistry.

**The Division of Physical, Theoretical and Analytical Chemistry** comprise 14 research groups that apply a variety of theoretical and experimental techniques to elucidate the molecular nature of materials. Many of the studies carried out in these laboratories are interdisciplinary in nature, belonging to the overlapping realms of materials science, life sciences, energy research, solid state, and nanomaterials.



### Ties with Israeli Industry

The interaction between the Faculty and industry may be divided into:

- ② Direct sponsored research of Faculty members by industry.
- ② Sponsored research of joint projects between academic groups and industry by governmental institutions.
- ② Start-up companies in which academic staff are involved.
- ② Consultancy work provided to industry by some of our Faculty members.
- ② Patent applications and commercialization.
- ② Service provided to industry by our general service research laboratories.

Some Faculty members have research directly sponsored by Israeli industries, such as Teva Pharmaceutical Company, and SCD Semiconductor Devices. In these cases, very focused applied research is carried out in collaboration with industrial programs, with financial support provided from the industrial side.

Some academic staff members are associated with large government-sponsored academic-industrial research through various programs, such as Magnet, Nofar, and MagneTon. In these cases, several industrial partners and academic groups join a large project that has several research and development aspects. Industrial partners in these large projects include, for example, Intel, Tower, SCD, Rafael, Teva, ELOP, 3GSolar, and others.

Several academic staff members have founded start-up companies based on research and patents developed within the Technion. Several of these start-up companies were successful.

All our general service research laboratories (NMR, MS, XRD, and the Surface Analysis and Characterization Laboratory) provide service work for various industries (mostly chemical and pharmaceutical) and research laboratories within and outside the Technion. In these cases, the service is carried out at predefined rates. Finally, our glassblowing workshop and machine shop also do occasional work for external users at predefined rates.







[http://schulich.technion.ac.il/  
The-chemical-and-surface-  
analysis-lab%20/](http://schulich.technion.ac.il/The-chemical-and-surface-analysis-lab%20/)

### Technical Services

The Faculty's technical services are organized in the machine, electronic, and glassblowing units. Our machine shop provides design, manufacturing, and technical support services for the Faculty's laboratories, for other Technion faculties, and for external clients.

Our highly skilled technicians possess extensive experience in manufacturing prototypes of experimental apparatus and separate precision parts according to special specifications, using diverse materials including plastics, stainless steel, aluminum, brass, and refractory metals. The machine shop also provides repair, maintenance, and modernization services for existing scientific instruments and experimental equipment in research laboratories. The scope of the shop's facilities allows the production of a wide range of components, from precision parts to large experimental apparatuses for many important applications, such as cryogenics, processes in high and ultra-high vacuum, optical and laser spectroscopy, chemical reactors, and systems and components for nanotechnology research and magnetic resonance.

### General Research and Service Laboratories

#### Chemical and Surface Analysis Laboratory

The Chemical and Surface Analysis Laboratory offers a wide range of characterization techniques, together with highly skilled expert personnel. This facility serves all Technion researchers, and other research institutes (universities and colleges), as well as industry.

#### The Laboratory's main equipment includes:

Veeco (Dimension 3100) Atomic Force Microscope (AFM) ➤ ESCAN (Vega-II) Scanning Electron Microscopy (SEM) ➤ Thermo Scientific CHNS Analyzer (Flash2000) ➤ Bruker (Tensor 27) Fourier Transform InfraRed (FTIR) ➤ TA instruments (Q10) Differential Scanning Calorimeter (DSC) ➤ Jobin Yvon (Fluorolog-3) Fluorometer for monitoring fluorescence of samples at wavelengths of 280 to 900 nm, and temperatures from -170°C to 90°C ➤ CEM Cop. (Discover) microwave reactor.

The Laboratory is managed by a PhD engineer in physical chemistry.

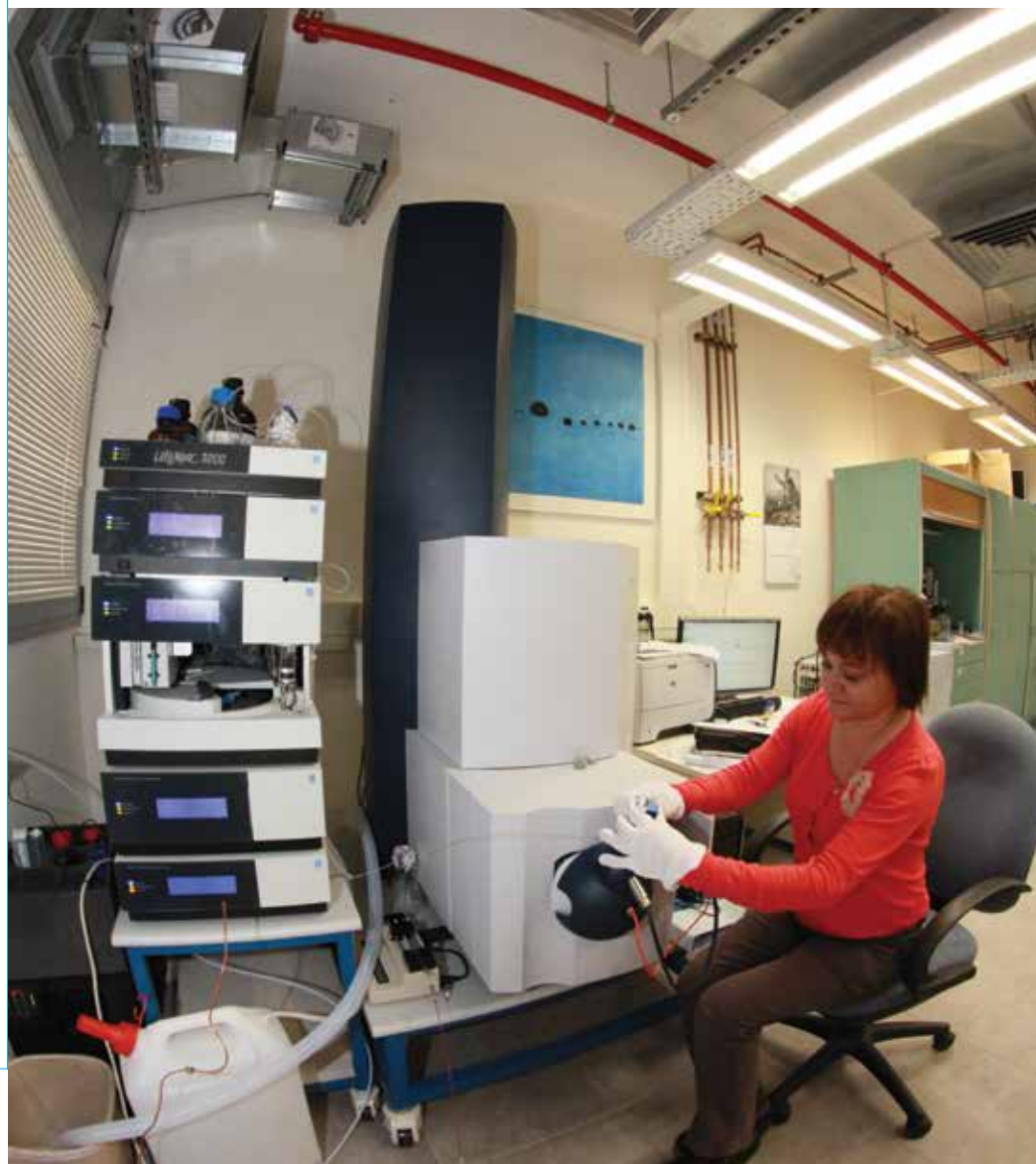


<http://nmrlab.technion.ac.il>



### Nuclear Magnetic Resonance Laboratory

This open-door laboratory provides instrumental services and user-training at all levels. It is equipped with five modern high-resolution Bruker spectrometers ranging from 4.7T up to 14.1T. The following five instruments serve our faculty: Bruker Avance 600 MHz, 500 MHz, 400 MHz, 300 MHz, and 200 MHz. The instrumentation available covers a broad range of experiments. Some examples of the most routine favorites for research include 1D spectra of multiple nuclei ( $^1\text{H}$ ,  $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{29}\text{Si}$ ,  $^{31}\text{P}$ , and  $^{103}\text{Rh}$ ) high-temperature  $^{13}\text{C}$  NMR, low-temperature  $^{19}\text{F}$  NMR,  $^1\text{H}$ - $^{13}\text{C}$  correlations,  $^{29}\text{Si}$  INEPT, and diffusion spectroscopy. The Laboratory is managed by two full-time, professional, PhD-level spectroscopists.





### Mass Spectrometry Laboratory

The Mass Spectrometry (MS) Laboratory provides method development and consultation services for elemental analysis for research faculty, staff members, and students at the Technion.

The laboratory has several state-of-the-art instruments:

⊕ **Waters Micromass LCT Premier (TOF) coupled to an HPLC.**

The instrument is an easy to use bench-top mass spectrometer that utilizes a high-resolution time-of-flight (ToF) analyzer to enable exact automated mass measurements. The ToF analyzer utilizes W-Optics, a novel method for enhancing resolution, which provides up to 10,000 FWHM resolution.

⊕ **Waters MALDI-TOF MS System**, featuring the MALDI micro-mass spectrometer, offers automated sample processing and MALDI target spotting, allowing for unattended operation and increased throughput and reproducibility.

⊕ **Waters AutoSpec Premier™** is the latest development in magnetic sector technology. It incorporates the Waters unique EBE, double-focusing geometry with extra wide gap magnet of the proven Ultima NT system, providing an unmatched combination of high sensitivity, high resolution, and low background noise. The AutoSpec Premier forms a powerful platform for high-resolution selected ion recording applications, such as dioxin, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), or drugs of abuse analysis.

⊕ **Bruker-QTOF-II**, enabling techniques of LC-MS, GC-MS, MS-MS, high-resolution MS with various modes of ionization.

### X-ray Crystallography Laboratory

This Laboratory has two X-ray machines, including a Nonius KappaCCD diffractometer. The services are provided by a PhD-level professional.

In addition, we post classified ads for open positions (industrial and academic) on our website.

Positions Available:

[http://schulich.technion.ac.il/  
Vacant-positions-at-chemistry  
-at-the-Technion](http://schulich.technion.ac.il/Vacant-positions-at-chemistry-at-the-Technion)



# FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING



<http://cee.technion.ac.il/eng/index.asp>

## Dean's Office

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## Industrial Affiliates Program

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The Faculty of Civil and Environmental Engineering in its current structure was established in 2002 by the merger of two veteran academic units, the Faculty of Civil Engineering and the Faculty of Agricultural Engineering. The Faculty of Civil Engineering was the first academic unit of the Technion when it opened its doors in 1924. The Faculty of Agricultural Engineering was established in 1952 by Professor Walter Clay Lowdermilk. Both faculties were inspired by the vision of settling Israel and developing the science and technology required for its transformation into a modern country. At this time, the country had a pronounced need for the housing and infrastructure that would support its economic growth and quality of life, while preserving its natural resources.

The Faculty is committed to providing high-level engineering support for projects. As a result, a range of support units, such as service units and testing laboratories, were developed and accredited as national laboratories. These laboratories have since made impressive achievements, recognized in Israel and abroad, and support Israeli industries. Further, the Faculties of Civil and Agricultural Engineering have thrust Israel to the forefront in fields such as housing, water supply and management, and advanced agriculture and environmental issues. The 2002 union, and the subsequent founding of the unified Faculty of



<div></div> <div><a href="http://cee.technion.ac.il/eng/Templates/showpage.asp?DBID=16&amp;NGID=16&amp;TMID=846&amp;FID=302">http://cee.technion.ac.il/eng/Templates/showpage.asp?DBID=16&amp;NGID=16&amp;TMID=846&amp;FID=302</a></div> <div><p><b>Contact</b></p><p><b>Assoc. Prof. Rachel Becker</b> Head Tel: +972-4-829-2248 becker@tx.technion.ac.il</p><p><b>Ms. Anat Avital</b> Secretary Tel: +972-4-8292-2423 Fax: +972-4-832-4534 nbri@tx.technion.ac.il</p></div>	<p>Civil and Environmental Engineering, was accompanied by structural changes and modernization of educational programs.</p> <p>Several research centers were established or upgraded, including the National Building Research Institute, the Transportation Research Institute, the Grand Water Research Institute, and the Agricultural Engineering Research Center, in which faculty members play a major role. Together with addressing industries and national needs, these centers have enhanced the opportunities and activities available to MSc and PhD students.</p> <p>The faculty is composed of three autonomous divisions. This structure enables a reasonable balance between the need to specialize in the various disciplines of civil and environmental engineering, and maintaining a mechanism that can foster cooperation across divisions in research and teaching.</p> <p><b>Research and Professional Activities</b></p> <p><b>Structural Engineering and Construction Management Division</b></p> <p><b>Research Areas:</b> Structural Engineering ➔ Construction Management ➔ Building Materials and Technology ➔ Physical Performance ➔ Geotechnology</p> <p>Many Faculty members of the Division conduct research within the framework of the National Building Research Institute (NBRI).</p> <p><b>National Building Research Institute (NBRI)</b></p> <p>NBRI research and development activity is based mainly on sponsored research, and covers the four main domains mentioned above, and interactions between them.</p> <p><b>Research areas include:</b></p> <p>structural earthquake resistance, impact and blast response of structures, penetration processes in structural and geotechnical systems, innovative methods for structural repair, structural behavior of repaired structures, building information modeling, lean construction, safety in the construction process, forming systems and equipment for construction, quality assurance and control, utilization of industrial by-products in building materials, durability of building materials,</p>
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**<http://cee.technion.ac.il/eng/Templates/showpage.asp?DBID=1&LANGID=1&TMID=84&FID=220>**

microstructure of cementitious materials, energy in buildings, heat and mass transfer in buildings, integrated performance of the building envelope, sustainability of the built environment, earthquake engineering and seismic behavior of soils, and soil-structure interaction.

NBRI has a long-standing collaboration with industry, assisting Israeli manufacturers and builders in the investigation of innovations, and in studying basic issues related to their products or processes. It provides testing services when other laboratories are not equipped to do so, but does not engage in standard testing and certification.

**NBRI facilities include** a large testing hall with a massive and strong test floor and, in addition, the following specific main laboratories: Testing Hall and Structural Engineering Laboratory ➤ Impact Laboratory ➤ Building Materials Laboratory ➤ Thermal and Energy Laboratory ➤ Radiation Safety in Construction Laboratory ➤ Seskin Virtual Construction Laboratory.

### **Environmental, Water and Agricultural Engineering Division**

#### **Research Areas:**

Water resources ➤ Hydraulic engineering ➤ Environment ➤ Air quality ➤ Agriculture

#### **Laboratories at the Agricultural Engineering Complex:**

Agricultural Machinery Laboratory ➤ Agricultural Materials Laboratory ➤ Control and Automation Laboratory ➤ Sensing of Natural Materials Laboratory ➤ Soil Chemistry and Fertility Laboratory ➤ Agro-biology, Soil Chemistry, and Soil Physics Laboratory ➤ Seidel Flow Measurement Laboratory ➤ Subsurface Hydrology and Hydrogeophysics Laboratory ➤ Irrigation Laboratory ➤ Environmental Fluid Mechanics Laboratory ➤ The Ecological Garden ➤ Technion PIV Laboratory at the IUI in Eilat

#### **Environmental Laboratory Complex (Grand and Sherman Buildings):**

The Environmental Science and Engineering Teaching and Research Laboratory Complex is a recent collaborative effort of the Faculty of Civil and Environmental Engineering and the Grand Water Research Institute.

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Laboratories within this complex:

Environmental Chemistry Laboratory ➤ Environmental Biotechnology Laboratory ➤ Aquatic Chemistry Laboratory ➤ Molecular Microbiology Laboratory ➤ Analytical Water Chemistry Laboratory ➤ Environmental Microbiology Laboratory

Faculty members conduct their research in one of these research centers:

- ⌚ Environmental and Water Resources Engineering Research Center
- ⌚ National Center for Research in Coastal and Marine Engineering- CAMERI
- ⌚ Research Center in Agricultural Engineering

Environmental and Water Resources Engineering Research Center

Water is at the core of the human activity, and as such receives the highest attention in the division of water, environment, and agricultural engineering. Key activities are related to understanding and development of processes for treatment of drinking or irrigation waters from various natural and artificial sources, and the treatment of domestic and industrial effluents. This includes primarily chemical and biological processes related to treatment of water and wastewater. The core business of this Center is the study of the dynamics of water flow through natural and artificial conduits, and the engineering of efficient water delivery systems and marine structures, which are all related through the general field of fluid mechanics.

A variety of tools (analytical and computational) are used to study source apportionment identification transport, and deposition of atmospheric particles. Advanced electron microscopy techniques have been developed and applied to characterize individual atmospheric particles, using morphology and elemental composition of single particles.

Research Areas:

Water and Wastewater Processes ➤ Water and Marine Systems ➤ Environmental Microbiology ➤ Water Resources Systems ➤ Aquatic Chemistry ➤ Air and Atmosphere ➤ Computational Fluid Dynamics ➤ Air-Sea Interaction ➤ Enviromatics ➤ Sustainable Water and Energy

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**Agricultural Engineering Research Center**

Modern agriculture is no longer limited to the development of cultivation tools, but focuses on automation and control, advanced local and remote sensing, precision, post-harvest treatment of biological materials, machine-soil interaction, energy-efficient development, and other topics. The Agricultural Engineering group deals with various topics related to mechanics and sensing in classical agricultural engineering, and all fields of environmental engineering and water systems.

**Research Areas:**

Automatic Control in Environmental, Water, and Agricultural Engineering  
 ➤ Monitoring of Agro-Biological Systems ➤ Post-Harvest and Biomaterial Properties ➤ Machine-Soil Interaction ➤ Off-road Mobility ➤ Field Machinery ➤ Robotics in Agriculture and Civil Engineering

**Transportation and Geo-Information Division****Research Areas:**

Road Safety ➤ Road and Pavement Engineering ➤ Transportation, Land Use Planning and Transportation Economics ➤ Traffic Engineering and Control ➤ Surveying and Geodesy ➤ Cartography and Mapping ➤ Photogrammetry and Remote Sensing

**Laboratories:**

Roads and Soil Laboratory ➤ Geographic Information Systems Laboratory ➤ Photogrammetry Laboratory ➤ Remote Sensing Laboratory ➤ Laser Scanning Laboratory ➤ Surveying ➤ Engineering Laboratory

**Relations with industry**

A survey conducted at our initiative concluded that in the next 10 years there will be a need for an additional 5,000 new civil and environmental engineers. To meet this challenge while enhancing the level of students entering our programs, we have launched special marketing efforts with industry in Israel.

**These efforts include:**

Establishing a teaching scholarship program with industry, which has grown over the last seven years to provide about 80 scholarships, at a total level of about NIS 3 million (about \$750,000) a year. More than 40



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companies and organizations are involved, and contribute NIS 18,000 a year to each student in the program. These companies have the option to hire the students after graduation. There are two tracks to the program, the first with the organization “Atidim in Industry” for students from the periphery, and the second for outstanding students.

For more than 30 years, the faculty has held a special awards and scholarship ceremony in which faculty members, donors, and alumni holding key positions in the infrastructure industries get together. During this special event, awards, scholarships, and personal research grants are awarded to outstanding undergraduate students, graduate students, and lecturers.

Undergraduate Office

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**Ms. Keren Seker Gafni**  
kerensg@technion.ac.il

For the last eight years the Undergraduate Office has conducted a special one-day “Fair Employment” event. About 50 to 60 companies participate in this event every year. The Fair Employment day creates opportunities for meetings between infrastructure companies and students.

The Undergraduate Office keeps an open channel with industry, and advertises a Jobs List for students on the Faculty website and special board.

**Ms. Tami Chachashvili**  
tami@cv.technion.ac.il

All undergraduate students take the “Introduction to Civil and Environmental Engineering” course in their first year. In this course, key persons from the infrastructure industry present their experience, and there are field trips to several companies, exposing our students to the profession in the real world.

# FACULTY OF COMPUTER SCIENCE



<http://www.cs.technion.ac.il>

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## Ms. Noa Mor

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The Faculty of Computer Science is the second largest academic unit in the Technion. It comprises about 50 Faculty members of international repute with expertise in a wide variety of fields. It is the largest department of computer science in Israel, and supplies the Israeli hi-tech industry with the highest caliber manpower. The Faculty engages in a wide range of research and teaching activities, and constitutes a unique meeting point between science and technology.

## Research Areas

### Theory of Computer Science:

Automata and Formal Languages ➤ Coding ➤ Complexity ➤  
Computational Geometry ➤ Cryptology ➤ Distributed Computing ➤  
Logic and Semantics ➤ Theory of Algorithms

### Systems:

Databases and Data Mining ➤ Distributed and Parallel Systems ➤  
Hardware ➤ Networks, Communication and Systems ➤ Programming  
Languages ➤ Software and Hardware Verification ➤ Software  
Engineering



<http://www.cs.technion.ac.il/iap>

<http://www.cs.technion.ac.il/iap/list.html>

### Artificial Intelligence:

Learning • Reasoning

### Intelligent Systems and Scientific Computation:

Geometric Modeling • Graphics • Image Processing and Computer Vision • Robotics and Complex Systems • Scientific Computation and Numerical Analysis

### Technion Computer Science Industrial Affiliates Program – IAP

The primary objective of the Technion Computer Science Industrial Affiliates Program (IAP), established in 2001, is to provide a platform for structured interaction between the Computer Science Department and the hi-tech industry in Israel and worldwide.

The program provides a solid bridge between academia and industry, from which both sides benefit significantly. On one hand, it has enabled the Technion community to become more attuned to industry needs, and exposed Faculty and students to a wide spectrum of companies and their R&D activities. On the other hand, it has given the IAP member companies a platform through which they can gain access to Faculty and students, and influence computer research, development, and education.

Some 30 companies of all sizes are now members of this club  
*see list of IAP members:*

### IAP Program Benefits

The IAP program offers many benefits to its members in return for a modest annual membership fee. The most important advantage is the opportunity to influence computing research and education.

### Research and Development

- Ⓢ Attend the faculty's annual Research Day.
- Ⓢ Participate in the Industrial Project course.
- Ⓢ Carry out joint software projects with the Faculty laboratories.
- Ⓢ Match partners for joint research proposals to the Chief Scientist and the European Union.
- Ⓢ Interact professionally with Faculty researchers.
- Ⓢ Participate in the Industry Advisory Board.

### Human Resources

- ② Hold company recruitment events and technological exhibitions in the Faculty's lobby.
- ② Advertise job openings by email to interested students; Advertise job openings on the IAP website, and on the electronic board in the Faculty lobby.
- ② Employ graduate students for summer internships.

### Teaching

- ② Attend faculty seminars, conferences and symposia (as auditors and as lecturers, if suitable).
- ② Offer mini-courses focusing on soft skills or technological topics.
- ② Offer guest lectures in academic courses.
- ② Send company employees to attend academic courses as free auditors.
- ② Access Faculty library.

### Public Relations

- ② Increase company visibility within the Faculty - company logo on the Industrial Affiliates web page and on a plaque in the Faculty lobby.
- ② Distribute announcements on company events (recruiting days, mini-seminars, etc.) to students.
- ② Advertise in Homepage – the Faculty's semi-annual magazine.

### Involvement of Industry in Academic Courses

IAP companies are encouraged to take an active role in the Faculty's academic courses, by teaching, designing, or creating such courses.

#### Such involvement may take one of three forms:

- ② An expert from industry teaching a course or part of it, in order to bring a unique specialty that our Faculty lacks.
- ② Projects guided by representatives from industry, either with one of the Faculty's laboratories, or directly through the Industrial Project course. The latter is a regular course given twice a year, with nearly 15 projects each semester. The projects are proposed and guided by interested companies.
- ② In addition, a specialist from industry may teach a mandatory or elective course in his/her area of expertise.



In all cases, there is academic supervision of these courses, to ensure their academic quality, and a proper grading procedure.

#### Extra-curricular Support for Students

The Industrial Affiliates Program sees it as one of its tasks to provide counseling and assistance services to students and graduates, with emphasis on extra-curricular courses on soft skills, and more directly, obtaining information on job opportunities.

#### Teaching and Research Laboratories

There are 12 teaching and research laboratories in the Faculty, many working closely with industry, carrying out projects and research led by Faculty members, engineers, graduate students, and undergraduate students.

More information about channels for collaboration is available in the laboratory's website.

**<http://www.cs.technion.ac.il/research-labs>**



# DEPARTMENT OF EDUCATION IN SCIENCE AND TECHNOLOGY



<http://edu.technion.ac.il/en>

## Contact

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The Department of Education in Science and Technology contributes to the Israeli educational system by preparing prospective science and technology teachers for high schools and technical colleges, and by encouraging its graduate students to contribute to Israel's higher education, the hi-tech industry, the IDF (Israel Defense Forces), and the public sector.

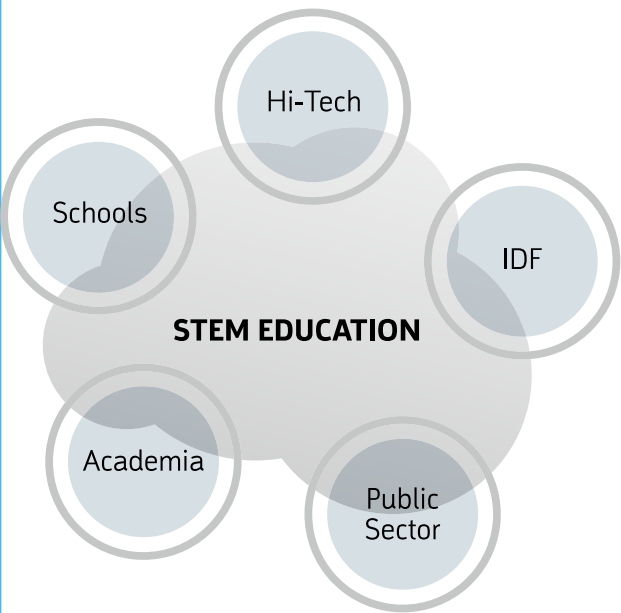
The Department's teaching and R&D activities are varied, and focus on the learning sciences, educational technologies, and education in a variety of subjects: mathematics, physics, chemistry, biology, environmental sciences, computer science, electrical engineering, and mechanical engineering. These topics are offered as part of the Department's BSc, MSc, and PhD programs. The Technion is the only university in Israel offering undergraduate programs in technology/engineering education.

Research and Development

Mathematics Education • Physics Education • Chemistry Education • Biology Education • Environmental Sciences Education • Computer Science Education • Electrical Engineering Education • Mechanical Engineering Education • Creativity and Giftedness • Environmental and Informal Education • Project Assessment • Learning Technologies • Science Communication • Virtual Reality and Neurocognition • Educational Robotics Learning Organizations

Affiliation Programs

Our vision is to be a leader in science, technology, engineering, and mathematics (STEM) education research and practice in many contexts, including schooling, higher education and the hi-tech industry, providing learners with a stimulating environment for intellectual and creative activities. Our strategic plan aims at strengthening connections and collaborative activities in the education system, industry, and the Technion.



STEM education as a core resource for all

The Department contributes to the Israeli educational system, not only by preparing prospective high school STEM teachers, but also by encouraging its graduates to take leadership roles in the educational system and contribute to Israel's higher education, the hi-tech industry, the IDF, and the Third Sector.





The Department recognizes the importance of teaching skills and learning processes in these sectors, and believes that all Technion students should acquire the skills and ability to communicate effectively.

#### To these ends:

- ☉ The Department launched the Views program in October 2011, with the objective of offering Technion graduates a unique opportunity to obtain a second BSc degree in Science and Technology Education that fulfills the requirements for a teaching certificate in their subject area. Study scholarships are available for four semesters, and Technion graduates who join the program are not required to commit themselves to teaching in the education system. The message delivered by these conditions is that pedagogical skills are important also in the hi-tech industry. As of February 2014, 250 Technion graduates have enrolled in the program (60 in its first year, 90 in the second, and 100 in the third). Many combine their studies with work in industry and teaching in high schools.



- ② The Department encourages students from other Technion programs to select courses offered by the Department as electives, and to complete an additional BSc degree in Science and Technology Education via the Views program. This program is called E&E - Engineer and Educator.

### Research and Development

#### Our collaboration with industry includes:

- ② Professional interaction with Faculty researchers;
- ② Projects with research centers and laboratories for the benefit of both partners, to advance mutual interests. Our collaboration with industry enables us to install state-of-the-art software tools in our research and teaching laboratories (e.g., robots and 3D printers);
- ② Research proposals submitted to different funding resources and funded (e.g., the EU);
- ② Organization of international research conferences on topics that bridge STEM education and technological development;
- ② A start-up incubator that promotes the development of technologies for STEM education.

### Teaching

The Department offers the following courses to all Technion students that address STEM learning and teaching from a multifaceted perspective, including the hi-tech industry:

Learning in Hi-Tech, Academia and Public Sector • Science Instruction and its Relationship to Technology Instruction • Research Ethics • Soft Skills in Computer Science • Science in Communications: Theory and Practice • Advanced Issues in Teaching Design and Manufacturing

#### In addition

- ② Faculty members from the Department give lectures in industry;
- ② Projects in educational technology, developed by the Department's students and Faculty, are presented at the national and international exhibitions, and participate successfully in international design competitions;
- ② Leading role holders from industry visit the Department and share their experience;
- ② The Department's relationship with industry enables us to help high school teachers, who wish to expose their pupils to the advantages of selecting STEM topics, coordinate visits to different industrial organizations.

# FACULTY OF ELECTRICAL ENGINEERING



<http://webee.technion.ac.il>



[https://www.facebook.com/  
TechnionEE](https://www.facebook.com/TechnionEE)

The Faculty of Electrical Engineering is ranked in the top tier of electrical engineering and computer science departments in the World. The Faculty is the major source of engineers leading the development of advanced Israeli technology in the fields of electronics, computers, and communications. It is the largest academic unit in the Technion, with over 2,000 students. An international evaluation committee, chaired by the current President of MIT, concluded that "the graduates of this Department, whether with a B.Sc., M.Sc., or Ph.D., are as well prepared (if not better prepared) as EE graduates of any top ranked institution anywhere in the world".

The Faculty acts as a center of excellence in applied and theoretical research, contributing to the advancement of knowledge in electrical and computer engineering in Israel and throughout the World. The Faculty's activities constitute an important component of the technological and scientific infrastructure of the State of Israel.

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Full list and more info:



[http://webee.technion.ac.il/  
Research/Labs-and-Centers](http://webee.technion.ac.il/Research/Labs-and-Centers)



[http://webee.technion.  
ac.il/Industrial-Relations/  
Mission-and-Activities](http://webee.technion.ac.il/Industrial-Relations/Mission-and-Activities)

Additionally, the department has extensive, multi-faceted relations with industry.

Research Areas

Computer architecture ➤ Parallel and distributed computing and systems ➤ Computer communication networks ➤ Electronic systems and devices ➤ Computer-aided design ➤ Very large scale integration (VLSI) ➤ Signal processing ➤ Image processing ➤ Computer vision ➤ Communication and information theory ➤ Automatic control ➤ Wave propagation and electromagnetic engineering ➤ Nano- and micro-electronic devices ➤ Solid-state electronics ➤ Electro-optics and opto-electronic systems ➤ Biological signals and systems ➤ Machine learning

Laboratories and Centers at the faculty of Electrical Engineering

The experimental and applied research activities are supported by advanced laboratories, some of which are also used for our highly acclaimed student project activity. There are 8 centers and over 20 laboratories.

Irwin and Joan Jacobs Center for Communication  
and Information Technologies (CCIT)

Overview

The Faculty of Electrical Engineering at the Technion has extensive relationships with dozens of companies, mostly through its research and teaching activities, but also directly. Its Industrial Liaison Program (ILP) includes some 30 member companies, from multi-nationals to startups. They are invited to attend special symposia and short courses, hold recruiting days, meet with faculty and students, and explore other avenues of contact. They are also invited to participate in the Industrial Advisory Board of the faculty, which convenes semiannually in order to receive updates and, more importantly, offer advice. This is also the venue for discussing high-level issues such as the professional longevity of engineers. The ILP is administered by the Center for Communication and Information Technologies (CCIT).

The Electrical Engineering Faculty's relationship with industry is very diverse, both in the area of activity and in the nature of the relationship,

reflecting the interests and needs of both sides. To this end, we have identified several needs and potential benefits for all involved, which guide us in exploring opportunities and setting up mechanisms.

**These include:**

**The Faculty's objectives and needs:**

- ② Obtaining support (funding, equipment, etc.)
- ② Obtaining access to information, platforms, and special equipment available in industry
- ② Awareness of needs and interesting problems
- ② Collaboration in complementary-capability situations (feedback and advice, teaching, project supervision and graduate-student supervision)
- ② Help in developing advanced technologies
- ② Visibility for our graduate students and, through that, convincing our best students to pursue advanced degree studies
- ② Visibility for our research, both in order to advance recognition of the Faculty in Israel and abroad, and to increase the impact of our research results, including commercialization of Technion IP.
- ② Receiving feedback and guidance from the field pertaining to both our curriculum and research directions

**Industry's objectives:**

- ② Quick access to expertise and knowledge (depth)
- ② Better solutions for specific problems
- ② Guarding the flanks (trying alternatives; becoming aware of dead ends)
- ② Guidance and feedback
- ② Using Technion IP in products in order to obtain a competitive advantage
- ② Company personnel: recruiting, retaining, developing (keeping current, adapting, etc.). Increasing professional life expectancy ("early burnout" stands to become a critical national socio-economic problem)
- ② Influencing our curriculum so as to better prepare our graduates for the industry's needs, and especially to ensure coverage of emerging fields.

Following are some modes of collaboration with industry, with representative examples.



Teaching

- ② A select group of instructors from industry teach courses. In some cases this assists in reducing class sizes by holding parallel sessions; in others, these are specialized graduate courses in the instructor's area of expertise, which enrich our curriculum.
- ② Undergraduate student projects are the strongest and most highly acclaimed elements in our curriculum, but are also quantitatively the most challenging teaching undertaking (more than 300 projects per year!). Here, the contribution of industry comes in various forms: equipment donation, financial sponsorship of projects, and project supervisors. Many of the supervisors have carried out projects as students in the same laboratories, and having them as supervisors is a true joy for all involved. Numerous companies are involved in the various modalities, ranging from large multi-nationals, through established Israeli companies, all the way to start-ups. One recent prominent example is a project in which students in the Communications Laboratory developed a sophisticated antenna that is dramatically smaller than the prior art. This project won the student project competition, and is being commercialized.

Participation in Government-Sponsored R&D Consortia ("Magnet")

These consortia are funded in large part by the Office of the Chief Scientist of the Ministry of Economy, and are aimed at promoting collaboration between Israeli companies and universities at the generic research and development stage in new, promising fields in which relevant expertise exists in Israel and there is a major export growth opportunity. This program, which started in 1990, fosters collaboration, with both research and product benefits. It also brings people together, giving faculty members and graduate students an opportunity to get to know the relevant industry, and vice versa.

Recent examples include:

- ② **Tera Santa:** developing the required components and system architecture for a Terabit (one million megabits) per second optical communication link with the ability to add and drop 10 Gbit/sec sub-channels. Five Technion Electrical Engineering Faculty members and their graduate students, and three of its laboratories are involved, covering optical devices, optical communication algorithms, and high-speed signal processing architectures.
- ② **CORNET:** cognitive radio networks.
- ② **RESCUE:** disaster handling technologies.

### Direct Funding of Research

This entails funding the research of individual faculty members by specific companies, often with some IP arrangements. Two recent examples are in the areas of machine learning and compressed sensing.

### Establishment of Research Centers

The most prominent recent example is the funding by Intel of the ICRI-CI, Intel Collaborative Research Institutes – Computational Intelligence. This center, based at the Technion and at the Hebrew University, brings together computer architecture and machine learning (two very active areas of research in the Faculty of Electrical Engineering) in order to address the issue of “intelligent computing:” using machine learning to help optimize computer systems in general, as well as developing computer architectures that are well matched to the computing needs of machine-learning applications. This center is unique in that it brings together different fields within the Faculty of Electrical Engineering, and also funds Intel personnel who work in it.

**The Technion Computer Engineering Center (TCE)** established jointly by the Electrical Engineering and Computer Studies faculties, offers yet another platform for industry-Technion collaboration by permitting industry personnel to spend time at the Technion on joint research.

### Multi-prong Championed Relationships

This refers to a situation wherein a specific person in a company explores opportunities and establishes relationships with our Department. One such effort has, over the past two years, involved student project funding, consulting by faculty members, and Summer Internships for our students, as well as research collaboration that very recently resulted in a best paper award.

### Commercialization of Technology Developed or Seeded in the Faculty

This takes place in various fields, and is rather challenging, as it is important to find the appropriate mechanisms that fairly reward all those involved, yet are also well matched to the proper structure of a company in the relevant area.

### Providing Services to Industry

In the micro- and nano-technology fields, we often require the help of industry, for example, fabrication facilities. However, the reverse is sometimes true, especially when it comes to test equipment,

microscopes and the like. Here, companies (often small ones) pay a fee and use our advanced equipment. Such equipment thus becomes a national resource of sorts, with priority given to use for Technion research. This helps us fund the equipment and the personnel who operate it, while assisting industry.

**Consulting and Individual Involvement of Faculty Members with Industry**

Many faculty members are personally involved with companies, mostly Israeli, through consulting and otherwise. This, even when carried out individually and not on behalf of the Technion, serves both to help Israeli industry and to open and maintain channels and a network that helps Technion-industry relations. Areas include optical components, chips for satellites, communications, signal processing, and computer engineering.

Some of the aforementioned activities can be viewed as 'bottom-up', namely a collection of individual 'sporadic' undertakings. These are complemented by 'top-down' activities, mostly through the ILP, which are aimed at facilitation of the individual engagement by reactive as well as proactive undertakings. The reactive undertakings include helping faculty members find industrial partners, and helping interested companies identify the relevant faculty members. Also, advice is offered regarding modes of collaboration based on cumulative experience. The proactive undertakings are aimed at planting seeds that will hopefully benefit us in the future, and maintaining continuity of contacts with companies.

In summary, the Faculty of Electrical Engineering has extensive and extremely diverse relationships with industry, corresponding to the diverse set of needs and opportunities, in line with the Technion's charter.

**I. Kidron Microelectronics Research Center in the Wolfson Building for Microelectronics and the Zisapel Building for Nanoelectronics**

I. Kidron Microelectronics Research Center in the Wolfson Building for Microelectronics and the Zisapel Building for Nanoelectronics share a facility that enables the fabrication of high-quality devices requiring patterning from 100  $\mu$  to 10 nm. Such devices can be based on flow of electrons, photons or fluids; and can produce electrical, chemical, or mechanical signals. The infrastructure is based on two butt-coupled buildings designed and built to serve as an R&D FAB. The two share



<https://www.dropbox.com/sh/9olg3dxolj2dh1w/Bzyj597ui4>

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[http://www.linkedin.com/groups?gid=4531094&trk=hb\\_side\\_g](http://www.linkedin.com/groups?gid=4531094&trk=hb_side_g)

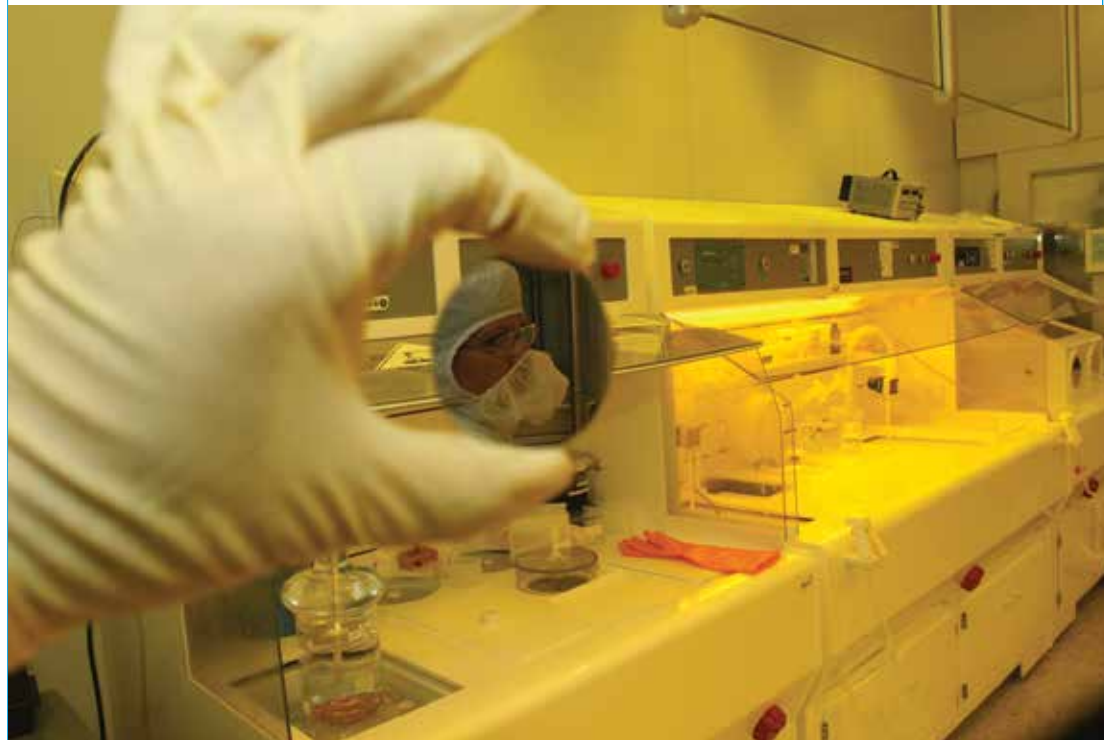


<https://www.facebook.com/groups/659210730770692/>

700 m<sup>2</sup> of clean rooms (Class 100) that are suspended to provide vibration isolation. This main facility, the micro-nano fabrication unit (MNFU), hosts a wide range of tools associated with micro, nano, and printing technologies, thus allowing for a full process flow to be designed and implemented. Maintaining the quality of the tools, reproducibility of the processes and minimal downtime is achieved thanks to a team of 12 dedicated technicians and process engineers with administrative support.

### You can benefit from our Center in several ways, the chief of which are:

- ② You or your engineers can be trained to use the facility and register as a user. As a registered user you have access to a web-based booking system that operates on a first come, first served basis (ALL users, be they professors, students, engineers, technicians, or whatever, have the same priority).
- ② You can ask us to perform a prototype development.
- ② If you need a unique tool that has to be installed in a clean room facility you can rent space in our facility, and we will help you to connect your tool to the supporting infrastructure.







# FACULTY OF INDUSTRIAL ENGINEERING AND MANAGEMENT



<http://ie.technion.ac.il>

The concept of Industrial Engineering and Management was first conceived by the founding fathers of our Faculty in the mid-1950s. The founders, a mixed group of industrial engineers and operations researchers, identified a need to educate engineers who would have basic management education in addition to engineering skills and knowhow. This new breed of engineers became a great success story in Israel, and similar programs were later opened in other universities and colleges. The demand for IE&M graduates is constantly on the rise, and their impact is felt across all economic and industrial sectors.

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<http://ie.technion.ac.il/Industry/affiliates.php>

Like all other engineering disciplines, IE&M is a dynamic entity. New areas of interest frequently appear, while mature areas that were exhaustively investigated gradually give way. Thus, there is no longer a need to compress management education into the undergraduate degree. Instead, there is a strong need to provide our students with the tools necessary in order to face the challenges that are posed by the ever-increasing presence of large and complex systems in every aspect of today's reality. This means a shift from IE&M towards industrial and systems engineering (I&SE). Indeed, we have already taken the first steps to explore this new and exciting direction, and are ready to continue our tradition of leading the academic community in Israel and beyond towards the challenges that await us as we start to implement the necessary changes in our research and teaching focus.

**Research Areas**

Behavioral Sciences and Management • Economics and Finance • Information Systems Engineering • Industrial Engineering | Reliability and Quality Assurance • Operations Research • Probability and Statistics

**Industrial Engineering and Management  
Affiliates Program (IE&M AP)**

The Industrial Engineering and Management Affiliates Program (IE&M AP) is dedicated to the creation of mutual cooperation between academia and leading industrial companies in Israel and worldwide. We believe that by establishing strong long-term relations between academia and industry, we can promote mutually important values focusing on knowledge, development, innovation, leadership, and excellence. The Program (IE&M AP) was established in 2010. The IE&M AP stimulates and supports the mutual needs of business, industry and academia in applied research and development, teaching, human resources, public relations, and advertising.

**Research and Development:**

- ⊗ Professionally interaction with Faculty researchers.
- ⊗ Students' Final Industrial Project Course: subject proposals and mentors given by companies for 4th-year students and MBA.
- ⊗ Faculty Newsletter issue: dedicated to company research and development program.
- ⊗ Faculty Newsletter distribution: for company employees.
- ⊗ Joint projects: with research centers and laboratories.

- ② Identification of partners for joint research proposals: to the Chief Scientist and European Community.

#### Teaching:

- ② Workshops, seminars and guest lecturers: presented within the faculty by representatives of suitable companies.
- ② Mini-courses, seminars, summer courses and Professional Graduate Programs: presented within the faculty by Faculty researchers to company employees.
- ② Free Auditor: option for company employees to choose specified Faculty courses.
- ② Industrial Advisory Board: held once a year to discuss teaching programs, research, laboratories and Faculty equipment.
- ② Library Services: limited.
- ② Guided Tours: opportunity for students to have a guided tour at company facilities.

#### Human Resources:

- ② Recruiting day: opportunity to hold an exclusive student recruiting day.
- ② Classified ad distribution by direct mailing, monthly Faculty newsletter, Faculty website, and bulletin boards and plasmas.
- ② Announcements via professional conferences, seminars, awards, scholarships, and recruiting days.
- ② Student employment during summer projects and hosting summer interns

#### Public Relations and Advertising:

- ② Increasing company visibility: Company name and logo presentation at the Faculty Academia Industry Affiliates Program web page linked to the official Faculty website.
- ② Sponsorship opportunity for alumni conferences, seminars, competitions, projects, etc.
- ② Sponsorship advertising announcement in the monthly Faculty newsletter, distributed to 4,000 alumni, industry personnel, Faculty staff and students.
- ② Advertising company activities/events: monthly Faculty newsletter, Faculty website, bulletin boards and plasmas.
- ② Exhibition presentations: in Faculty building.
- ② Links for selected web pages/company presentations to the Faculty Academia Industry Affiliates Program web page.



<http://ie.technion.ac.il/Labs/Commerce/>

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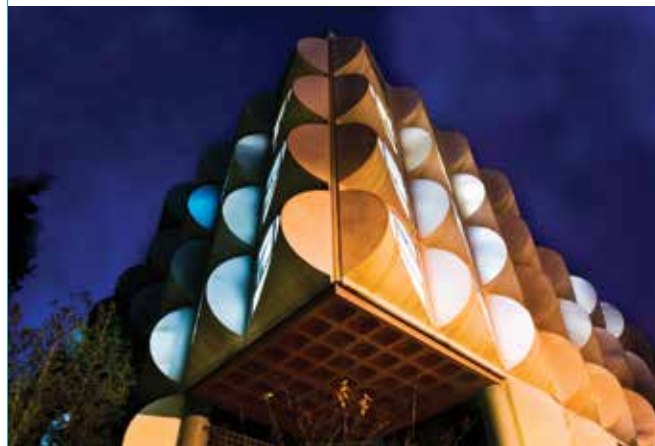
### Technion-Microsoft Electronic Commerce Research Center

The Technion-Microsoft Electronic-Commerce Research Center was established in October 2011, and is located at the Technion campus. It promotes basic research in areas of computer science, artificial intelligence, game theory, economics, and psychology; focusing on the connections between these subjects in the e-commerce domain. The Center supports research projects with at least one PI from the Technion, and at least one PI from Microsoft (as sponsor or direct collaborator).

Through a five-year joint research partnership, the Center will explore scientific and technological insights in e-commerce, such as online advertising and the use of social networks for commerce.

### Projects

Competition between information markets ➤ On the gap between preference and satisfaction ➤ Game Theoretical Perspectives in Cloud Systems ➤ Efficient Contextual Machine Learning ➤ P2P Networks for the Gain of the Members and of Society ➤ Uncertain Entity Resolution: Models and Algorithms ➤ Adversarial content-based relevance ranking ➤ Pricing in cloud computing and online auctions ➤ Pricing Schedules for Due-Date Jobs in Cloud Computing ➤ Automatic Sequential Decision Processes in E-Commerce Applications







<http://materials.technion.ac.il/en/>

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## FACULTY OF MATERIALS SCIENCE AND ENGINEERING

The mission of the Faculty of Materials Science and Engineering is to serve as the national center of teaching and research, by educating world-class scientists and engineers, and conducting research in specific fields of materials science and engineering.

The research activities of the Faculty cover most of the important and advanced topics in materials science and engineering. The Faculty includes a broad range of research centers and laboratories for processing and characterization of materials, equipped with a wide range of advanced facilities, supported by experienced staff.



<http://materials.technion.ac.il/>  
**Access-to-Research-Facilities**

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**Research Areas**

Metals and Alloys ➔ Ceramic Materials ➔ Polymers ➔ Nano-materials ➔ Biomaterials ➔ Electronic Materials ➔ Functional Materials ➔ Materials for Energy Conversion and Storage ➔ Interfaces in Materials ➔ Microstructural Characterization

**Research Facilities Providing Services to Industry**

**Materials Characterization**

**Scanning Electron Microscopy:**

Imaging, chemical mapping (EDS, WDS), crystallographic analysis (EBSD)

**Transmission Electron Microscopy:**

High-resolution imaging (atomic scale), crystallographic analysis (electron diffraction), chemical mapping (EDS, EELS), *in-situ* heating and cooling experiments

**X-ray Diffraction:**

Phase identification, strain analysis, *in-situ* heating experiments

**Atomic Force Microscopy:**

Surface topography and related parameters

**FTIR:**

Chemical bonding

**Dilatometer:**


Elongation measurements as a function of temperature, useful for sintering. Analysis and measurement of coefficients of thermal expansion. Temperature range: room temperature to 1600°C

**Thermal Gravimetric Analyzer (TGA):**

Weight loss as a function of temperature. Temperature range: room temperature to 1100°C

**Differential Scanning Calorimeter (DSC):**

Measures the amount of heat required to increase the temperature of a solid. Used mainly for identifying the type of reaction (endothermic/exothermic). Temperature range: room temperature to 1400°C

<p><b>Mr. Ronen Aviram</b> Tel: +972-4-829-4289</p>	<p><b>Mechanical Properties:</b> Evaluation of mechanical properties of materials and components using tension, compression, flexure, fatigue, impact, and torsion tests</p> <p><b>Hardness and Micro-Hardness:</b> Surface hardness and related mechanical properties</p> <p><b>Dual-Beam Focused Ion Beam:</b> Used for nanometer length-scale fabrication, 3D characterization, and TEM specimen preparation</p>
<p><b>Dr. Tzipi Cohen-Hyams</b> Tel: +972-4-829-5144</p>	<p><b>Specimen Preparation</b></p> <p><b>Metallographic Laboratory:</b> Cutting, hot mounting press, grinding, and polishing systems</p> <p><b>Furnace Laboratory:</b> Carbolite air furnace (R.T-1100°C), electric arc furnace</p>
<p><b>Mr. Ronen Aviram</b> Tel: +972-4-829-4289</p>	<p><b>Conventional TEM specimen preparation</b></p>
<p><b>Eng. Michael Kalina</b> Tel: +972-4-829-5795</p>	<p><b>Magnetron Sputtering:</b> Thin-film depositions</p>
<p></p> <p><a href="http://matwww.technion.ac.il/Mika">http://matwww.technion.ac.il/Mika</a></p>	<p><b>Electron Microscopy Center</b></p> <p>The Electron Microscopy Center, located at the Faculty of Materials Science and Engineering, serves Faculty and students within the Technion, as well as from other institutions and local industry. The Center provides services on all the microscopes, and trains students and scientists for independent use of the equipment.</p> <p>The facilities are run by five staff members, and include computerized light microscopy (LM), scanning electron microscopy (SEM), and transmission electron microscopy (TEM). In addition, a complete specimen preparation laboratory is included within the framework of the Electron Microscopy Laboratory.</p> <p><b>The Main Microscopes in the Center</b></p> <p><b>FEI Titan 80-300 keV S/TEM:</b> The Titan 80-300 FEG-S/TEM (FEI) is a platform dedicated to correction and monochromator technology. The Titan S/TEM system is the world's highest resolution commercially</p>



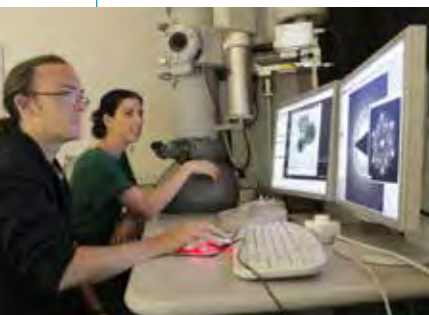






available microscope, yielding powerful sub-Angstrom (atomic scale) imaging and analysis.

The Titan's dedicated platform for corrector and monochromator technologies and their applications is designed for a high degree of automation, and provides ultimate stability, performance, and flexibility. The microscope transfers information deep into sub-Angstrom resolution, providing the highest performance available in both transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM) modes, enabling extraordinary new scientific opportunities for direct observation aimed at enabling analysis of individual nanostructures at an unprecedented resolution of 0.7 Å, which is approximately one-third the size of a carbon atom.



#### **FEI Tecnai G2 T20 S-Twin TEM:**

200keV (or 120keV) TEM with a LaB6 electron source and an FEI Supertwin Objective Lens. This microscope is also equipped with BF and DF STEM detectors, an EDS detector, a plate camera, and a 1x1K Gatan 694 retractable slow scan CCD.

#### **FEI Strata 400s Dual Beam FIB:**

The dual-beam focused ion beam (FIB) at the Technion was purchased with the support of TELEM and the Russell Berrie Nanotechnology Institute. The system is based on a FEI Strata 400S.



The Strata 400 STEM Dual-Beam system is a fully digital field emission scanning electron microscope (FEG-SEM), equipped with FIB technology and a Flipstage-STEM assembly. It provides for complete *in-situ* sample preparation and high-resolution analysis. The key enabling technologies integrated onto a single platform include:

- ④ Ultra-high resolution electron optics (magnetic immersion lens with ultra-high brightness Sirion emitter) with SE and BSE in-lens detection and STEM imaging.
- ④ High-resolution (field emission) ion optics (Sidewinder™ column).
- ④ Advanced control of gas chemistries, including delineation etch, metal etch, and C, Pt, SiO<sub>2</sub>, and Au deposition.
- ④ High-precision piezo specimen stage with 100 mm travels along the x and y axes, and integrated loadlock.
- ④ Omniprobe 200 sample extraction system for lift-out TEM specimen preparation.
- ④ Flipstage pivoting TEM grid mounts.

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<http://materials.technion.ac.il/x-ray-lab-Materials-Engineering>

- ③ Retractable, multi-region STEM detector (including HAADF)
- ③ A high-resolution 4k digital patterning engine.
- ③ Automation with full access to e-beam, i-beam, patterning, and gas chemistry functionality.
- ③ The system architecture is optimized for automation, which includes AutoFIB, AutoTEM, AutoSlice, and View, and the ability to develop custom-made routines for specific application needs.

**Zeiss Ultra-Plus FEG-SEM:**

A Schottky field emission gun SEM (FEG-SEM), which includes a heating stage up to 1050°C, an 80 mm<sup>2</sup> active area Oxford SDD EDS detector with an energy resolution of 127 eV, and a unique combination of detectors:

- ③ Everhart Thornley chamber secondary electron detector.
- ③ In-lens secondary electron detector.
- ③ In-lens energy selected back-scatter detector.
- ③ Four-quadrant angular selected back scatter detector, allowing imaging in orientation, topographic, or composition modes.
- ③ Transmission electron detector for STEM operations, allowing bright and dark field imaging modes.

**FEI E-SEM Quanta 200:**

An environmental SEM, enabling characterization of non-conducting materials without a conductive coating, equipped with EDS (light element), WDS, and EBSD.

**X-Ray Diffraction Laboratory**

The Rikagu SmartLab high-resolution diffraction system available in this laboratory represents the state of the art in fully-automated modular XRD systems. The system incorporates a high-resolution theta/theta closed loop goniometer drive system, CBO, an in-plane scattering arm, a 9.0 kW rotating anode generator, and a fully-automated optical system to make advanced measurements possible for both expert and novice users of the system.

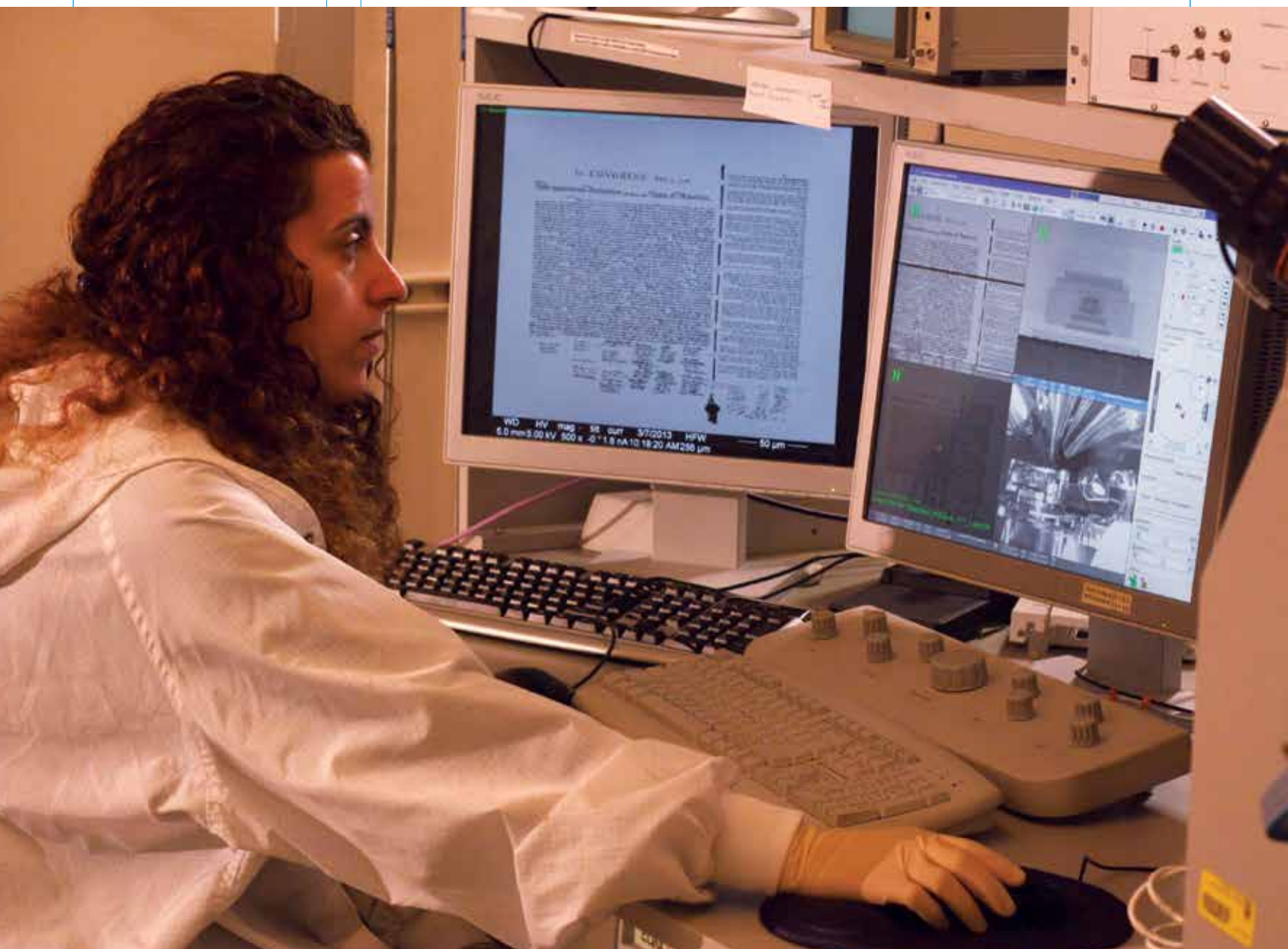
This diffractometer allows for the investigation of the preferred orientation of individual crystallites, and residual stress analysis of powders, polycrystalline materials, and polycrystalline thin films, as well as single crystalline films. With this system it is also possible to measure the rocking curves of the samples in the sample-detector decoupled

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mode, and to take diffraction profiles in grazing incidence. In addition it is equipped with an automatic sample changer, a capillary module for small amounts of powdered samples, and a hot stage operated in various inert environments (up to 1100°C). Another available mode of the system's operation is glancing angle X-ray reflectivity, which provides information on surface roughness and electron density variations beneath the surfaces and buried interfaces of various crystalline and non-crystalline materials, including glasses and polymers.





# MATHEMATICS



<http://www.math.technion.ac.il>

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The Faculty of Mathematics was founded in 1950. Today it is one of the leading mathematics departments in Israel. The Faculty is engaged in world-class research in both pure and applied mathematics. The research interests of the Faculty include algebra, applied mathematics, approximation theory, combinatorics, complex analysis, differential equations, ergodic theory, functional analysis, geometry and topology, linear algebra, nonlinear analysis, number theory, optimization theory, and probability theory.

The Center for Mathematical Sciences (CMS) was founded at the Faculty in 1988. Since then it has supported a large variety of research activities, conferences, special lecture series, workshops, etc.

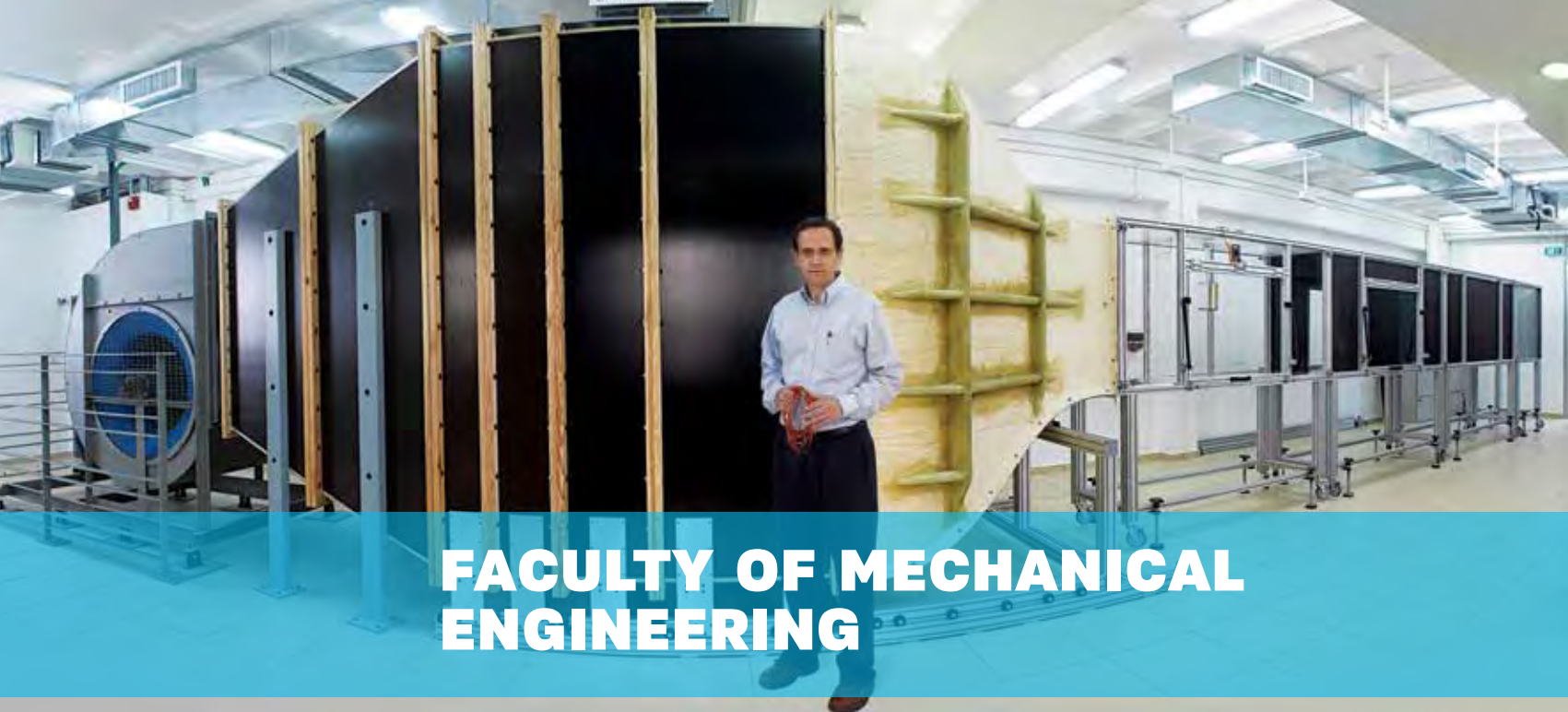
## Industrial Activity at the Faculty of Mathematics

The Faculty of Mathematics has been involved in applied mathematical research for many years and in many capacities:

- ③ **Startup companies:** A number of successful companies were founded by the Faculty members and graduates in different areas, including optics, image processing, and signal processing.
- ③ **Consulting to industry:** Our Faculty members are engaged in various consulting activities, covering a wide range of areas, including optimization, optics, mechanics, control, fluid mechanics, and 'big data'.
- ③ **In-house inventions:** A number of innovative technologies and algorithms were invented in the Faculty and patented by the Technion.

**Student Projects:** A number of industrial projects were carried out by our undergraduate students as part of a special training course.





# FACULTY OF MECHANICAL ENGINEERING



<http://meeng.technion.ac.il/en>

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The Faculty of Mechanical Engineering at the Technion is the major source of high-level mechanical engineers for Israeli industry and R&D. Graduates of the Faculty of Mechanical Engineering fill senior positions in Israeli industry, particularly in the high-tech and defense industries. The Faculty's facilities include advanced teaching and research laboratories, a computer facility, and a spacious well-equipped library.

The Faculty of Mechanical Engineering at the Technion has been recognized as one of the leading departments in its field. The research in the faculty is diverse, highly multi-disciplinary, and is at the forefront of science and technology. Research in the Faculty is carried out through research centers. The centers provide Faculty members and their students with the facilities, manpower and support to conduct their projects.

## Research Areas

Biomechanics ➔ CAD ➔ Control ➔ Design and Production ➔ Design in Marine Environment ➔ Dynamical Systems ➔ Energy ➔ Flow-Structure Interaction ➔ Fluid Mechanics and Transport Phenomena ➔ Mechanics of Materials ➔ Mechatronics ➔ Micro-systems ➔ Nano-Mechanics ➔ Optical Engineering ➔ Reliability ➔ Robotics ➔ Surface Engineering



<http://meeng.technion.ac.il/research-labs/>

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## Research Centers and Labs:

### Materials Mechanics Center

The Materials Mechanics Center specializes in the mechanical testing of materials at low strain rates and in the fatigue regime. The Dynamic Fracture Laboratory (DFL) specializes in high rate testing of the deformation and fracture mechanics of materials (metals, polymers, ceramics, and composites). Our dedicated equipment includes several Split Hopkinson tension and compression bars, shear experiments, a materials characterization facility (optical and SE microscopy), and numerical simulations capability (Abaqus, Ansys). Moreover, we have a high-speed camera (Kirana), with a 5 million fps frame rate, total 180 high resolution pictures.

The DFL is a unique facility in Israel, at the forefront of the research in the field of dynamic failure of materials.

### Computational Fluid Dynamics laboratory (CFDLAB)

The Computational Fluid Dynamics Laboratory (CFDLAB) specializes in high-fidelity modeling and simulation of turbulent flows, with applications in aerodynamics, aeroacoustics, biological/cardiovascular, combustion, microfluidics, and multiphase flows. Specifically, we focus on advanced numerical methods and models related to applying the large eddy simulation technique for turbulent flows. We employ high-performance parallel computing, and feature a 768 core dedicated Linux cluster computer for our work. We also feature the use of open-source codes, such as OpenFOAM, and commercial packages, such as Star-CCM+, depending on the problem.

### Multiphase Flow and Thermal Management Laboratory

The Multiphase Flow and Thermal Management Laboratory specializes in all forms of boiling and multiphase flow phenomena, in particular as related to thermal management of electronic and optical components, such as high power computer chips, signal amplifier lasers, and the like. Our dedicated equipment includes high-speed video, as well as all the standard thermal-laboratory equipment.

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<http://ncds.technion.ac.il>

**Internal Combustion Engines Laboratory**

The Technion Internal Combustion Engines Laboratory (TICEL) specializes in the development, testing, and modeling spark ignition and diesel engines for UAV and automotive applications, as well as advanced hybrid propulsion systems. TICEL is equipped to study engines and propulsion systems fueled with both conventional and alternative fuels. The TICEL staff has gained a rich experience in development, modeling, and testing 4-stroke, 2-stroke, and rotary internal combustion engines; road tests of motor, hybrid, and electric vehicles; and assessment of energy and environmental impacts of vehicles and transportation systems. Our dedicated equipment includes several engine dynamometers, including the dyno with transient capabilities; facilities for mechanical loss measurement; engine indicating; measurement of fuel consumption, gaseous and particle emissions; a high-speed camera; and a facility for flame velocity studies. Our numerical simulation capabilities include GT-SUITE software. The TICEL is a unique knowledge center in Israel, at the forefront of the research in the field of UAV and automotive propulsion.

**Nonlinear and Chaotic Dynamical Systems (NCDS) Laboratory**

The Nonlinear and Chaotic Dynamical Systems (NCDS) Laboratory specializes in the analysis and characterization of nonlinear materials and structures. The focus of the NCDS Lab includes both identification of complex material properties that cannot be obtained by standard linear analysis, and investigation of unstable and non-stationary structures that are subject to severe and unsteady environmental conditions. We make use of multiple-scale asymptotics and numerical bifurcation analysis to resolve nonlinear spatio-temporal interactions; and employ chaos theory to determine instabilities governed by sensitivity-to-initial-conditions. We are thus able to derive consistent model-based estimation procedures for validation of combined geometric (large deformation) and material (thermo-visco-elastic) nonlinearities from experiments that exhibit self-excited modulation and multiple coexisting solutions (hysteresis) due to parametric and internal resonances. The NCSD Lab includes both non-intrusive (high-speed cameras) and intrusive (strain/acceleration) capabilities to conduct experiments in high vacuum (and thus isolate the influence of internal thermo-elastic damping from air drag). The NCDS lab, located within the Material Mechanics Center at the Technion, is a unique facility in Israel that is at the forefront of the research in the field of nonlinear dynamical systems.

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**Shamban and Microsystems Tribology Laboratories**

The Shamban and Microsystems Tribology Laboratories specialize in science and technology of interacting surfaces in relative motion. Our research, both theoretical and experimental, is in contact mechanics, adhesion, friction, wear, and lubrication related to fields ranging from mechanics to biology. We consult and help to solve problems related to wear reduction, energy conservation, and increasing reliability and service life of mechanical components and systems. Our dedicated equipment includes optical and scanning electron microscopy, surface profilers and hardness testers, and 15 various custom-built tribometers capable of working in different contact schemes, motion types, and wear modes.

**Micro- and Nano-Fluidics Laboratory (MNFL)**

The Micro- and Nano-Fluidics Laboratory (MNFL) specializes in studying transport processes of electrolyte/colloids/cells/biomolecules within micro- and nano-fluidic devices. We target a number of application areas, involving primarily electrokinetic actuation, such as energy (e.g. electro-chemo-mechanical energy-conversion, heat management), healthcare (e.g. Lab-on-a-chip) and environmental (e.g. desalination) applications. Fabrication of the devices is done either within the Technion's shared micro-fabrication facilities (photolithography, E-Beam, FIB) or in our own Class 1000 clean room. The MNFL laboratory has state-of-the-art imaging and electronic sensing instruments. The key to studying electrokinetic phenomena in micro- and nano-fluidics is to have an exquisite control over the generated AC/DC electric field, together with high-precision current and impedance measurements. The laboratory contains the following main equipment: spinning-disk confocal and epi-fluorescence imaging microscopes, Andor's latest sCMOS and EMCCD high-sensitivity camera, TSI  $\mu$ -PIV, impedance and current meters, function generators, and power supplies.

**Technion - Mechanical Engineering Industrial Affiliates Program (IAP)**

The Technion's Mechanical Engineering Industrial Affiliates Program (IAP) was launched in 2009 to serve as a bridge between the Faculty and leading industrial companies in Israel and worldwide for the exchange of excellence, and as a framework for relations and collaboration in the fields of Education and Teaching, Human Resources & Employment, Research & Development, and Public Relations & Marketing. Program components were constructed to bypass obstacles to collaboration, provide win-win solutions to short- and long-term



needs, and pave the way to the consolidation of strategic ties, focusing on securing the best outcome for the State of Israel and its future. Through the IAP, industrial companies of all types and sizes, both domestic and foreign-based, can gain equal access to Faculty resources, and implement a range of activities to expose the various levels of company activities to Faculty staff and alumni, and undergraduate and graduate students in all tracks. All company activities within the framework of the program are performed with the full support of the Faculty’s academic, administrative, and technical staff.

Members’ Benefits

Companies joining our IAP are awarded access to a comprehensive benefits package, including components from the fields of Education and Teaching, Human Resources and Employment, Research and Development, and Public Relations and Marketing. The backbone of the program consists of package components, listed below. Companies are always welcome to offer the Faculty new initiatives that enrich the dialogue, and deepen common grounds and utilization of growth opportunities to extend the existing benefits package.

Access to Faculty members and students at all levels, with the following options:

Education and Teaching

- ⌚ Offering suggestions for students’ final projects.
- ⌚ Collaboration with the Faculty-led Technion Formula SAE Initiative.
- ⌚ Collaboration with the Faculty-led Technion PACE Initiative.
- ⌚ Collaboration with the Faculty’s annual Women’s Day Initiative.
- ⌚ Participation in a special annual ‘Faculty Council’ meeting open to industry.
- ⌚ Giving short courses or seminars.
- ⌚ Giving guest lectures within the Faculty’s TechTalk Framework.
- ⌚ Organizing mini-courses, seminars, summer courses, or advanced degree programs for company employees (additional payment).
- ⌚ Attending free Faculty courses for company employees (advance notice required).
- ⌚ Access to Faculty library services (advance notice required).

Human Resources and Employment

- ⌚ Holding an exclusive Student Recruiting Day twice a year.
- ⌚ Participating in a Student Recruiting Day held once a year in the Faculty building for several companies at a time.

- ③ Advertising open positions to all Faculty students and alumni through the Faculty's Newsletter.
- ③ Awarding scholarships to Faculty students.
- ③ Sponsoring Faculty alumni reunions.
- ③ Sponsoring Faculty graduation ceremonies.
- ③ Sponsoring Faculty seminars, conferences, and symposia.

#### Public Relations and Marketing

- ③ Company name and logo on a special "Industrial Affiliates" website linked to the ME Faculty website.
- ③ Company name and logo on a special "Industrial Affiliates" board in the ME building lobby.
- ③ Advertising company activities at the Faculty on electronic boards located in main entrances to Faculty building.
- ③ Linking selected company web pages to the Faculty IAP website.
- ③ Presenting exhibitions in the Faculty building.
- ③ Advertising articles and advertisements in the Faculty's Newsletter sent to all students, staff and alumni (about 6,000 recipients).

#### Research and Development

- ③ Participation in the annual ME "Research Day", held once a year, in which graduate students present their research to Faculty students, staff, Faculty alumni, Technion Management, and senior industry executives.
- ③ Participation in the annual Project Expo, where Faculty undergraduates in their 4th year present projects they have designed and built in collaboration with leading industrial companies.
- ③ Confidential and reliable channel to Faculty researchers.
- ③ Receiving copies of publications and annual activity reports produced by the Faculty.
- ③ Organizing visits to selected Faculty laboratories.
- ③ Organizing round-table meetings with staff operating in fields of mutual interest.
- ③ Access to the list of courses and research topics of graduate students.
- ③ Listing company R&D needs, and making connections to Faculty capabilities.
- ③ Discount on execution of company projects in Faculty laboratories.



**FACULTY OF MEDICINE**

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<http://md.technion.ac.il>

#### Dean's office

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The Faculty of Medicine is one of the few medical faculties worldwide integrated in a technological institute. Research in the Technion Faculty of Medicine has made impressive achievements.

In the short time since its establishment in 1969, the Faculty has earned the scientific community's highest respect in several research areas.

Two of our Faculty members, Distinguished Professors Avram Hershko and Aharon Ciechanover, were awarded the Nobel Prize in Chemistry in 2004 for discovering the Ubiquitin system and its crucial role in protein degradation and cell cycle. The Faculty Center for Degenerative Brain Diseases is world-famous, and has brought about the development of new medicines for protection against brain degeneration. Our stem cell scientists are well known as pioneers in their field. Technion Faculty members have contributed to the understanding of "crush syndrome" that has enabled the rescue of thousands of earthquake victims around the world. The Faculty Centers for Cardiovascular Diseases and Cancer Research have made important discoveries in the growth of blood vessels and future pharmacological treatment of patients with vascular disease and cancer. These most impressive achievements are only the tip of the iceberg, and have already earned our Faculty a reputation for being at the forefront of medical research.

#### Teaching Hospitals

Rambam Health Care Campus ➔ Bnei Zion Medical Center ➔ Carmel Medical Center ➔ Hillel Yaffe Medical Center ➔ Emek Medical Center ➔ Shaar Menashe Mental Health Center ➔ Tirat Hacarmel Mental Health Center ➔ Mental Health Center Mazra ➔ Fliman Geriatric Center ➔ Shoham Geriatric Center ➔ French Hospital - Nazareth ➔ Sanz Medical Center - Laniado Hospital, Netanya





[http://t2med.technion.ac.il/?page\\_id=36](http://t2med.technion.ac.il/?page_id=36)

### Medicine Affiliates Program - T2Med

The Medicine Affiliates Program (MAP T2Med) is dedicated to cooperation between physicians and leading industrial companies in Israel and worldwide. Biomedical research is viewed as an essential contribution to promoting health for individuals and populations. The modern physician is obliged to incorporate multiple technologies in his practice, and his role is crucial in defining the unique challenges, features, and needs of his specific field.

The development of medical technology has revealed the crucial role of the physician-engineer-scientist team. Therefore, there is an urgent need to cultivate the adoption of the highest proven standards of scientific approach in biomedical research. The new model of medical research requires collaboration with engineering disciplines, computation, and physical and mathematical sciences.

Many of the entrepreneurs who took part in the medical technology revolution in Israel were Technion graduates and/or Technion faculty members, both physicians and engineers. The Technion's unique position in technology and sciences, together with the Faculty of Medicine with its affiliated hospitals, combine to generate an optimal environment for innovation in biomedical research and technology development for promoting health.

### Research and Development

The various T2Med activities have produced many collaborations and grant applications together with researchers from other faculties.

The MD thesis is encouraged to be multidisciplinary. Specific arrangements exist with the Faculties of Electrical Engineering and Mechanical Engineering. Currently, a few MD thesis projects receive joint mentoring from various faculties and the Faculty of Medicine

### Teaching

- ④ Workshops, seminars and guest lecturers: presented in the Faculty by industry.
- ④ Multidisciplinary teaching courses involving academia, clinicians, and industry, such as Innovation in Medical Technology and Bio-Innovation and Entrepreneurship.
- ④ Non-clinical Faculty members give talks at the various clinical facilities to encourage cross-pollination of ideas.

### Meetings

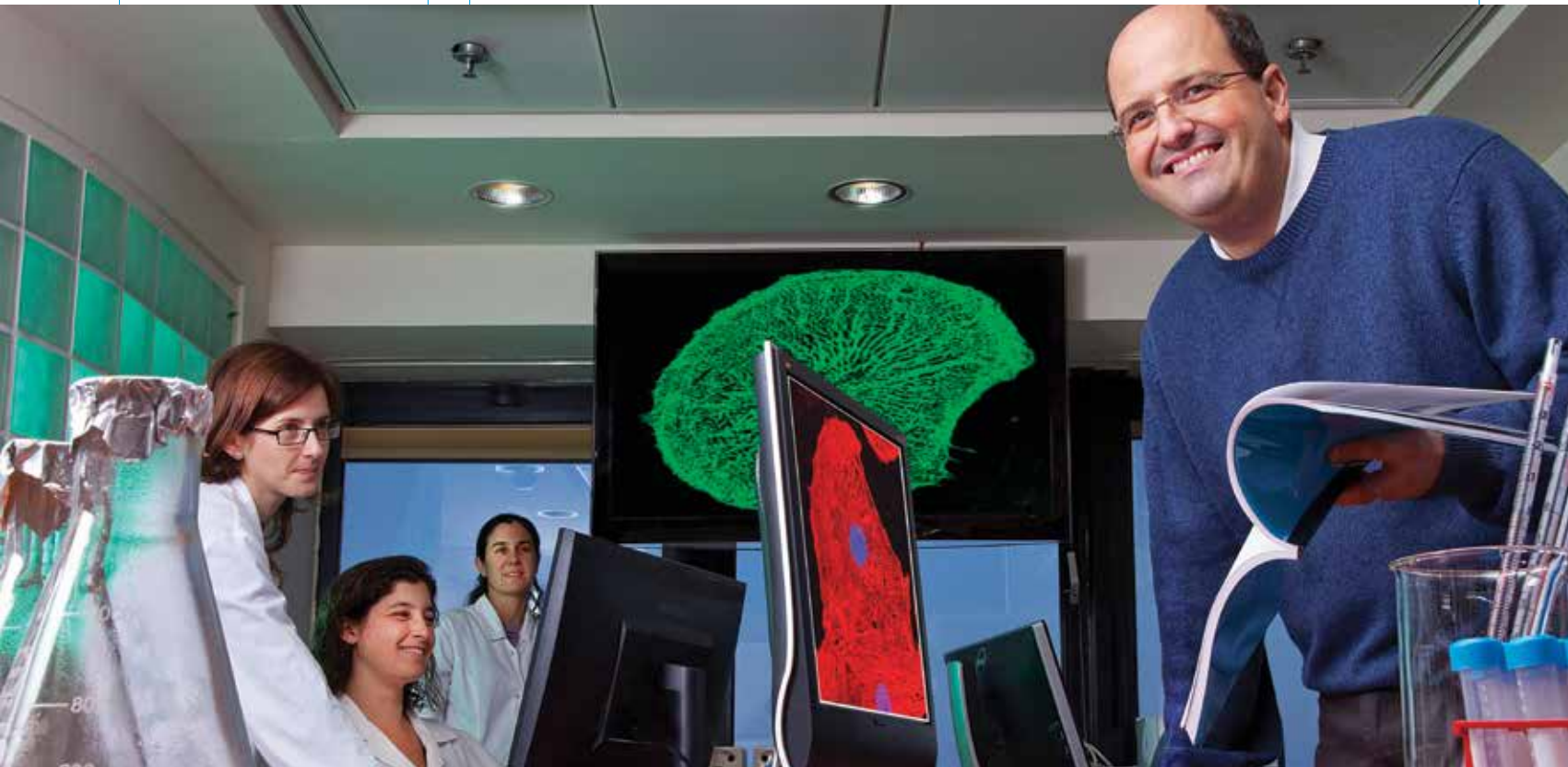
T2Med holds two multidisciplinary meetings entitled "Challenges in Medicine" every year. The meetings involve academia, clinicians, and industry; and focus on the dialog between clinical needs and technology. This year, one meeting will be devoted to students from different faculties to encourage and teach entrepreneurship and medical technology development. The other is entitled "Social-Mobile-Cloud Meets Medicine @ Technion", in collaboration with Cornell University and the Technion Computer Science Faculty.

In addition, the Faculty of Medicine and the Faculty of Architecture and Town Planning hold an annual joint conference entitled "Architecture and Medicine in the 21st Century".

### Public Relations and Advertising

The program uses tools to maximize exposure (e.g. mailing list, internet site, Facebook).

An initial database of all life science-related scientists (PubMed based) was established to maximize collaboration.





<http://www.medicinelab.org.il>

Contact

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Ruth and Bruce Rappaport  
Faculty of Medicine  
(Bat Galim, Haifa)

Biomedical Core Facility

The Biomedical Core Facility (BCF) is your one-stop shop for state-of-the-art technology and expertise. Over the years the Faculty of Medicine, together with the Rappaport Research Institute, has been committed to providing excellent resources to our scientists, and has invested in both advanced instruments and highly-trained personnel to operate the instruments and support the science. At the BCF we help with all stages of the experiment – design, execution, and data analysis. Our services include microscopy, imaging, whole-animal imaging, flow cytometry, mass cytometry, genomic services, supported by miscellaneous research equipment. Access to these resources is available to all researchers in industry and academia at affordable prices. Our team of scientists and trained technicians works in close collaboration to advance your science seamlessly in different fields and technologies.

Imaging and Microscopy Center

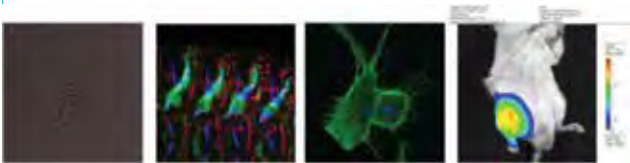
- Transmitted light microscopy
- Wide field fluorescence
- Live-cell imaging
- Laser scanning confocals
- Automated imaging scanner
- Whole-animal imaging systems

Genomic Center

- Next Generation Sequencing: PGM of Ion Torrent
- Single-cell gene expression
- Digital PCR
- Microarrays (SNP, genotyping, CNV, CMA, gene expression and methylation)
- Sanger sequencing and STR genotyping
- Automated DNA/RNA extraction and purification
- Automated DNA and RNA electrophoresis
- Fluorometric quantification of DNA, RNA , and protein

Flow Cytometry Center

- Multi-color flow cytometry
- Fluorescence-activated cell sorting
- Mass cytometry (CyTOF)



Contact

**Dr. Edith Suss-Toby**,  
Head of Imaging and  
Microscopy Center  
ediths@tx.technion.ac.il

Imaging and Microscopy Center, BCF

The Imaging and Microscopy Center is headed by Dr. Edith Suss-Toby, and offers advanced state-of-the-art technologies enabling visualization, digitization, and image analysis from subcellular resolution up to the whole animal (rodent). We support your research with sample preparation, system operation, image acquisition, analysis, result interpretation, and implementation of new

technologies and image analysis applications. We have extensive experience with a variety of research imaging applications, including cancer, stem cells, and cardio-vascular.

**The Center comprises two units:** Microscopy, and Whole-Animal Imaging, including functional MRI. We thus provide a variety of research methodologies to help close the gap between the cellular level and the whole animal.

**Microscopy**

The Microscopy Unit offers fluorescence wide-field and laser scanning confocal microscopes for the visualization and digitization of molecules, proteins, and organelle in live cells, fixed 3D matrices, and tissues. We also offer short- or long-term live cell time-lapse systems, an automated fluorescence digital scanner for high-resolution large-scale slice information and an applied spectral imaging karyotype station. Our image analysis stations are equipped with advanced image analysis software: Imaris, ZEN, Image Pro, FIJI, Photoshop, and custom-made software.

**Whole-animal Imaging**

The Whole-Animal Imaging Unit provides an optical imaging system for fluorescence and bioluminescence detection (IVIS 200), a fluorescence stereoscope for *ex-vivo* imaging, a high-resolution micro-ultrasound system (Vevo-2100) equipped with acquisition modules suitable for vascular cancer, contrast agent application, and cardiac high resolution US imaging. We operate an Aspect 1T MRI system suitable for anatomical imaging, and a 9.4T Bruker high-resolution functional MRI system.

Our Whole-Animal Imaging Unit is a unique research platform, enabling multimodality imaging, data co-registration, and combination with behavioral studies.

Our Center provides annual workshops and courses for training and education, technological List-serve, support, and presentations. Our professional team supports our users in achieving superior quality of data acquisition and analysis.



Contact

**Dr. Liat Linde,**  
Head of Genomic Center  
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**Genomic Center, BCF - Technion Faculty of Medicine**

The Genomic Center is headed by Dr. Liat Linde, and provides cutting-edge technologies and services. We support your research throughout the project, from experiment design through high-quality experimentation, and data analysis. Our team consists of highly-trained and experienced scientists, including a PhD biostatistician and MSc technicians. We can deal with large-scale projects with up to 10,000 samples, as well as small highly-tailored projects with a few samples. Among our customers are several pharmaceutical and biotech companies from across the country.

**Sequencing and NGS**

The Genomic Center offers PGM Ion Next-Generation Sequencing (NGS) for PCR applications or libraries for total reads of 25 Billion bases per day. We perform hundreds of Sanger sequencings each day, and provide the results within two working days.

**Microarrays**

One of the busiest technologies in the Center is Illumina microarrays for single nucleotide polymorphism (SNP) genotyping, copy number variation (CNV) and chromosomal microarray analysis (CMA), gene expression, and DNA methylation.

**Single-cell Genomics**

As part of our commitment to cutting-edge science, we offer the Fluidigm BioMark system for single-cell gene expression and digital PCR.

**Automated Processes**

We also offer STR genotyping, automated DNA/RNA extraction, and QC of samples. We provide user-friendly, boutique, and knowledge-based genomic solutions, and specialize in human genetics with clinical orientation. We provide full data analysis, including differentially expressed genes, identifications of indels, definition of biological pathways and networks, etc. All analyses use the highest quality software, such as JMP Genomics and Ingenuity.

Contact

**Dr. Ofir Goldberger,**  
Head of Flow  
Cytometry Center  
ofirg@technion.ac.il

**Flow Cytometry Center, BCF**

The Flow Cytometry unit is headed by Dr. Ofir Goldberger, and provides a suite of services for state-of-the-art Flow Cytometry and Mass Cytometry. Our expert team supports your research with experiment design, instrument operation, data analysis, and interpretation.

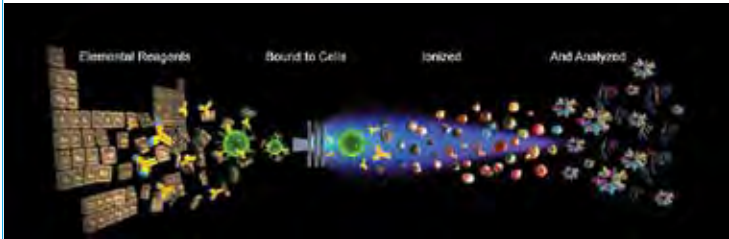
**Fluorescence Activated Cell Sorting**

We operate two advanced cell analyzers - BD LSR Fortessa, and Dako CyAN ADP, which can measure up to 15 and 11 parameters respectively. Over the years our team has developed expertise in various assays, including polychromatic staining, cell-cycle, rare event detection, and small particle analysis.

For cell sorting, we offer an upgraded BD FACSAria IIIu Cell Sorter with four lasers, including near-UV and Yellow/Green lasers which can measure up to 15 parameters. We provide expertise in rapid enrichment sorting, precision sorting, and single cell sorting.

**Mass Cytometry**

The Cytometry unit operates Israel's first mass cytometry instrument – the CyTOF – which can measure up to 100 parameters on every cell by using antibodies (as in FACS) labeled with metal isotopes. Mass cytometry allows ground-breaking science for discovery, diagnostics, and high-throughput screening. Our team will be happy to introduce you to the technology and its utility for your R&D.



Contact

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Preclinical Research Authority

For the last three decades the Experimental Surgery and Laboratory Animal Unit, or in its current name, the Preclinical Research Authority has been a leading research facility, supplying quality preclinical study services to leading biomedical and start-up companies, and providing a superior platform for academic research.

Our main expertise lies in preclinical study design and conduction of efficacy and safety studies. Over years of activity we have acquired experience in product development studies, and servicing leading and pioneering researchers and companies in fields of cardiology, invasive cardiology, cardiovascular surgery, orthopedics, orthodontics, gastroenterology, obstetrics, and imaging. Expertise gained through years of research, combined with constant input in structure and equipment, enables conduction of top quality animal studies in our unit.

Advanced research environment and up-to-date medical equipment:

Digital Fluoroscopic machines ➡ X-ray ➡ Echocardiography ➡ ICUS ➡ IVUS ➡ Endoscopy and Laparoscopy platform ➡ By-pass machine ➡ Orthopedics equipment ➡ Microsurgery tools ➡ In-house laboratory including blood gas analysis, CBC, and ACT ➡ Availability of CT and MRI screening

Animal Enrollment

All animals are obtained from approved suppliers, and are recruited after health screening. A period of acclimatization or isolation and animal preparation is mandatory for all participating animals.

In-house recovery and hospitalization ➡ Long term maintenance, at a secluded farm under PCRA supervision ➡ Full monitoring and record-keeping ➡ Conduction of all studies requires the approval of the Technion Institutional Animal Care and Use Committee, and is carried out in strict compliance with international guidelines.

Facility Description

Total size of over 2000 m<sup>2</sup>, including an SPF rodent section, five surgery rooms, a large animal section, and a service area.

The SPF rodent section is a self-contained section of the Unit with animal maintenance and isolation rooms, and has its own separate service area and surgery room. Animals are maintained in individually ventilated cages (IVCs), and rooms are equipped with laminar flow

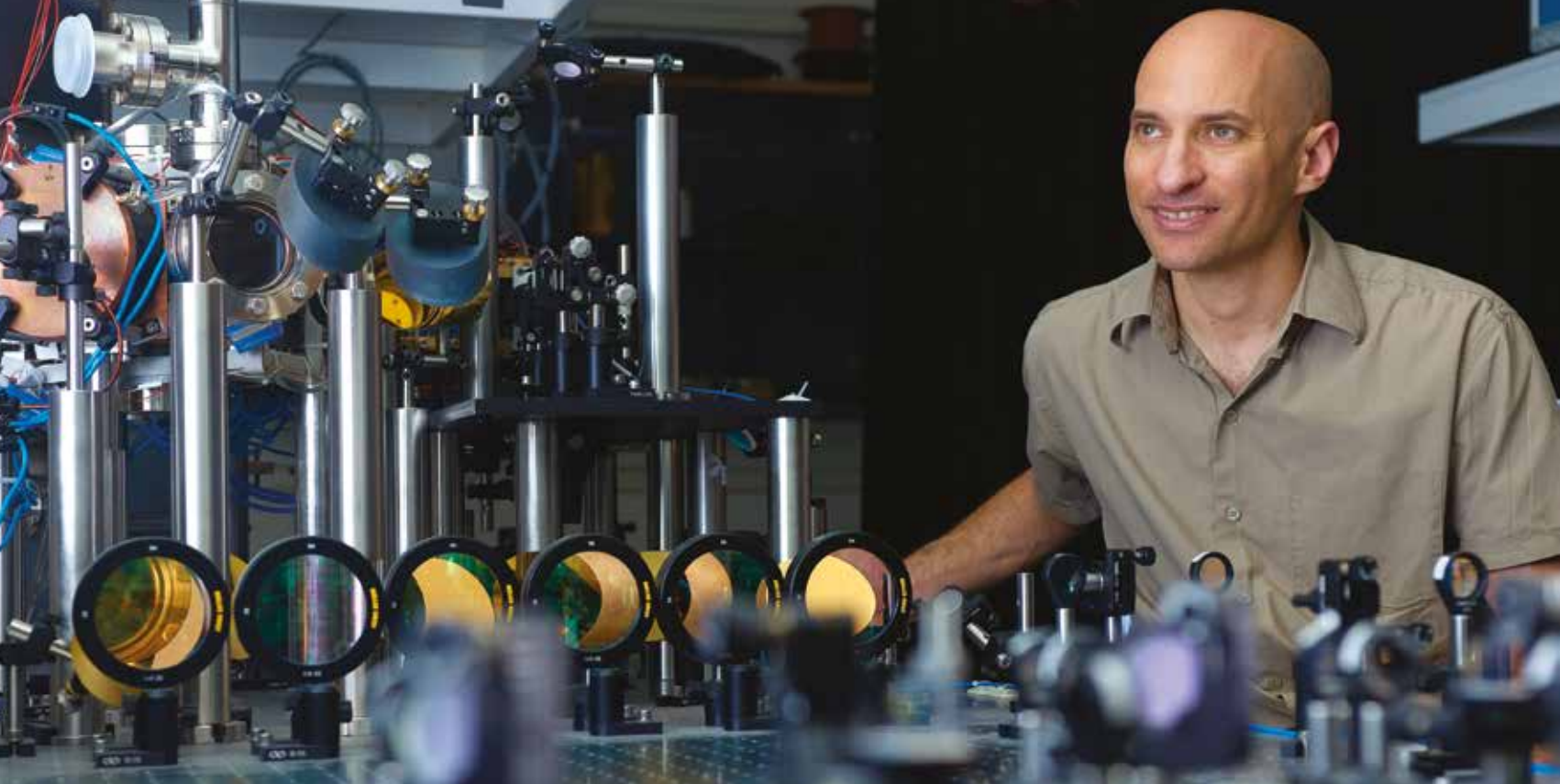
work stations. Isolation rules apply to this section, and it has separate entrance and exits. All rooms have air filtration, and positive air pressure gradient is maintained and monitored. Access is restricted to authorized researchers, and dedicated personnel are assigned specifically to this section in order to ensure strict separation from the rest of the unit.

The Multidisciplinary Laboratories of the Bruce Rappaport Faculty of Medicine and those of Life Sciences in the main campus offer advanced imaging equipment:

MRI 9T ➤ MRI1T ➤ Micro US-Vevo 2100 (Visualsonics) ➤ IVIS 200 ➤ NMR ➤ Stereoscopes ➤ Fluorescent Stereoscope ➤ Laser Doppler - Moor Inst

The large animal surgery section comprises five modern, fully-equipped surgery rooms and an X-ray room located together in an isolated area. All rooms are equipped with anesthetic machines and PP ventilators, monitoring equipment, ceiling-mounted surgery lights, and central gas supply and evacuation systems. The rooms have air filtration by Hepa-filters, and positive air pressure is maintained and monitored. All rooms, doors and windows are x-ray shielded.





## FACULTY OF PHYSICS



<http://phys.technion.ac.il/en>

During the first 30 years of its existence, the Technion had no separate science departments, although a basic education in physics was considered important, and was included in the curriculum of the Technion from the outset. In 1948 after the War of Independence the Technion started expanding, and in 1952 a Faculty of Science was established. A Department of Physics was formed as a part of the Faculty. The first Department chairman was Prof. Nathan Rosen, Einstein's last assistant.

The first class of six students graduated in 1956. Since then the Faculty has kept growing, and today maintains a vigorous research program in all the major fields of physics, including astrophysics, high-energy physics, condensed matter physics, and biophysics. Research programs in experimental physics include high energy physics, bioelectronics, plasma physics, semiconductors and quantum structures, nonlinear optics, magnetism, and superconductivity.

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#### Industrial Relations Coordinator

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[http://phys.technion.ac.il/en/  
research/research-groups](http://phys.technion.ac.il/en/research/research-groups)

List of people by research  
topic can be found in:  
[http://phys.technion.ac.il/en/  
people/by-topic](http://phys.technion.ac.il/en/people/by-topic)

The Faculty has a strong teaching program both at the undergraduate and graduate levels. Along with the regular undergraduate program in Physics, the Faculty currently emphasizes the development of interdisciplinary undergraduate programs. These programs lead to a double degree in Physics and in Electrical Engineering, Physics and Materials Engineering, Physics and Mathematics. The Faculty also has a joint program with Mechanical Engineering for Opto-Mechanics. The graduate program offers both courses and thesis research projects in all the above-mentioned subjects. Over the years the Faculty's graduates have taken leading positions both in industry and in academic institutions, and they continue to be in strong demand.

The Faculty has been responsible for teaching physics to all Technion students. Approximately 4,000 students from all departments take physics courses each semester. Due to this fact, the Faculty of Physics has a great advantage, as almost every student in the Technion goes through our Faculty, thus giving us full access to them all.

The Faculty of Physics is all about research. Nevertheless, we are dedicated to interfacing with the world of industry, and we see the importance and strength of the connection between both worlds. We do our best to give our students the knowledge and tools that they need to advance in both the research and industrial sectors. Our main goal is to further enhance the mutual contribution and benefit of both sides.

#### Research Areas

Astrophysics and General Relativity ➤ Atomic and Molecular Physics  
➤ Biophysics and Non-Equilibrium Statistical Mechanics ➤ Condensed  
Matter and Materials Physics ➤ High-Energy Physics ➤ Mathematical  
Physics ➤ Nanoscience and Nanotechnology ➤ Non-linear Optics ➤  
Plasma Physics

#### Research Groups

Astrophysics ➤ Atomic Physics ➤ Computational Physics ➤ Electron  
Spectroscopy ➤ Extreme Nonlinear Optics Group ➤ Experimental High  
Energy Group ➤ Magnetism ➤ Optics ➤ Plasma Physics ➤ String Theory ➤  
Theoretical Particle Physics

**Physics Industrial Affiliates Program**

**Research and Development**

- ⌚ Professional interaction with Faculty researchers
- ⌚ Departmental colloquia
- ⌚ Joint projects: with research centers and laboratories
- ⌚ Sponsoring laboratory sets/experiments/equipment

**Teaching**

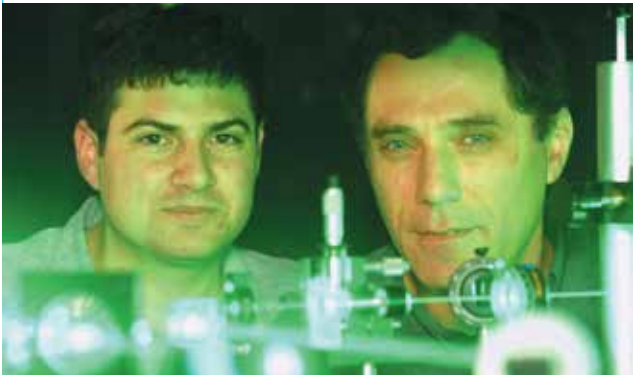
- ⌚ Workshops, seminars and guest lectures: presented in the Faculty by representatives of suitable companies.
- ⌚ Mini courses, seminars, summer courses and professional graduate programs: presented in the Faculty by Faculty researchers to company employees, and vice versa.

**Human Resources**

- ⌚ Recruiting day: company recruitment events: company's R&D fields and technology.
- ⌚ Announcements via professional conferences, seminars, awards, scholarships, and recruiting days.

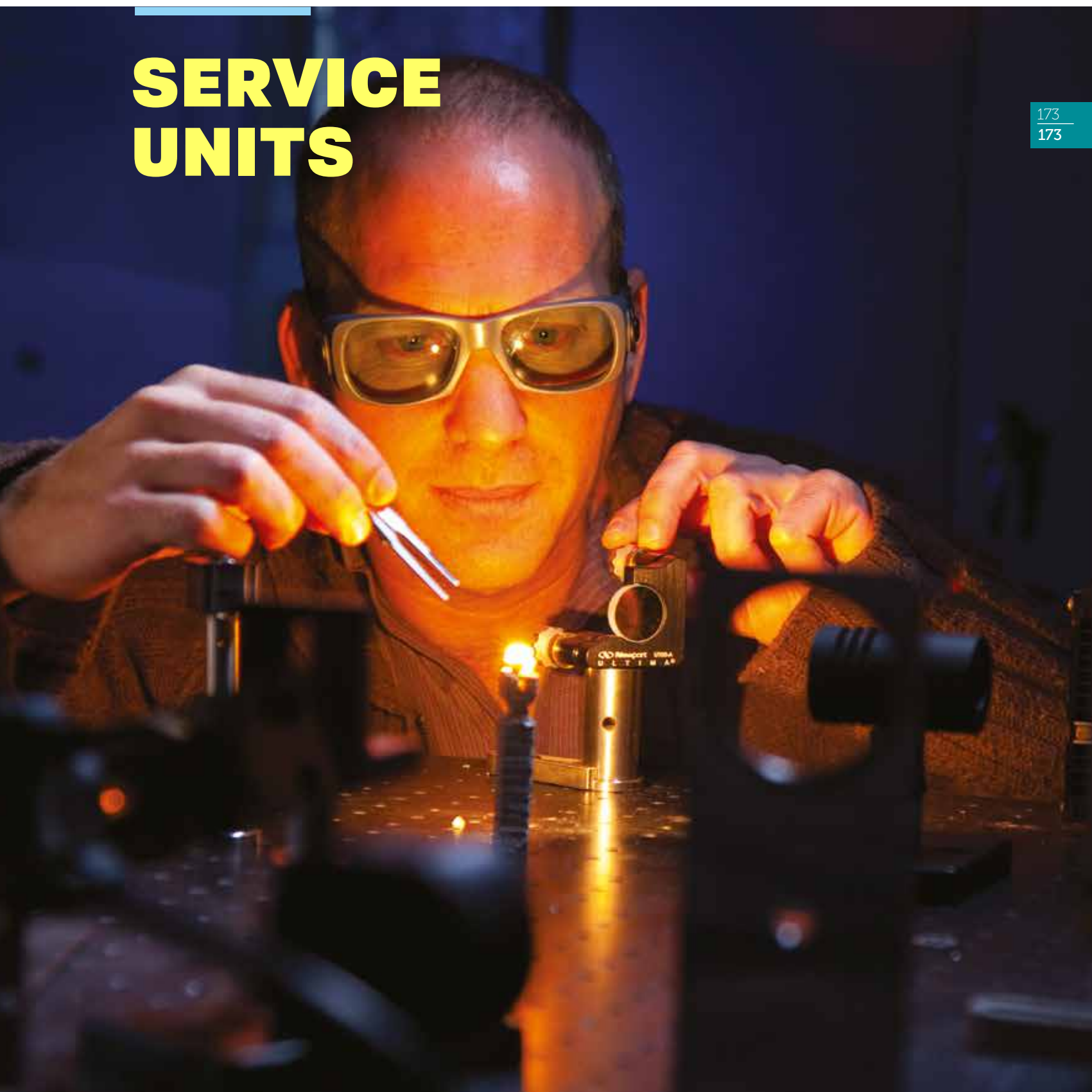
**Public Relations and Advertising**

- ⌚ Increasing a company's visibility: company's name and logo presentation at the Faculty Academia Industry Affiliates program web page linked from the Faculty official website.
- ⌚ Classified ads distribution by direct mailing, faculty website and bulletin boards; Sponsorship opportunity for alumni conferences, seminars, competitions, projects, etc.
- ⌚ Advertising company's activities/events: Faculty monthly newsletter, Faculty website, bulletin boards to staff and students.
- ⌚ Sponsoring academic contest for graduate/undergraduate students.



# SERVICE UNITS

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[http://nnscc.technion.ac.il/  
index.htm](http://nnscc.technion.ac.il/index.htm)

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## RUSSELL BERRIE NANOPARTICLES AND NANOMETRIC SYSTEMS CHARACTERIZATION (NNSCC)

The Russell Berrie Nanoparticles and Nanometric Systems Characterization Center was established by the Russell Berrie Nanotechnology Institute, the Faculty of Biotechnology and Food Engineering, and the Wolfson Department of Chemical Engineering.

It was founded to provide accessibility and support for a variety of facilities and techniques for nanoparticle and nanosystem analysis. Instruction on proper use of the instruments in the Center is provided in training sessions that are advertised periodically.

The center serves Technion users as well as other academic or industrial clients.

### Facilities

#### Spectroscopy

NNSCC is equipped with a highly sensitive FluoroLog 3-22 spectrofluorometer. It can scan samples very rapidly, avoiding sample decomposition due to photobleaching. A unique 3D capability enables scanning of both excitation and emission spectra for locating optimal fluorescent response wavelengths. It can measure additional properties, such as fluorescence polarization and anisotropy. A plate reader is available.

A TENSOR Series FT-IR Spectrometer (Bruker) provides mid-infrared (IR) spectroscopy, which is an extremely reliable and well-recognized fingerprinting method. Our spectrometer is equipped with different measuring cells, giving the possibility of characterizing solid, powder, and liquid materials. These include a transmission cell especially designed for secondary structure analysis of water-soluble proteins; an ATR flow cell with temperature control, enabling the study of temperature effects on protein structure (The instrument is equipped



with a temperature-controlled water bath to ensure constant temperature and allow studying temperature gradient effects). An ATR cell for powders is also available. A protein spectra databank is available for secondary structure analysis, and identification purposes.

### Static and Dynamic Light Scattering

We operate particle size and Zeta potential analyzers based on dynamic light scattering. We have two instruments: ZetaPals (Brookhaven Instruments, Inc.) and Zetasizer Nano Series (Malvern Instruments Ltd.), both of which can determine particle size distribution in the range from a few nanometers to a few microns in relatively concentrated solutions. Zeta potential can be determined for particles over a wide range of mobilities. Molecular weight can also be measured using the Zetasizer. The center is equipped with a particle size analyzer based on the laser diffraction technique. The Mastersizer 2000 (Malvern Instruments Ltd.) analyses particle size distribution in the range of 20 nm to 2 mm. This instrument uses a Hydro S sample dispersion unit, allowing sampling in both aqueous and organic media.

Static and dynamic light-scattering measurements (S/DLS) are made with a BI-200SM Research Goniometer System (Brookhaven Instruments, Inc.). DLS measurements provide particle size distribution, and can be used for samples with wide distribution. SLS can be used to characterize various parameters, such as molecular weight, radius of gyration, second virial coefficient, and many others.

The BI-DNDC Differential Refractometer (Brookhaven Instruments, Inc.) is used to determine refractive index increment.

### Atomic Force Microscope

The NanoWizard® II BioAFM measures topography with nanometric resolution. Other sample characteristics, originating from probe-surface interactions, are acquired simultaneously with the topography in the different imaging modes, and are demonstrated as images. This AFM is also able to perform measurements in a controlled liquid environment (flow, temperature), which can be critical for living cell experiments. Measurements can be made in the temperature range from 0 to 100°C.



### Preparative HPLC

The Waters purification system is equipped with a Quaternary Gradient Module which is a four-solvent, low-pressure mixing gradient pump, connected to a UV detector and a fully automated Waters fraction collector. The modules can be configured to perform in a variety of purification modes, including organic synthetics, natural products, peptides, and proteins. The system can provide flow in the range of 1-50 mL/min (analytical and preparative capability) for purification of milligrams to grams of material, and can accommodate a wide variety of column lengths, diameters, and particle sizes.

### LCMS

The Xevo® G2 ToF mass spectrometer with UPLC®/MSE and QuanTof technology offers exceptional levels of sensitivity, selectivity, in-spectrum dynamic range, speed of analysis, quantitative accuracy and exact mass performance simultaneously for any experiment, whether UPLC/MS or MSE.



- ③ QuanTof technology - for the most sensitive, exact mass, quantitative and qualitative benchtop MS/MS system.
- ③ UPLC®/MSE - a simple, patented method of unbiased data acquisition that comprehensively catalogs complex samples in a single analysis.
- ③ UPLC/FastDDA – Rapid automated, intelligent MS/MS data acquisition for targeted qualitative analyses.
- ③ System Solutions – System solutions software to ensure success in biopharmaceutical characterization, metabolite profiling, forensic toxicology, food and environmental analysis, chemical industry research and proteomics studies.



<http://iim.technion.ac.il>

## Contact

### Research and Development:

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### Metallurgical Engineering:

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### Foundry Technology:

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### Corrosion Prevention:

**Eng. Malka Rotel**, Head of  
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Surface Treatment, and Laser  
Technology Laboratory

# ISRAEL INSTITUTE OF METALS (IIM)

The Israel Institute of Metals is a research institute operating under the Technion umbrella in full cooperation with the scientists and researchers of the Technion. The Institute was founded in 1963 to serve as a bridge between the academic community of the Technion and traditional Israeli industry. The Institute leads in engineering, scientific, and technological innovations. Its activities include the industrial application of advanced capabilities stemming from cutting-edge technology. In order to fulfill its mission, the Institute is involved in national and international research activities, as well as cooperating with leading global research institutions in bilateral and multilateral research frameworks.

The Institute's researchers are served by the wide range of the Technion's laboratories and state-of-the-art facilities.

## In order to provide efficient coverage of metals-related issues, the Institute operates four professional laboratories:

- ② Metallurgical Engineering and Powder Technology.
- ② Foundry Technology.
- ② Corrosion Prevention, Surface Treatment, and Laser Technology.
- ② Vehicle and Mechanical Engineering.

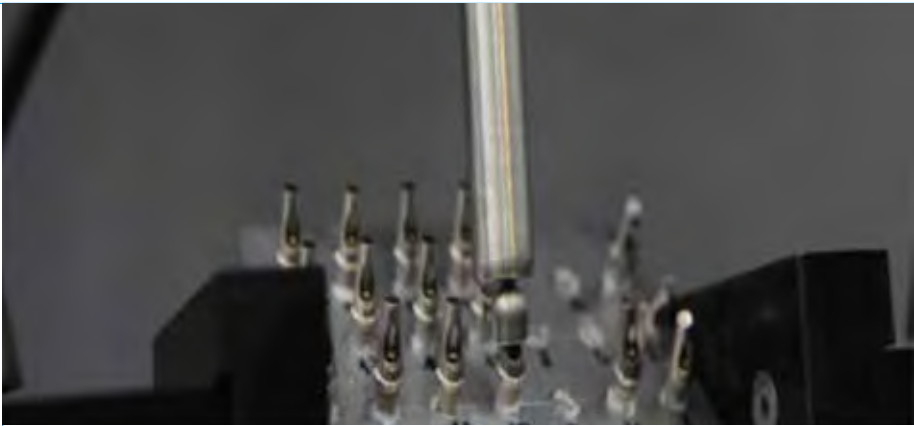
The Institute is certified under ISO 17020 (Inspection Activity) and ISO 17025 (Testing Laboratory), and is well known for its highly professional staff and operation.

## Metallurgical Laboratory

The Metallurgical Laboratory is intimately linked to industrial development projects, as well as trouble-shooting and failure analyses. Its excellent reputation stems from a continuous creation of innovative applications and meticulous routine work.

The Laboratory usually handles three or four major long-term projects concurrently, lasting 1 to 2 years. The laboratory addresses a wide range of topics, generating innovative technological research results. The team





works in a highly collaborative manner, with all staff members being involved.

Being an ISO/EURO 17025 accredited laboratory is evidenced in all operations, including an orderly decision-making process, and clear development status reporting. Laboratory equipment is continuously tested and certified to leading national and international testing standards.

**Mechanical Property Measurements:**

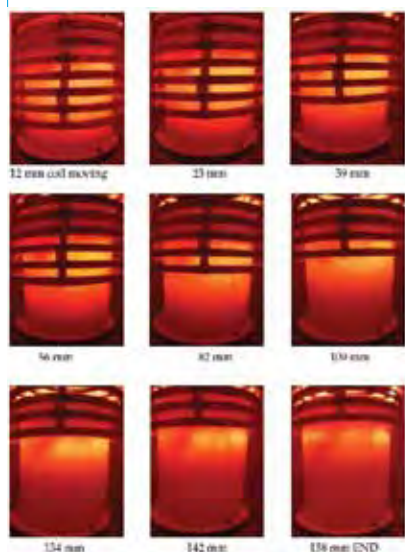
Tension tests at room and elevated temperatures • Fatigue endurance testing of parts (specializing in dental implants) • Fracture Toughness K1c and J-Integral, Impact and instrumented impact tests

**Property-Testing Capabilities including:**

Hardness measurement by HRC, HRB, HRA, HRV, Brinell, Micro-Vickers, and Knoop methods, scanning electron microscope and EDS characterization, tensile strength, Charpy impact toughness measurement, coefficient of thermal expansion measurement, surface roughness measurement, glow discharge optical emission spectrometry, thermal conductivity measurement, X-RAY Diffraction, HR SEM, and failure analysis expertise: fractographic analysis.

**Technological Expertise:**

Materials choice and selection, choice and tailoring of surface treatments, and manufacturability counseling.



### Foundry Technology Laboratory

The Foundry Technology Laboratory has accumulated expertise in the field of casting of light and heavy metals, and light metal-based composites (mainly magnesium and aluminum). The Laboratory staff carries out numerous research projects, operating modern complex equipment.

#### Fields of Activity:

Ferrous and non-ferrous castings ➔ Improving of pressure die casting technologies ➔ Semi-solid casting (thixocasting, thixoforming) ➔ MMC casting technology (composite materials in pressure die-casting, permanent mold casting, and investment casting) ➔ Light metal matrix reinforced by nano-particles ➔ Rapid solidification of Mg alloys ➔ Development of refining processes for metals.

#### Semi-industrial on-site facilities:

High-vacuum unidirectional solidification casting machine, Semi-industrial press for hot and cold sintering, pressing, extrusion, drawing,

etc., Die-casting/ sand-casting/investment casting/permanent-mold casting machines, Low-pressure and vacuum-casting machine, Melting/ induction/electrical resistance furnaces, Melting under protective atmosphere, Heat treatment with protective atmosphere or vacuum, Semi-solid casting machines, Power injection molding machines, Melt-spinning technology.

#### Analytical Equipment:

Optical Emission Spectrometer (OES), X-Ray Diffractometer (XRD), Scanning Electron Microscope, including high resolution (SEM/HRSEM), Transmission Electron microscope, including high resolution (TEM/HRTEM), Differential Scanning Calorimeter (DSC), Thermal Gravimetric Analyzer (TGA).

#### Corrosion Prevention, Surface Treatment and Laser Technology Laboratory

The Corrosion Prevention, Surface Treatment and Laser Technology Laboratory has accumulated many years of experience in the field of corrosion prevention and surface treatment of materials, especially metals and metal matrix composites (MMC's). The laboratory has the metallurgical facilities needed to deal with industrial challenges. The staff comprises a group of highly-qualified specialists with wide scientific and technological knowledge.

#### Main Fields of Activity:

Corrosion testing and prevention, including corrosion failure analysis

➤ Corrosion measurements and tests ➤ Electrochemical corrosion measurements ➤ Development of coolants ➤ Surface treatment including electroless coating deposition and electrodeposition of metal alloys and metal/particle composite coatings ➤ Electrophoretic deposition for the formation of ceramic coatings ➤ Conversion coatings

Laser Technology: including laser surface treatment (hardening, texturizing, etc.), laser welding, laser cladding.

#### Facilities:

Electrochemical measurement systems, potentiostats, impedance electrochemical spectroscopy (EIS) instruments with suitable software, scanning electrochemical work station SVP and SECM micro- corrosion measurement system. Zetasizer for measurement of nano-particle size and stability of suspensions, power supply, micro-hardness tester (Vickers and Knoop), optical microscopes, salt spray (fog) chamber,





chemical laboratory facilities, metallographic cross-section preparation equipment, TABER abrasion test, Nd: YAG laser: pulse laser working at wavelengths of 1064 nm, 532 nm, and 266 nm, with pulse duration of 7 ns (or long pulse 3 ms), 10 Hz, 10 W with computerized table, Diode laser: CW laser, 2 kW with the following heads: welding, surface treatment and cladding, including computerized table (x-y-z and spindle, SEM and EDS, HRSEM, GDEOS, XRD, mechanical characterization (e.g. hardness testers, INSTRON for tensile strength measurements, etc.), TEM, HRESEM, GDA, Auger, and XPS spectroscopy.

### Cooperation with industry

The Israel Institute of Metals operates in close cooperation with industry.

#### Main activities include:

- ② Improvement of current production processes, and development of new production processes.
- ② Development of new products, and improvement of existing products.
- ② Fundamental research and follow-up research for the development of new technologies.
- ② Fundamental research and follow-up research for the development of advanced material systems.
- ② Investigation of product properties, failure analysis, supporting and guiding factories in various processes.
- ② Training/guidance, courses, and metallurgical support for plants and factories.





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# AZRIELI CONTINUING EDUCATION AND EXTERNAL STUDIES DIVISION

The Azrieli Continuing Education and External Studies Division has developed study programs over the years in professional academic disciplines for industrial organizations and institutions, including the senior teaching staff of Technion faculties.

By virtue of belonging to an academic institution of global standing and reputation, the Unit is required to meet strict standards, and provide study programs at the highest level of quality.

The study programs develop through learning the needs of the organization, and examining the challenges it faces.

The programs combine academic knowledge with applied tools for translating theory into practice, and include managers from the organization.

The programs are conducted according to organizational needs - seminars, workshops, and courses at the client's site, at the Technion in Haifa, the Technion campus at Sarona in Tel Aviv, and the Technion annex in Jerusalem.



<http://phycomp.technion.ac.il/~tamnun>

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**Dr. Joan Adler**

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#### Technion Division for Computing and Information Systems:

**Ms. Yulia Halopovich**

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[technion.ac.il](mailto:hpc-support-l@listserv.technion.ac.il)

## CENTER FOR COMPUTATIONAL NANOSCIENCE AND NANOTECHNOLOGY AND TECHNION MINERVA CENTERS (TAMNUN)

TAMNUN was funded by the Technion, through the Minerva Foundation and RBNI, and has been operational since July 2012.

TAMNUN is a contraction of Technion-Minerva-NANO, and also alludes to an oCtoPUS with many CPUs.

#### Technical Description

- ③ TNN/SGI (Silicon Graphics) is the vendor and the cluster configuration includes 88 compute nodes with 12 Intel cores, which is 1056 cores with 96GB RAM per node, plus a master node.
- ③ Four of the compute nodes have GPUs.
- ③ All nodes are connected by MELLANOX infiniband switches with 2:1 blocking.
- ③ The software includes RedHat LINUX, the PBS queueing system, and Intel compilers.
- ③ A large variety of codes, including MATLAB, Fluent, Gaussian, VASP, and LAMMPS are installed, with usage subject to license restrictions.

System and user support is provided by the Technion Division for Computing and Information Systems.

# RESEARCH EQUIPMENT

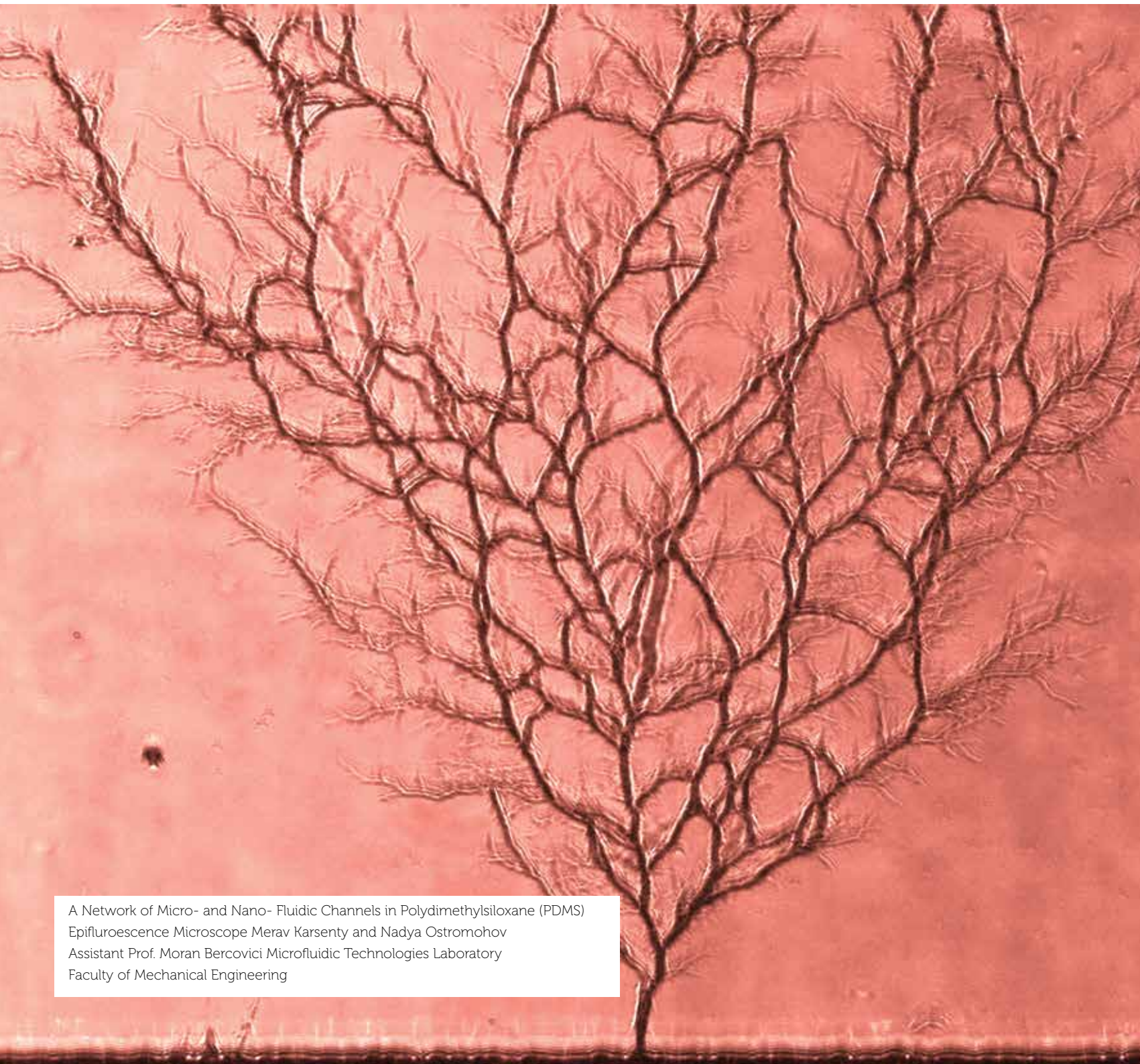
FIELD	INSTRUMENT	LOCATION	LINK
Light Microscopy	Inverted / upright light microscope	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
		Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
		Materials Science & Eng.	<a href="http://materials.technion.ac.il/Mika/index.html">http://materials.technion.ac.il/Mika/index.html</a>
	Fluorescent light microscope	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
		LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
	Confocal laser scanning microscope	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
		Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Fluorescent light stereoscope	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
		LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
Live	Time-lapse microscope	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
		Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
Image analysis and processing support	4D analysis software - Bitplane	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	IMARIS image J, Image Pro, Zen, LSM	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
Whole animal Imaging	Fluorescent and luminescent	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	High resolution I ultrasound MRI 1T		
	M2 high performance platform		
	Whole animal Ultrasound	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
Electron Microscopy	SEM (+ with EDS, WDS and EBSD)	Materials Science & Eng.	<a href="http://materials.technion.ac.il/Mika/index.html">http://materials.technion.ac.il/Mika/index.html</a>
	Cryo-SEM	Chemical Eng.	<a href="http://www.technion.ac.il/~ceritit">http://www.technion.ac.il/~ceritit</a>
	Dual beam FIB	Materials Science & Eng.	<a href="http://materials.technion.ac.il/Mika/index.html">http://materials.technion.ac.il/Mika/index.html</a>
	S/TEM (+EDS, EELS)	Materials Science & Eng.	<a href="http://materials.technion.ac.il/Mika/index.html">http://materials.technion.ac.il/Mika/index.html</a>
	TEM	Materials Science & Eng.	<a href="http://materials.technion.ac.il/Mika/index.html">http://materials.technion.ac.il/Mika/index.html</a>
	Cryo-TEM	Chemical Eng.	<a href="http://www.technion.ac.il/~ceritit">http://www.technion.ac.il/~ceritit</a>
Scanning Probe Microscopy	AFM NSOM/AFM (STM/AFM)	Materials Science & Eng.	<a href="http://materials.technion.ac.il">http://materials.technion.ac.il</a>
		Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>
	BioAFM		<a href="http://nnscc.technion.ac.il">http://nnscc.technion.ac.il</a>
		Biotech.	<a href="http://www.technion.ac.il/~eshimoni">http://www.technion.ac.il/~eshimoni</a>
	SAM (Scanning Auger Microscope)	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>

FIELD	INSTRUMENT	LOCATION	LINK
Flow Cytometry	FACS Calibur (2 lasers)	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
	BD LSR - II (4 lasers)		
	BD FACS Aria-III-sorter (4 lasers)		
	FACS Calibur (2 lasers)	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	CyAn ADP (3 lasers)		
	BD FACS Aria-sorter		
Microarrays	Illumine HiScan	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Roche NimbleGen		
Automated Electrophoresis	BioRad Experion	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
Real-Time PCR	Corbett Rotor Gene ABI 7000	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	ABi7300	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
	BioRad SFX96	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
Sequencing and Genotyping	Illumina HiSeq 2500	LS&E	<a href="http://isu.technion.ac.il/tgc">http://isu.technion.ac.il/tgc</a>
	Illumina MiSeq	LS&E	<a href="http://isu.technion.ac.il/tgc">http://isu.technion.ac.il/tgc</a>
	High-Throughput Sequencing Unit	LS&E	<a href="http://isu.technion.ac.il">http://isu.technion.ac.il</a>
	ABI 3130xl Genetic Analyzer	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
Spectroscopy / Spectrometry	Mass Spectroscope	Chemistry	<a href="http://chemistry.technion.ac.il/mass_spectroscopy.htm">http://chemistry.technion.ac.il/mass_spectroscopy.htm</a>
	Micro Raman Spectroscope	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>
	XPS-X ray Photoelectron Spectrometer	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>
	SIMS-Secondary Ion Mass Spectrometer	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>
	TOF-SIMS Time of Flight Secondary Ion Mass Spectrometer (Ion ToF TOF SIMS V)	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>
X-ray	HR XRD - high resolution X-ray diffraction	Solid State Ins. & Physics	<a href="http://solid-state.technion.ac.il">http://solid-state.technion.ac.il</a>



FIELD	INSTRUMENT	LOCATION	LINK
X-ray	X-ray diffractometer	Materials Science & Eng.	<a href="http://materials.technion.ac.il">http://materials.technion.ac.il</a>
	Solid Identification by X-ray	Physics	<a href="http://physics.technion.ac.il/eng/index.php/he/services/substances-identification">http://physics.technion.ac.il/eng/index.php/he/services/substances-identification</a>
	Small-angle X-ray scattering (SAXS)	Chemical Eng.	<a href="http://chemeng.technion.ac.il/research_facilities.php">http://chemeng.technion.ac.il/research_facilities.php</a>
NMR	NMR computer cluster	Chemistry	<a href="http://nmrlab.technion.ac.il">http://nmrlab.technion.ac.il</a>
Computation	TAMNUN		<a href="http://phycomp.technion.ac.il/~tamnun">http://phycomp.technion.ac.il/~tamnun</a>
	Bioinformatics Knowledge Unit (BKU)	Biology	<a href="http://bku.technion.ac.il/BKU/index.asp">http://bku.technion.ac.il/BKU/index.asp</a>
Proteomics	OrbiTrap	Biology	<a href="http://biweb2.bi.technion.ac.il/proteomics/index.htm">http://biweb2.bi.technion.ac.il/proteomics/index.htm</a>
	Q-TOF Premier	Biology	<a href="http://biweb2.bi.technion.ac.il/proteomics/index.htm">http://biweb2.bi.technion.ac.il/proteomics/index.htm</a>
	Maldi – ToF ToF	Biology	<a href="http://biweb2.bi.technion.ac.il/proteomics/index.htm">http://biweb2.bi.technion.ac.il/proteomics/index.htm</a>
Micro Nano Fabrication Unit	Clean room facilities		<a href="http://webee.technion.ac.il/micro">http://webee.technion.ac.il/micro</a>
Nanomaterial-Based Devices	Probe station		<a href="http://lnbd.technion.ac.il/">http://lnbd.technion.ac.il/</a>
	Kelvin probe		<a href="http://lnbd.technion.ac.il/">http://lnbd.technion.ac.il/</a>
	QCM		<a href="http://lnbd.technion.ac.il/">http://lnbd.technion.ac.il/</a>
	Spectrophotometer		<a href="http://lnbd.technion.ac.il/">http://lnbd.technion.ac.il/</a>
	Ellipsometer		<a href="http://lnbd.technion.ac.il/">http://lnbd.technion.ac.il/</a>
Other	Laser light scattering		<a href="http://nnscc.technion.ac.il/index_files/Page824.htm">http://nnscc.technion.ac.il/index_files/Page824.htm</a>
	TapeStaion 2100	LS&E	<a href="http://isu.technion.ac.il/tgc">http://isu.technion.ac.il/tgc</a>
	Laser microdissection	Biomedical Eng.	<a href="http://www.bm.technion.ac.il">http://www.bm.technion.ac.il</a>
		Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Optical tweezers	Biomedical Eng. / RBNI	<a href="http://www.bm.technion.ac.il">http://www.bm.technion.ac.il</a>
	Spectrofluorometer	Chem. Eng. / Biotech	<a href="http://rbni.technion.ac.il/?cmd=infrastructure.277">http://rbni.technion.ac.il/?cmd=infrastructure.277</a>
	Solar simulator	Materials Science & Eng.	<a href="http://rbni.technion.ac.il/?cmd=infrastructure.339">http://rbni.technion.ac.il/?cmd=infrastructure.339</a>
	Fermentors	Biotech. and Food Eng.	<a href="http://biotech.technion.ac.il/Members/Shoham.html">http://biotech.technion.ac.il/Members/Shoham.html</a>
	Microcalorimetry (ITC and DSC)	Biotech. and Food Eng.	<a href="http://biotech.technion.ac.il/Members/Shoham.html">http://biotech.technion.ac.il/Members/Shoham.html</a>

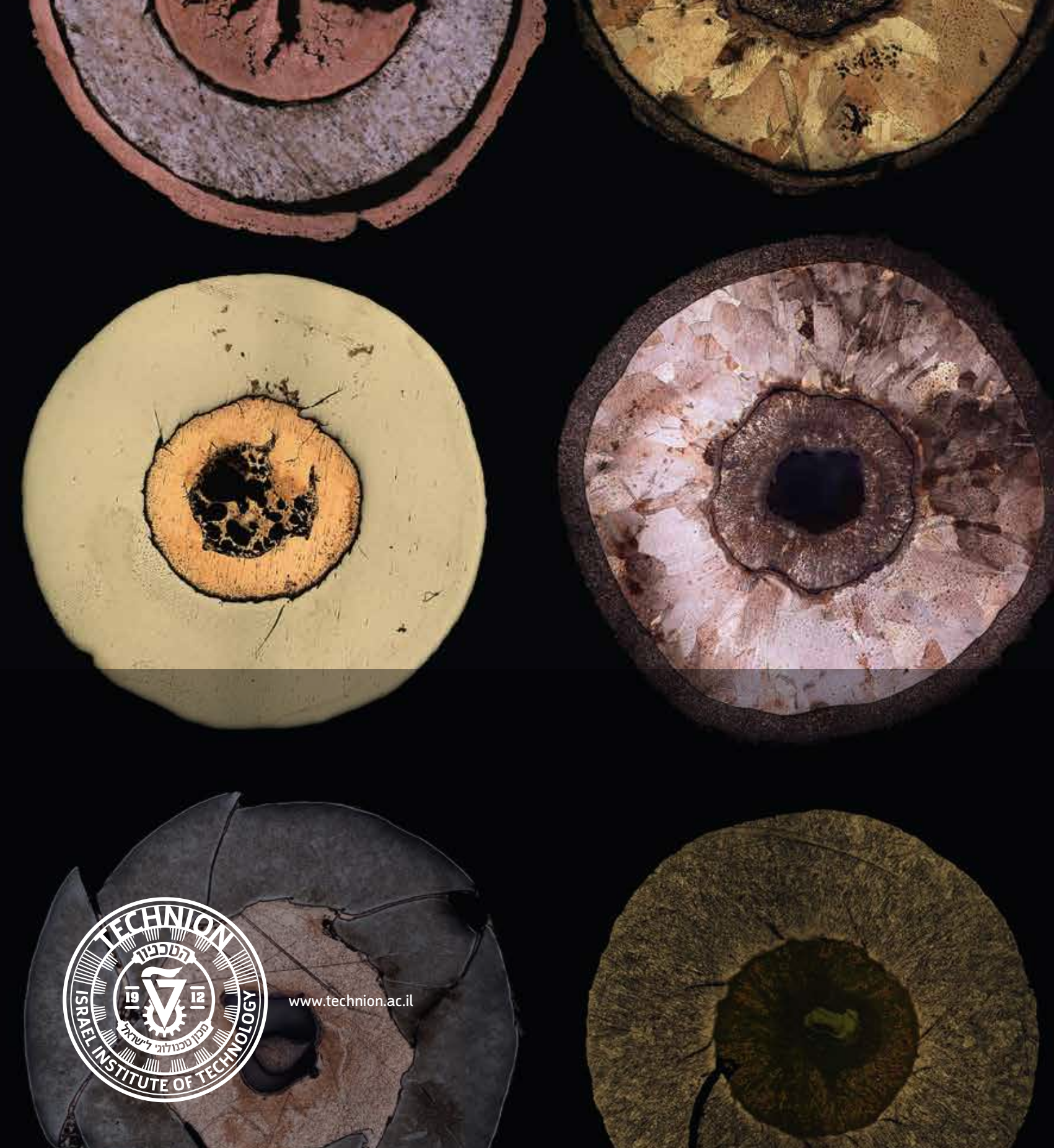
FIELD	INSTRUMENT	LOCATION	LINK
Other	Fluorescence microplate reader- FLUOstar galaxy	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Microplate spectrophotometer reader- Zenyth 200	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	UV-Vis Spectro-photometer- Nano Drop	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Lyofilizer-ALPHA 1-4	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Sonicator-Vibra-Cell VCX 750	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Controlled rate freezing system	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	High-speed refrigerated centrifuge - RC-5C	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Incubator-Innova 4335	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Phosphor imager-FLA2000	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Bio-safety virus room	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Low-speed refrigerated centrifuge-RC-3C Plus	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Micro-ultracentrifuge-RC-M150	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Ultracentrifuge - WX90	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>
	Ultracentrifuge - Combi	Medicine	<a href="http://www.medicinelab.org.il">http://www.medicinelab.org.il</a>



A Network of Micro- and Nano- Fluidic Channels in Polydimethylsiloxane (PDMS)  
Epifluorescence Microscope Merav Karsenty and Nadya Ostromohov  
Assistant Prof. Moran Bercovici Microfluidic Technologies Laboratory  
Faculty of Mechanical Engineering







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