

The Iby & Aladar Fleischman Faculty of Engineering

**Master Class on Materials Sciences: Review of the
Department of Materials Science and Engineering
at Tel-Aviv University**

Website: <http://en-materials.tau.ac.il>



Prof. Noam Eliaz

Founding Head

Email: neliaz@eng.tau.ac.il

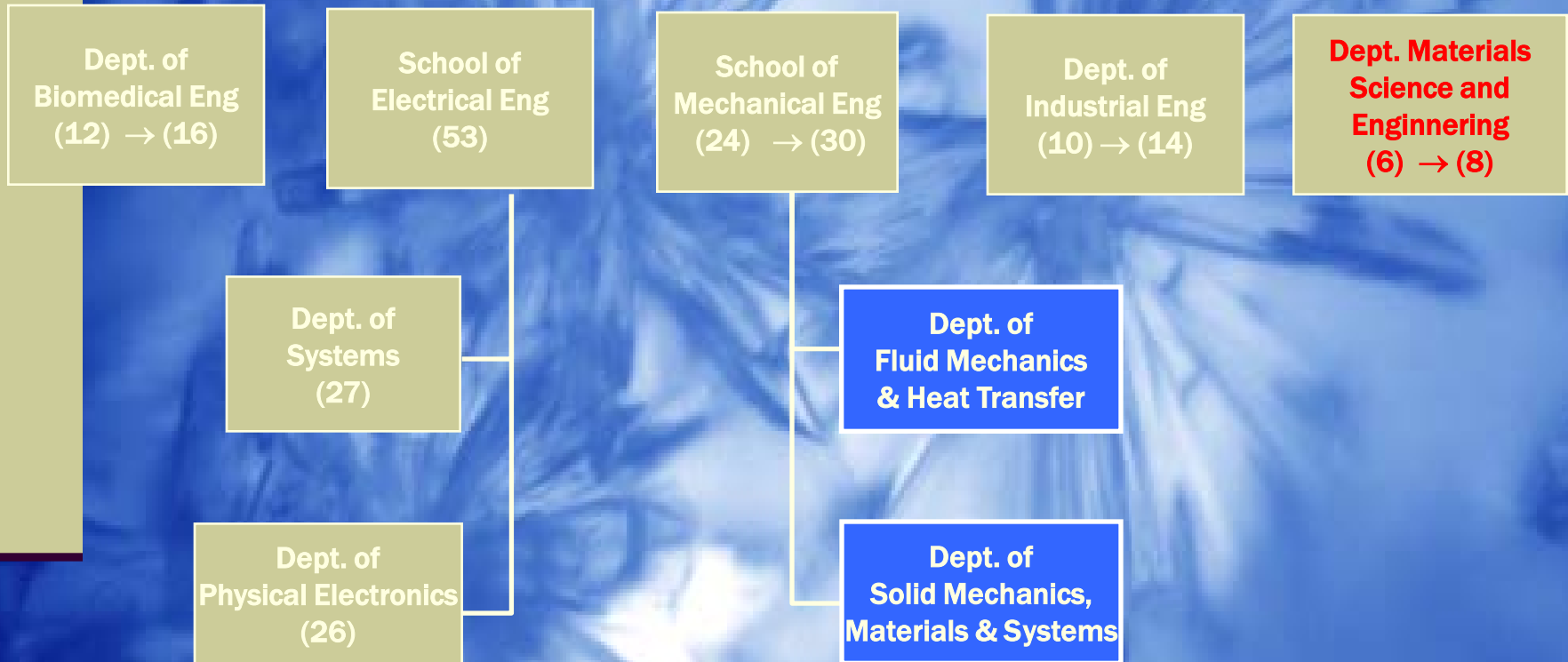
**TEMPUS MMATENG Project Consortium
Meeting, Tel-Aviv University,
November 3rd, 2014**

Tel-Aviv University in Brief: Excellence in Research

- Israel's largest and most diverse institution of higher education
- About 29,000 students
- 14,000 graduate students
- 1,000 faculty members
- Nine faculties
 - Medicine
 - Life sciences
 - Exact sciences
 - Engineering
 - Law
 - Business
 - Humanities
 - Social sciences
 - Arts
- 126 schools and departments



Faculty Structure

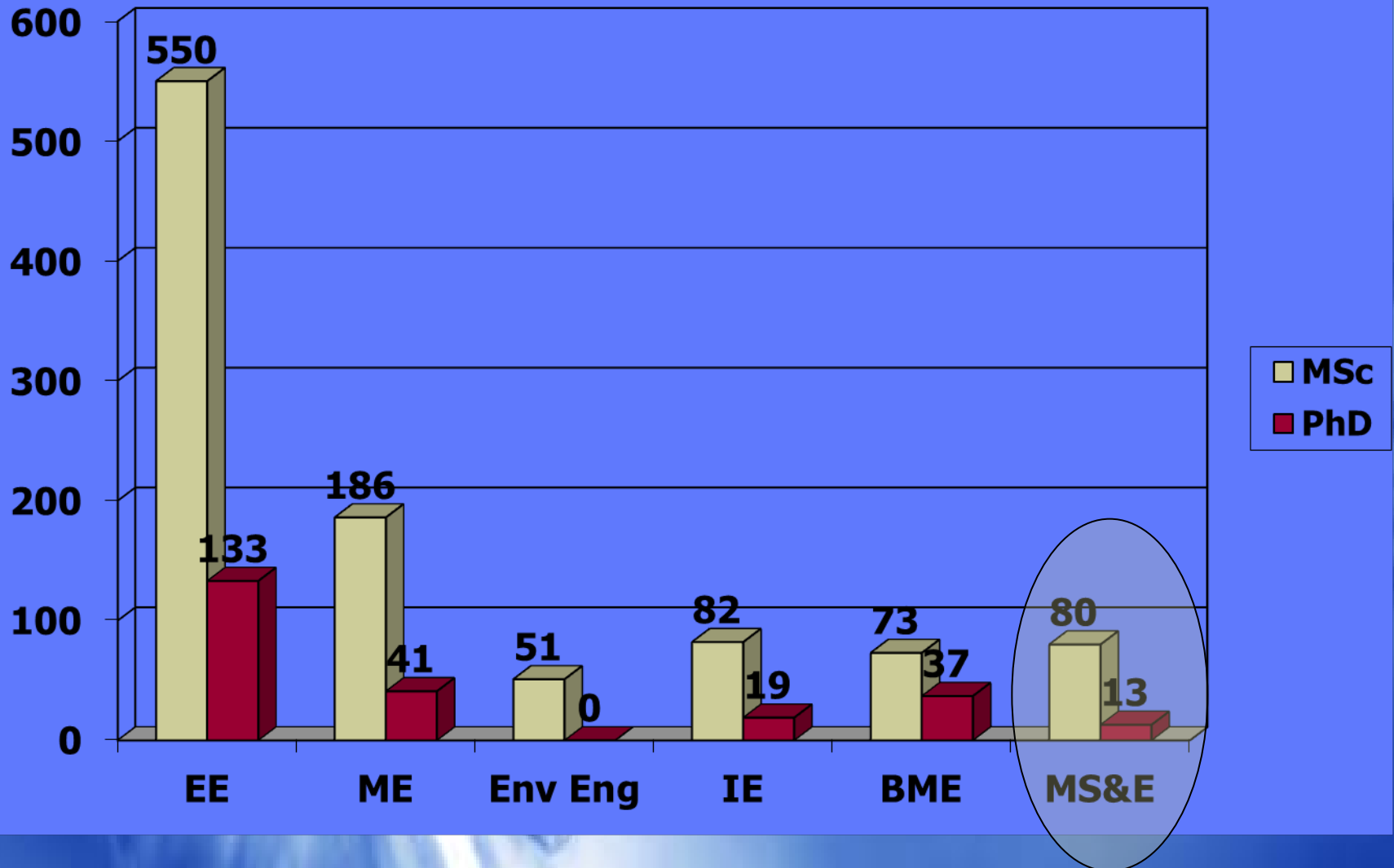


Numbers in parenthesis = Faculty members

Total: 105 Faculty Members → 120

Graduate Programs

(~ 1020 M.Sc. ~210 Ph.D. 21 Postdocs)



Historical Perspective

- Founding of the Wolfson Applied Materials Research Center (1994)
- Launching of the Materials Science and Engineering Program (2002)
- Launching of the Materials and Nanotechnologies Program (2009)
- Founding of the Department of Materials Science and Engineering (2013)
- Launching of the Materials Science and Engineering program for graduate studies (2014)
- Launching of the undergraduate combined program in Materials Science and Engineering and in Chemistry (2014)



The mission of the DMS&E

- To conduct cutting-edge research in MS&E, thus gaining international reputation and collaborations
- To become a center of excellence within Tel-Aviv University for education and R&D in MS&E
- To support the Israeli industry, government and defense organizations, either by R&D or by consultation services
- To educate world class engineers that will lead the next technological breakthroughs. The DMS&E fills a national strategic need by operating the only focused MS&E academic programs in the Center of Israel, close to many relevant companies, research centers, government and defense organizations

The strengths of the DMS&E

- The Core and Affiliated Faculty are world leaders in their research fields and have won many prestigious international awards
- The unique diversity of departments at Tel-Aviv University and the institutional spirit encourage multidisciplinary R&D projects
- Young and vibrant department where students will learn in a warm and supportive environment
- The curriculum was carefully planned and constructed with reference to curricula in leading institutions in the field worldwide
- The School of Chemistry, with which the B.Sc. Program was constructed, is internationally acclaimed and is known for excellence both in teaching and in research

The strengths of the DMS&E – Contd.

- Education of students for excellence and many achievements. Graduate students advised by our faculty have won several prestigious awards such as the Israel Security Award, Chief of Staff Award, Promotion of Women in Science Award, SAMPE Israel, outstanding presentations at international conferences, etc.
- Most of the DMS&E faculty have been collaborating with industry and defense organizations and contributing to the development of technologies and products that have an impact on homeland security, health, environment, and economy
- Close vicinity to industrial companies, defense organizations and R&D centers

Our People – Going Multidisciplinary!

DMS&E Core Faculty



1. Prof. Noam Eliaz, DMS&E Chair
2. Prof. Ilan Goldfarb
3. Assoc. Prof. Shachar Richter
4. Dr. Oswaldo Dieguez
5. Dr. Ariel Ismach
6. Dr. Brian A. Rosen



Two more core faculty will be recruited in the coming 2-3 years
(First priorities: analytical transmission electron microscopy and crystallography,
physical/mechanical metallurgy, advanced polymers/ceramics/composites)



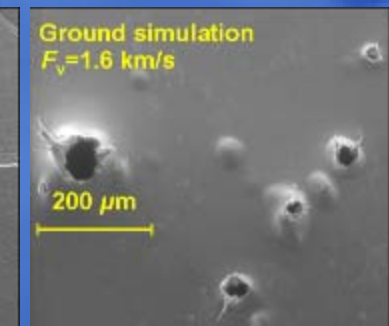
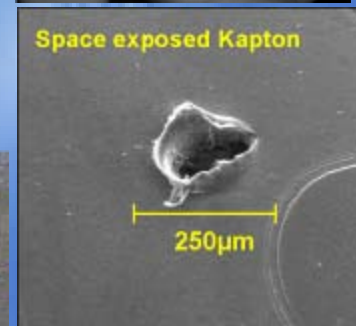
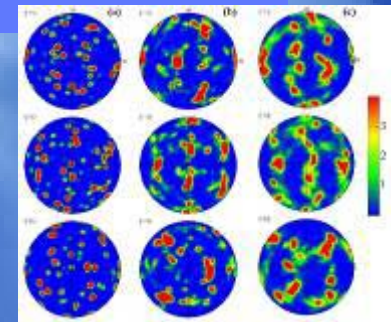
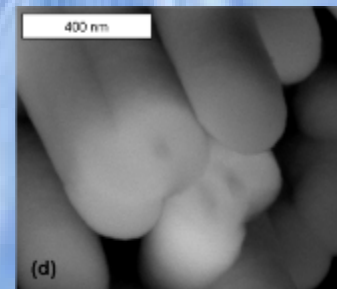
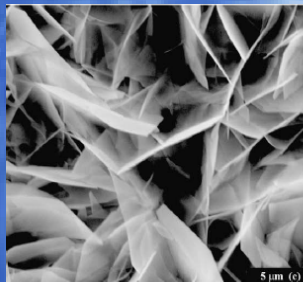
Prof. Noam Eliaz

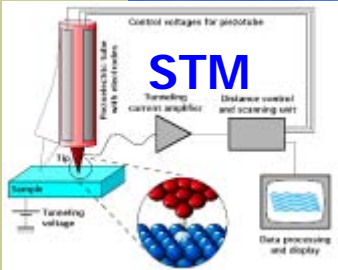
neliaz@eng.tau.ac.il

<http://www.eng.tau.ac.il/~neliaz/>



- Electrocrystallization of hydroxyapatite and other calcium phosphates for orthopedic and dental implants.
- Bio-Ferrography (osteoarthritis, efficacy of drugs, wear of artificial implants, cancer).
- Electroless and electroplating of rhenium-based alloys.
- Materials durability in space-simulating environments
- Corrosion in different environments (e.g. aircraft, navy, nuclear reactors, *in vivo*)
- Failure analysis





Real lattice imaging in real time

(Scanning Tunneling Microscopy, STM)

Objectives: tailoring desired properties in **self-assembled functional nanostructure arrays** (quantum dots and wires, nano-contacts, nano-magnets, etc.)

Tools of Surface Science:

- Scanning Tunneling Microscopy (STM)
- Scanning Tunneling Spectroscopy (STS)
- Atomic Force Microscopy (AFM)
- Property measurements (magnetic, electronic, etc.)

Prof. Ilan Goldfarb

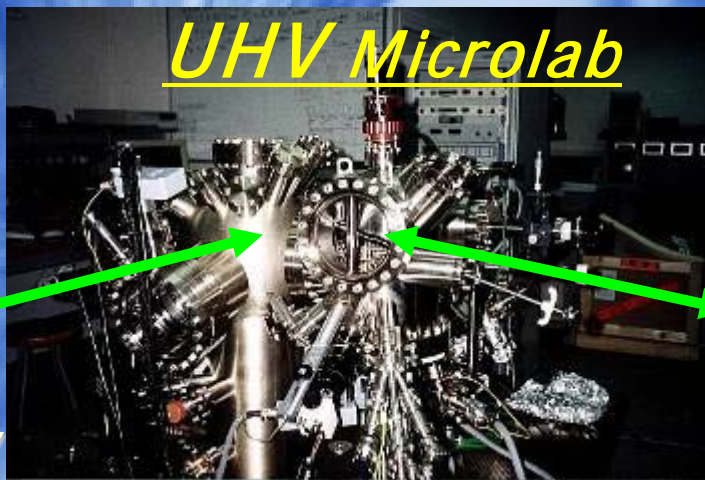
Surface Science & Nanostructures Lab

ilang@eng.tau.ac.il

<http://www.eng.tau.ac.il/~ilang/>



UHV Microlab

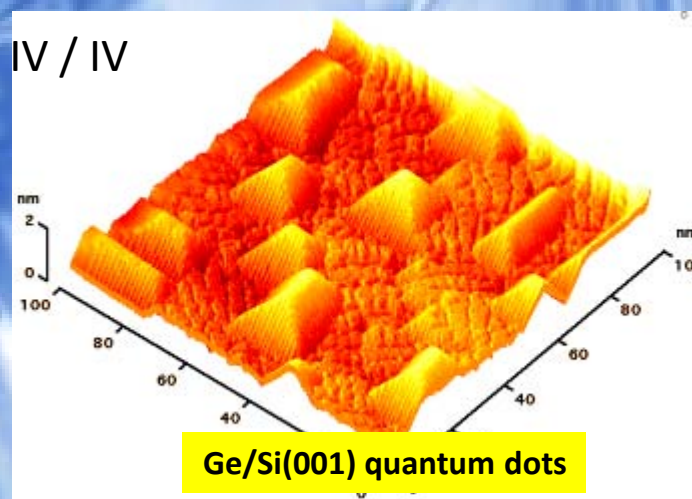
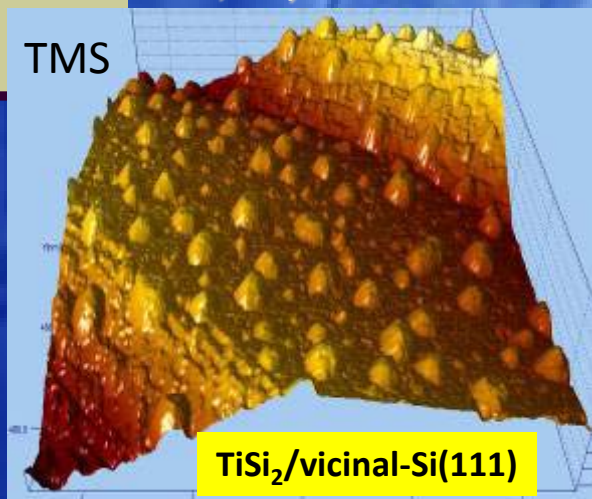


Means: Molecular Beam Epitaxy (MBE) in Ultra-High Vacuum (UHV) on **self-organized surfaces**

Tools of Surface Science:

- Reflection High-Energy Electron Diffraction (RHEED)
- Low Energy Electron Diffraction (LEED)
- Auger Electron Spectroscopy (AES)
- X-ray Photoelectron Spectroscopy (XPS)

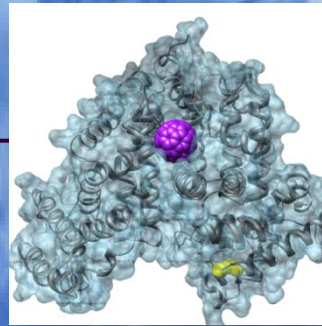
Examples



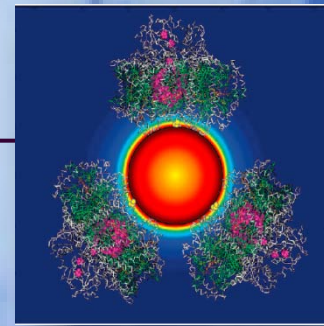
Assoc. Prof. Shachar Richter

The Bio- and Molecular-Electronics Group

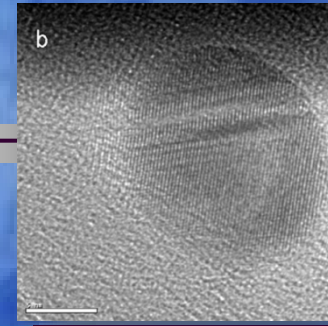
<http://www.tau.ac.il/~srichter/>



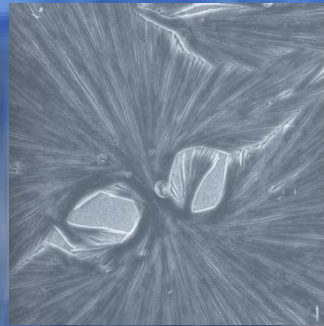
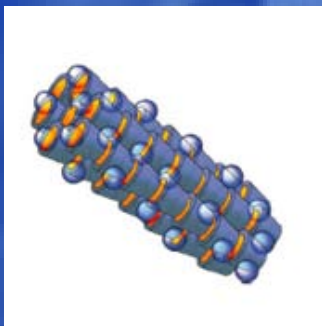
Deterministic doping



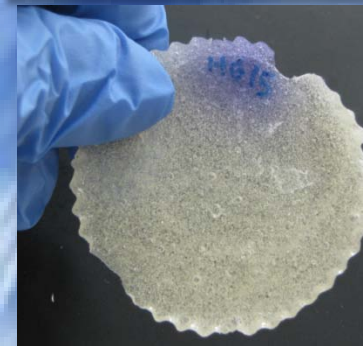
Molecular Plasmonics



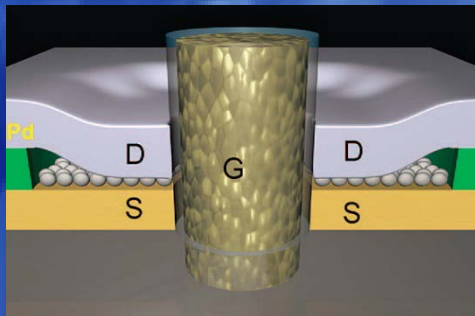
Nano chirality



Multi -hierarchy self Assembly



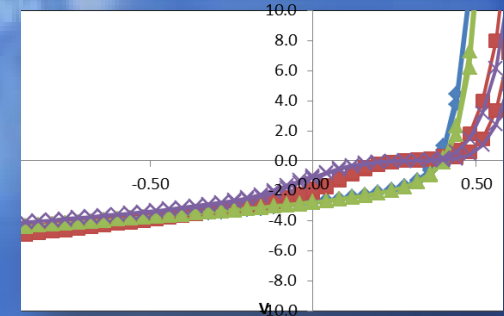
"Smart" nano-biocomposites



Molecular and Bio Transistors



Optoelectronics



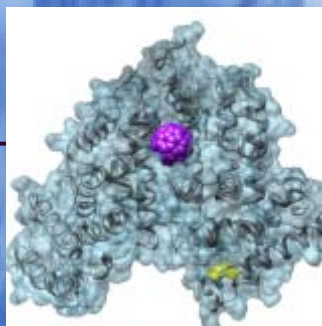
Solar Cells



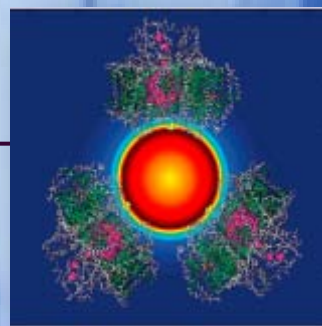
Assoc. Prof. Shachar Richter
 srichter@post.tau.ac.il

The Bio- and Molecular-Electronics Group

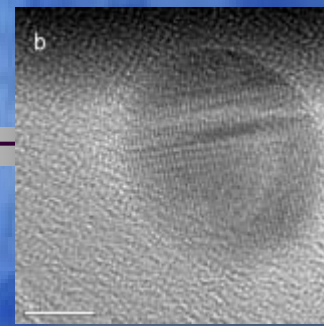
<http://www.tau.ac.il/~srichter/>



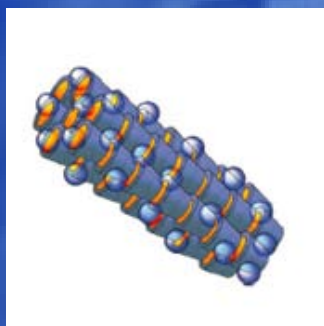
Deterministic doping



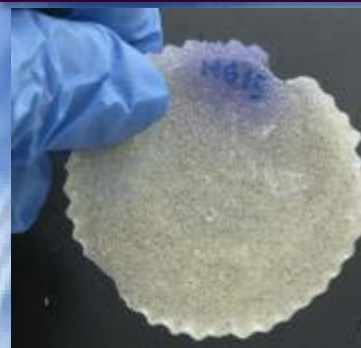
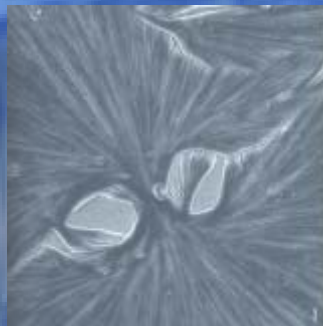
Molecular Plasmonics



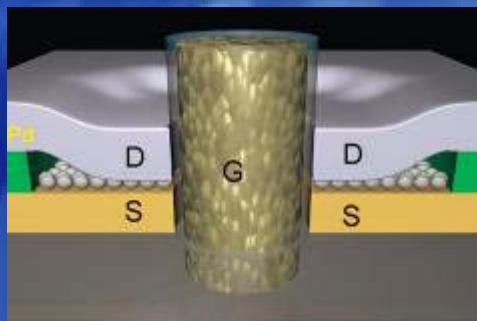
Nano chirality



Multi -hierarchy self Assembly



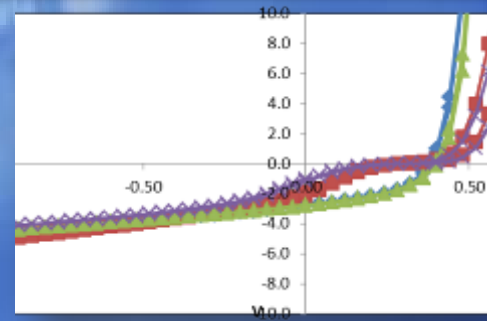
"Smart" nano-biocomposites



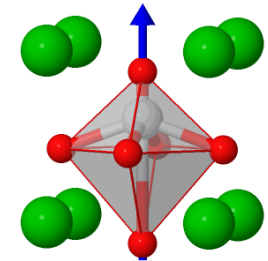
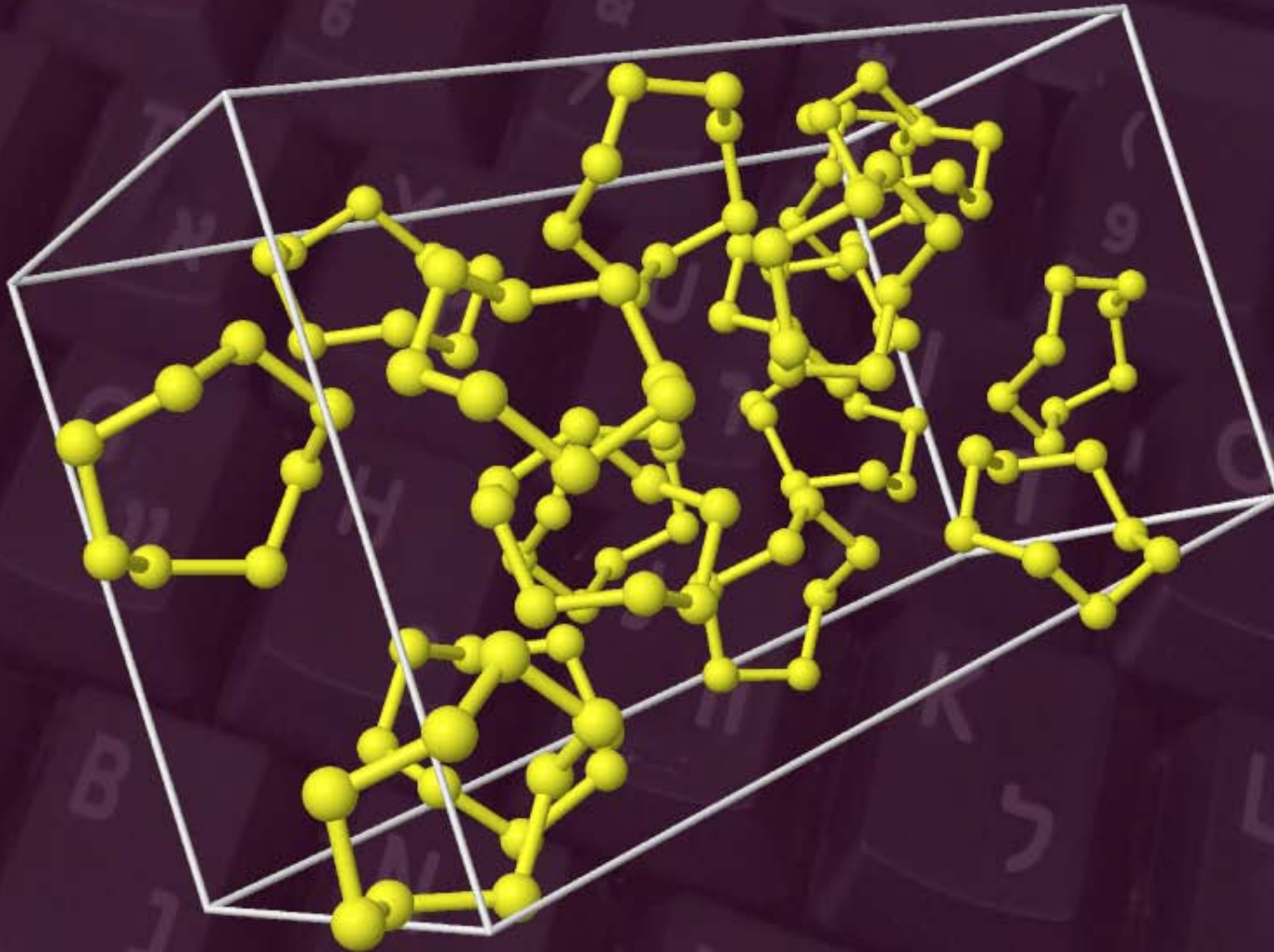
Molecular and Bio Transistors



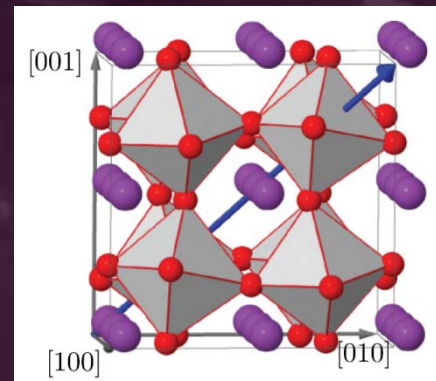
Optoelectronics



Solar Cells



$a = 3.890 \text{ \AA}$
c phase



Atomistic Simulation of Materials Group

Researching the properties of materials by using computer simulations

FELLOWSHIPS AND RESEARCH PROJECTS AVAILABLE: dieguez@tau.ac.il

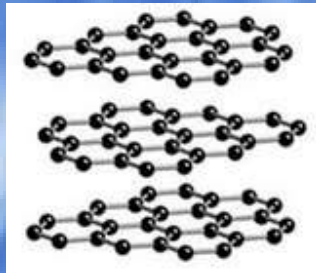
<http://www.eng.tau.ac.il/~dieguez/>

Dr. Ariel Ismach
2D Atomic-Films Lab
aismach@post.tau.ac.il
<http://www.eng.tau.ac.il/~aismach/>

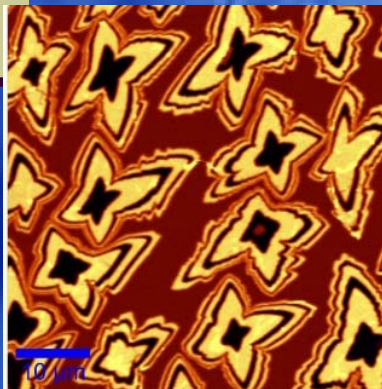
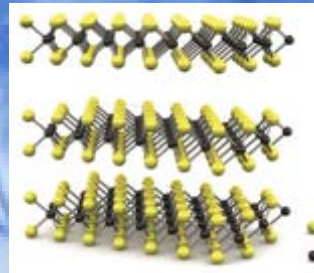


- Synthesis of 2D atomic-films
- Structure-properties correlation
- Electronic and chemical property control

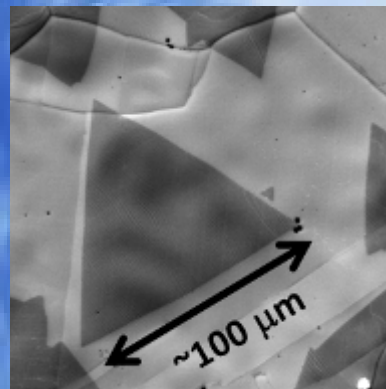
Graphite



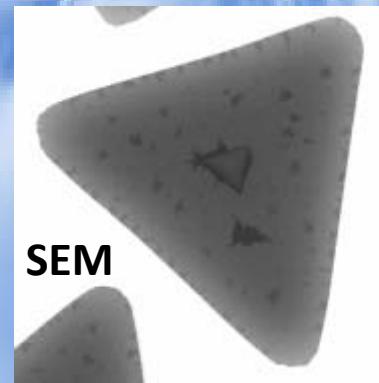
MoS₂



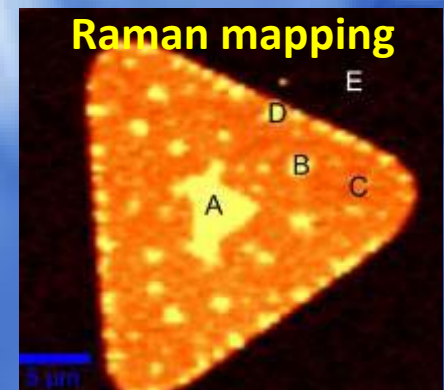
Graphene domains



Single-crystal
h-BN domain



MoS₂





ENERGY MATERIALS LABORATORY

מעבדה לחומרי אנרגיה • אוניברסיטת תל אביב



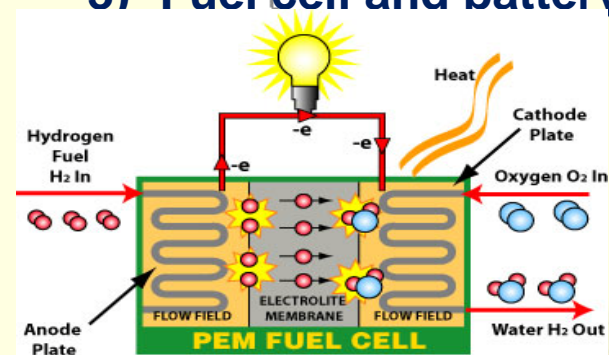
Dr. Brian Rosen

barosen@post.tau.ac.il

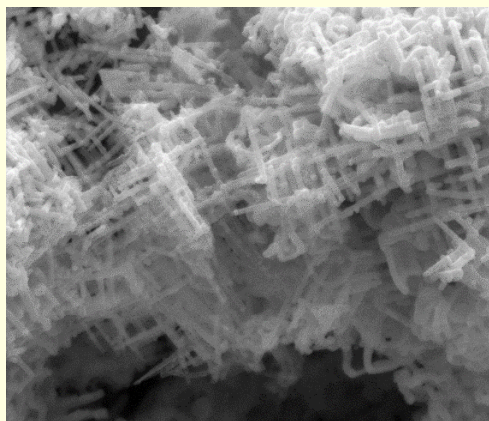
<http://www.tau.ac.il/~barosen/>

Ongoing Research Projects:

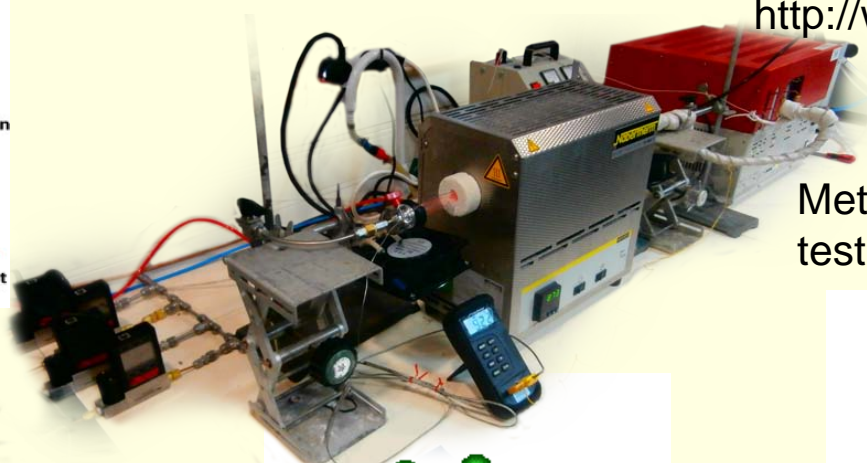
- 1) Catalytic materials for methane gas-to-liquid (GTL) technology
- 2) Binary and Ternary surfaces for oxygen reduction reaction
- 3) Fuel cell and battery electrode materials



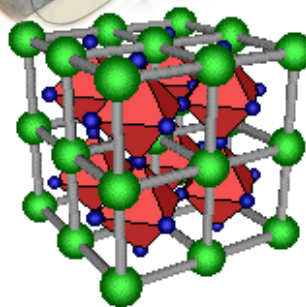
Materials for improved fuel cell operation



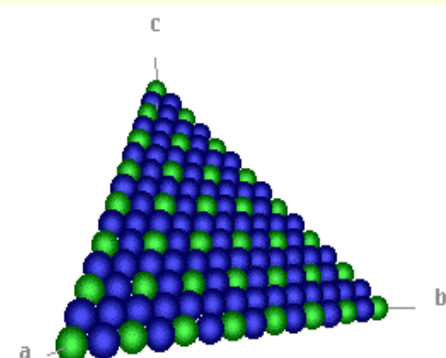
Ni doped Re-Sn nanowires for Methane GTL



Methane (GTL) Conversion testing apparatus



Customizable ABO_3 materials for CH_4 and O_2 conversion



(111) plane of Perovskite catalyst

Our People – Going Multidisciplinary!

DMS&E 11 Affiliated Faculty

Biomed Eng

Meital Zilberman

Mech Eng

Rami Haj-Ali

Electrical Eng

Yossi Rosenwaks

Yosi Shacham

Physics

David Andelman

Yoram Dagan

Enabling Technology

Chemistry

Gil Markovich

Fernando Patolsky

Molecular Microbiology and Biotechnology

Ehud Gazit

Tal Dvir

Cell Research and Immunology

Dan Peer

* In blue text: members of the DMS&E Founding Committee

DMS&E International Advisory Board

- 1) **Distinguished Professor Dan Shechtman**,
Faculty of Materials Science and Engineering, Technion, ISRAEL.
Web: <http://materials.technion.ac.il/dan-shechtman-quasi-crystals-nobel>
Research interests: Quasicrystals, electron microscopy, rapidly solidified alloys.
Awards: **2011 Nobel Prize in Chemistry**; 1999 Wolf Prize in Physics; member of the American National Academy of Engineering, the European Academy of Sciences, and the Israel Academy of Sciences.
- 2) **Professor Joanna Aizenberg**,
School of Engineering and Applied Sciences, Harvard University, USA.
Web: <http://aizenberglab.seas.harvard.edu/index.php>
Research interests: Biomimetic inorganic materials synthesis, self-assembly, nanofabrication, biooptics, biomaterials, biomechanics.
Awards: Fellow of the American Physical Society; R&D 100 Award for Top Technology and Innovation (2012 & 2013).
- 3) **Institute Professor Robert S. Langer**,
Department of Chemical Engineering, MIT, USA.
Web: <http://web.mit.edu/langerlab/>
Research Interests: Tissue engineering, drug delivery.
Awards: 2013 Wolf Prize in Chemistry; 2002 Charles Stark Draper Prize; 2008 Millennium Prize; 2005 Dan David Prize; the most cited engineer in history; member of the American National Academy of Engineering, and the American National Academy of Sciences.

4) **Professor Charles M. Lieber,**

Department of Chemistry and Chemical Biology, Harvard University, USA.

Web: <http://cmliris.harvard.edu/>

Research interests: Nanotechnology – from biology/medicine to energy

Awards: 2012 Wolf Prize in Chemistry; 2013 Willard Gibbs Medal; member of the American National Academy of Sciences and the American Academy of Arts and Sciences; #1 in Top 100 Chemists (Web of Knowledge)

5) **Professor Ke Lu,**

Institute of Metal Research, Chinese Academy of Sciences, CHINA.

Web: <http://lu-group.imr.ac.cn>

Research interests: Nanostructured metals and alloys.

Awards: Distinguished Visiting Fellow of the Royal Academy of Engineering UK; member German National Academy of Sciences Leopoldina, Third World Academy of Sciences, and the Chinese Academy of Sciences; MRS Fellow.

6) **Professor Christine Ortiz,**

Department of Materials Science and Engineering & Dean for Graduate Education & founding and faculty Director – MISTI MIT-Israel Program, MIT, USA.

Website: <http://web.mit.edu/cortiz/www/>

Research interests: Structural or load-bearing biological materials, nanomechanics.

Awards: NSF Presidential Early Career Award for Scientists and Engineers.

7) **Professor Baldev Raj,**

President of the Indian National Academy of Engineering, INDIA.

Web: http://www.inae.in/president_inae.html

Research interests: Non-destructive evaluation (NDE), materials in energy systems, fast breeder reactor science and technology, materials characterization and performance.

Awards: Presidential honor Padma Shri; 2012 Homi J Bhabha Gold Medal Award from the Prime Minister of India; member of the Indian Academy of Sciences, the Indian National Academy of Engineering, the Third World Academy of Sciences, and the German Academy of Sciences.

8) **Professor David N. Seidman,**

Department of Materials Science and Engineering, Northwestern University, USA.

Web: <http://www.matsci.northwestern.edu/people/faculty/profiles/david-n-seidman.html>

Research interests: Interfacial phenomena on the atomic scale, Atom-Probe Tomography (APT), physical metallurgy.

Awards: Member of the American Academy of Arts and Sciences and the American Association for the Advancement of Science; Fellow MRS, Sackler (Tel-Aviv University), Microscopy Society of America, ASM International, TMS, and APS.

9) **Professor Knut W. Urban,**

Director of the Institute for Microstructure Research at Research Centre Juelich, GERMANY.

Web: http://en.wikipedia.org/wiki/Knut_Urban

Research interests: High-resolution transmission electron microscopy, electro ceramics, quasicrystals, intermetallic phases.

Awards: 2011 Wolf Prize in Physics; former President of the German Physical Society (DPG, 2004-6).

10) **Professor David Vanderbilt,**

Department of Physics and Astronomy, Rutgers – The State University of New Jersey, USA.

Web: <http://www.physics.Rutgers.edu/~dhv/>

Research interests: Computational materials science, novel oxide materials.

Awards: Member of the American National Academy of Sciences; Fellow APS.

11) **Professor Karen I. Winey,**

Department of Materials Science and Engineering, University of Pennsylvania, USA.

Web: <http://winey.seas.upenn.edu/>

Research interests: Polymer nanocomposites reinforced with carbon nanotubes and metal nanowires, ion-containing polymers.

Awards: Fellow APS, MRS.

International scholars at TAU (partial list)

- Dr. Brian Rosen (USA), Fulbright & Nanocenter postdoctoral scholar (Eliaz)
- Dr. Wangping Wu (China), Pikovsky Valazzi postdoctoral scholar (Eliaz)
- Dr. T.M. Sridhar (India), Pikovsky Valazzi postdoctoral scholar (Eliaz)
- Dr. J.K. Tripathi (India), Nanocenter postdoctoral scholar (Goldfarb)
- Federico Cesura (Italy), PhD student (Goldfarb)
- Dr. Pankaj Poddar (India), postdoctoral scholar (Markovich)
- Dr. Xingkun Man (China), postdoctoral scholar (Andelman)
- Dr. Simon Villain (France), postdoctoral scholar (Andelman)
- Dr. Roland Netz (Germany), postdoctoral scholar (Andelman)
- Dr. Supidta Mondal (India), postdoctoral scholar (Gazit)

All graduate courses are given in English if the attendees include non-Hebrew speakers!

Infrastructures at Tel Aviv University: The Wolfson Applied Materials Research Center (WAMRC)

<http://www.tau.ac.il/institutes/wamrc/>



Director: Prof. Ilan Goldfarb

Mission : State-of-the art
materials characterization for
academia & industry



Infrastructures at Tel Aviv University: Center for Nanoscience and Nanotechnology

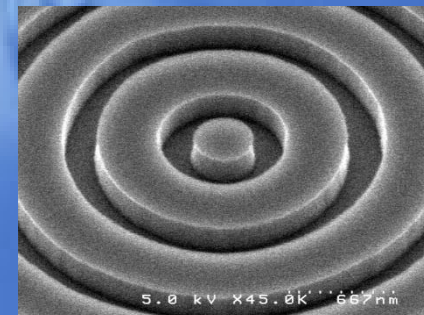
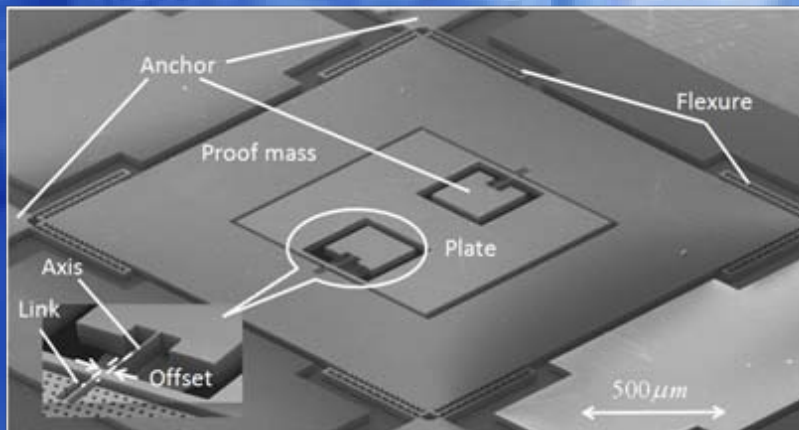
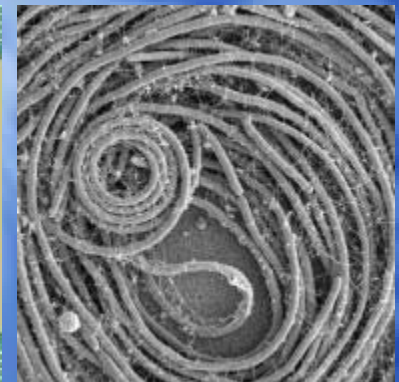
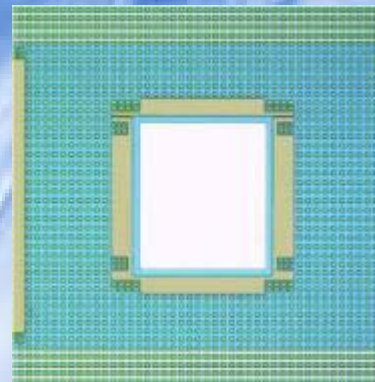
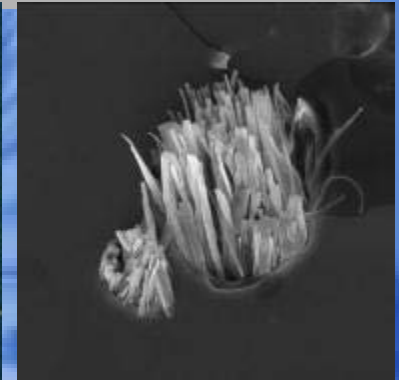
<http://nano.tau.ac.il/>

Director: Prof. Yael Hanein

Scope of activities

First center in Israel

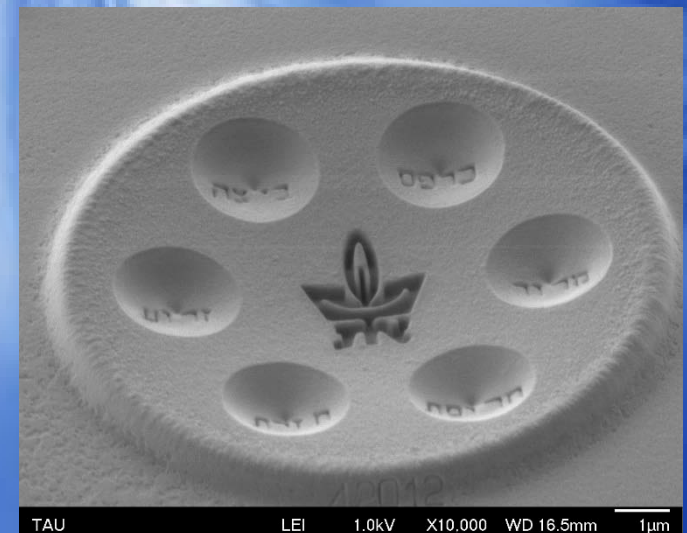
- Nanomaterials
- Nanomedicine
- Nanophotonics
- Bio interfacing



Infrastructures at Tel Aviv University: The Micro & Nano Fabrication Facility

<http://nano.tau.ac.il/mncf/>

- A multimillion \$\$ 150 m² class 1000 clean room (class 100 in selected locations), and a wet chemical fabrication laboratory.
- Especially suited for silicon Micro-Electro-Mechanical-System (MEMS) and Optical MEMS (MOEMS) R&D.
- Serves as a central R&D process and characterization hub for a number of Consortia, and some leading MEMS and MOEMS companies.



The Center for Renewable Energy

<http://energy.tau.ac.il>

Head: Prof. Yossi Rosenwaks

Scope of activities

Solar, Wind, Thermal, Biomass
Energy storage and management
Energy Policy, Law, Economics

Facts and Figures

55 Faculty members from 7 faculties
135 Energy Ph.D. Students
162 Energy M.Sc. Students
950 Scientific Journal publications (2007-2011)
170 Patents & patent applications
\$13,500,000 in competitive grants (2007-2011)

Breakthroughs

Micro-Batteries: Developed miniature 3D Batteries on chip with world record power density
Fuel cells: Hydrogen tribromide world record regenerative fuel cell
Solar cells: Development of dry photovoltaic cells based on photosynthetic proteins



BSc Program Design

Oxford

MIT

Technion TAU

...

	A	B	C	D	E	F
124						
125		6.001 Structure and Interpretation of Computer Programs (5+3)	Fortran (4.0)		Programming 05091821, 3	
126	Characterisation of materials or Materials modelling mod	3.021J Introduction to Modeling and Simulation (4)	Computer Applications in Materials Eng., 2.0		Matlab for Engineers 05092935, 3	
127	IT skills	1.00 Introduction to Computers and Engineering Problem Solving (5+1)			Introduction to Finite Elements 05424223, 3.5(?)	
128						
129	Engineering drawing classes				Computer Aided Drafting 05091514, 1.5	
130						
131	Thermodynamics & Kinetics	3.046 Thermodynamics of Materials, 12(4)	Thermodynamics of Materials (4.0)		Thermodynamics 1, 05422600, 4 (overlaps chemistry)	
132					Thermodynamics 2, 05424120, 3.5	
133	Ternary Phase Diagrams	3.14 Physical Metallurgy, 12(3)				
134						
135						
136			Transformation Kinetics in Materials (2.5)		add physical metallurgy	
137						
138	Structure and transformation of materials	3.012 Fundamentals of Materials Science and Engineering (5)	Structure and Properties of Materials 1 (2.5)		Introduction to Materials Science and Engineering 05421830, 4	
139	Origins and Stability of Microstructure	3.022 Microstructural Evolution in Materials (3+3)	Structure and Properties of Materials 2 (2.5)			
140	Advanced Microstructural Characterisation of Materials	3.024 Electronic, Optical and Magnetic Properties of Materials (3+3)	Symmetry Elements (2.5)			
141	Characterisation of materials or Materials modelling mod	3.071 Diffraction and Structure, 12	Structure and Composition characterization (3.5)		Structure and Characterization of Materials - move from MSc	
142	Tensor Properties of Materials	3.072 Symmetry, Structure, and Tensor Properties of Materials, 12(4)	Elements of Crystallography, 2.0		add crystallography	
143	Crystallography classes					
144	Introduction to Materials Structure					
145	Crystallography & Diffraction					
146	Microstructure of Materials					
147						
148	Phase Transformations & Diffusion		Diffusion in Solids (2.5)			
149						
150	Mechanical properties					
151	Fracture & Fatigue					
152	Strength & Failure of Materials	3.032 Mechanical Properties of Materials (4+2)	Mechanical Behaviour of Materials (3.5)		Mechanical Behavior of Materials 05424720, 3.5	
153	Elastic Behaviour in Isotropic Materials		Introduction to Solid Mechanics (2.5)		Mechanics of Solids 1, 05422200, 3.5	
154	Microplasticity				Mechanics of Solids 2, 05422300, 3.5	
155	Creep				Mechanical Design 05422400, 3	
156	Macroplasticity & Mechanical Working Processes					
157	Fracture					
158	Elasticity & Structures					
159	Mechanical Properties				Introduction to Theory of Elasticity 05424221, 3.5	
160						
161						
162						
163	Semiconductor Devices				Basic Electronics 05121202, 4.5	
164	Materials For Nanoscale Information Storage				Introduction to Semiconductor Physics 05122507, 3.5	
165	Structural and Functional Nanomaterials (double option)					
166	Materials & Devices for Information Technology	3.155J Micro/Nano Processing Technology, 12(3+4)	Materials for Micro-Mechanical Systems (MEMS), 2.0		Introduction to Micro-Electro-Mechanical Systems 05124702, 3.5	
167	Electronic properties of materials	3.153 Nanoscale Materials, 12(4)			Nano and Micro-Technologies of Integrated Electronic Systems 04553041	
168	Semiconductor Device Fabrication		Processes in Microelectronics, 2.5		Microelectronics 05124700, 3.5	
169	Optoelectronic Devices		Properties of Electronic Materials (2.5)			
170	Electronic Structure of Materials		Reliability of Microelectronic Devices, 2.5		Solid State Devices 05124704, 3.5	
171	Semiconductor Materials	3.15 Electrical, Optical, and Magnetic Materials and Devices, 12(4)	Semiconductor Devices (for Materials Eng.), 2.5		Electronic Devices 05122508, 5	
172	Electrical & Optical Properties of Materials				Electromagnetic Fields 05122525, 3.5	
173	Electrical & Magnetic Properties					
174	Magnetic Properties of Materials					
175						
176	Polymer Synthesis					

The Combined BSc Program in MS&E and in Chemistry

Semester 1 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
6	7		2	5	From Math		Linear Algebra	0509-1824
5	6		2	4	From Math		Calculus 1b	0509-1846
5	6		2	4	Prof. Alex Gerber (Physics)		Physics 1	0509-1826
7	7		2	5	Dr. Amir Goldburt		General Chemistry 1	0351-1105
4	4		1	3	Prof. Kedma Bar-Eli		General Chemistry 2	0351-1110
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30 hours, 27 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 2 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
5	5		2	4	From Math	Calculus 1b	Calculus 2b	0509.1847
5	6		2	4	Prof. Alex Palevsky (Physics)	Physics 1	Physics 2	0509-1829
1	2	2					Physics Lab	0509-1834
3	3		1	2	Prof. Michael Aurbach	General Chemistry 1,2	Kinetics	0351-1825
7	7	7			Prof. Kedma Bar-Eli		Chemistry Laboratory 1	0351-1108
3	3		1	2	Prof. Yoel Kashman		Introduction to Organic Chemistry	0351-1109

27 hours, 24 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 3 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
3.5	4		1	3	From Math	Calculus 1b, Linear Algebra	Ordinary Differential Equations	0509-1845
3.5	4		1	3	From Math	Calculus 2b, Linear Algebra	Introduction to Probability and Statistics	0509-2805
3.5	4		1	3	Prof. Ilan Goldfarb	Chemistry 1,2	Introduction to Materials Science and Engineering	0581-2111
0.5	1	1			Prof. Ilan Goldfarb, Prof. Noam Eliaz, Prof. Shachar Richter, Prof. Ariel Ismach	Simultaneously: Introduction to MSE	Introduction to Materials Science and Engineering – Laboratory	0581-2132
2	2			2	External		English Technical Writing	0509-2192
6	6		2	4	Prof. Haim Diamant	Year 1 courses, except labs	Thermodynamics	0351-2202
5	5		1	4	Prof. Shlomo Rosen	Chemistry 1,2, Introduction to Organic Chemistry	Organic Chemistry 1	0351-2304

26 hours, 24 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 4 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
3	4		2	2	Yoav Ram, Noga Levi		Programming - Paython	0509-1820
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3.5	4		1	3	Dr. Amiram Moshaiov (ME)	Ordinary Differential Equations, Physics 1	Mechanics of Solids	0555-2407
6	6		1	5	Prof. Oded Hod	Thermodynamics, Kinetics	Quantum Mechanics and the Chemical Bond	0351-2206
4	4	4			Dr. Yoram Selzer, Dr. Yael Roichman	Year 1 courses, Thermodynamics, Kinetics	Physical Chemistry Laboratory	0351-2210
5	5		1	4	Prof. Haim Diamant	Organic Chemistry 1	Organic Chemistry 2	0351-2305
3.5	4		1	3	Dr. Alon Bahabad	Physics 2	Introduction to Semiconductor Physics	0581-2191

27 hours, 25 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 5 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
2.5	3		1	2	Dr. Yuli Idelman	Ordinary Differential Equations	Partial Differential Equations	0509-3193
1	2			2	Prof. Dan Hupert		Horizons in Chemistry	0351-3110
2	2			2	Dr. Amiram Moshaiov (ME)	Ordinary Differential Equations, Physics 1	Introduction to Electrochemical Methods and their Applications in Materials for Energy Systems	0581-5271
2	2			2	Dr. Oswaldo Dieguez	Introduction to Probability and Statistics	Design of Experiments	0581-3191
3.5	4		1	3	Dr. Oswaldo Dieguez	Introduction to Semiconductors Physics	Materials Science	0581-3121
3.5	4		1	3	Prof. Ilan Goldfarb	Introduction to MSE	Physical Metallurgy	0581-3111
3	3			3	Prof. Shachar Richter	General Chemistry 1, Introduction to MSE	Polymers	0581-3112
3	3			3	New recruit	General Chemistry 1, Introduction to MSE	Ceramics	0581-3113
0.5	1	1			Prof. Ilan Goldfarb, Prof. Noam Eliaz, Prof. Shachar Richter, Prof. Ariel Ismach	Introduction to MSE	Engineering Materials Laboratory	0581-3131

24 hours, 21 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 6 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
5	6		2	4	Prof. Michael Margaliot	Ordinary Differential Equations, Physics 2	Introduction to Electrical Circuits	0512-1201
8	8	8			Prof. Michael Gozin, Prof. Moshe Portnoy, Prof. Doron Shabath	Organic Chemistry 1, Chemistry Lab 1	Organic Chemistry Laboratory	0351-2302
5	5		1	4	Dr. Azam Abdousalam	Organic Chemistry 1. Recommended: Chapters in Cell Biology, Organic Chemistry 2 (simultaneously)	Biochemistry for Chemistry Students	0351-2809
3.5	4		1	3	Prof. Ilan Goldfarb	Introduction to MSE OR Solid Mechanics 1	Mechanical Behavior of Materials	0581-3181
4	5		2	3	Dr. Oswaldo Dieguez	Introduction to MSE, Materials Science	Computer Assisted Modeling and Design of Materials	0581-3122
2.5	3		1	2	New recruit	Introduction to MSE, Partial Differential Equations	Diffusion in Solids	0581-3123
1.5	3	3			Prof. Shachar Richter, Dr. Ariel Ismach	Introduction to MSE, Materials Science	Laboratory in Advanced Techniques for Material Characterization	0581-3132 ***

31-34 hours, 28-29.5 credits

*** Either this course + 3 h extra elective course OR Advanced Lab in Physical Chemistry (semester 8)

The Combined BSc Program in MS&E and in Chemistry

Semester 7 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
2	2			2			Core Program 1 (www.core.tau.ac.il)	
2	2			2	Dr. Yoram Selzer	Quantum Mechanics and the Chemical Bond	Applications of Spectroscopy	0351- 3208
3	3			3	Prof. Noam Eliaz	Chemistry 1,2, Introduction to MSE	Corrosion Engineering	0581-4311
3.5	4		1	3	New recruit	Partial Differential Equations, Diffusion in Solids	Momentum, Heat and Mass Transfer	0581-4121
2.5	3		1	2	New recruit	Introduction to MSE	Composite Materials	0581-4112
3	3			3	New recruit	Introduction to MSE, Physical Metallurgy	Manufacturing Processes for Engineering Materials 1	0581-4113

17 hours, 16 credits

The Combined BSc Program in MS&E and in Chemistry

Semester 8 (Compulsory)

Credits	H	Lab	Ex	Lec	Lecturer	Prerequisites	Title	Course #
2	2			2			Core Program 2 (www.core.tau.ac.il)	
6	6	6			Prof. Uzi Even, Prof. Ori Cheshnovsky	Physical Chemistry Lab 1, Kinetics, Thermodynamics, Quantum Mechanics and Chemical Bond, EITHER Quantum Chemistry OR Statistical Thermodynamics	Advanced Laboratory in Physical Chemistry	0351-3206 ***
3	3			3	Prof. Israel Goldberg	Kinetics, Thermodynamics, Quantum Mechanics and Chemical Bond,	Crystallographic Introduction to Structural Chemistry	0351- 3104
3	3			3	New recruit	Introduction to MSE, Physical Metallurgy, Manufacturing Processes for Engineering Materials 1	Manufacturing Processes for Engineering Materials 2	0581-4114
3	3			3	New recruit	Introduction to MSE	Materials Selection	0581-4115

11-17 hours, 11-17 credits

*** Either this course or the course Laboratory in Advanced Techniques for Material Characterization (semester 6) + 3 h extra elective course

Semester 9 (Compulsory)

12 hours, 12 credits

The Combined BSc Program in MS&E and in Chemistry

Semesters 6-9 (Elective Courses)

- Students should choose based, on their interest, 24-27 h elective courses from a list of 37 courses.
- These include: Smart materials, Failure analysis, Non-destructive testing, Materials for high-temperature applications, Friction and wear of materials, Scanning electron microscopy, Solid mechanics laboratory, Electronic devices, Technologies of micro- and nano-electronics, Basic electronics, Introduction to micro-electro-mechanical systems, Cellular biology, Biomaterials, Polymeric biomaterials, Cellular and tissue engineering, Cell and tissue mechanics, Hi-tech entrepreneurship, Statistical thermodynamics, Random walks in chemistry and biology, Introduction to chemical dynamics, quantum chemistry, Advanced methods in analytical chemistry, Laboratory in advanced methods in analytical chemistry, Laboratory in computational chemistry, Chemistry lab 2, Symmetry, Advanced inorganic chemistry, Applications of physical methods in organic chemistry, Fundamentals of electrochemical technology, Advanced laboratory in organic chemistry, Advanced organic chemistry, Carbohydrate chemistry, Spectroscopy, Magnetic Spectroscopy, Applications of NMR in organic chemistry, biochemistry and bio-medicine, Biochemistry of nucleic acids and molecular biology

The Materials Science and Engineering MSc Program

Compulsory Courses (9 hours)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
A + B	Prof. Shachar Richter		1	Joint Seminar	0581.5111
A	Prof. Alex Gelfgat (ME)	Complex Functions	3	Mathematical Methods in Engineering	<u>0540.5001</u>
A	Prof. Uri Shmueli (Chemistry)		2	X-Ray Crystallography	0581.5131
B	Prof. Shachar Richter		3	Introduction to Surface Science	0581.5121

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Surface Science and Computer Atomistic Simulations					
A	Dr. Oswaldo Dieguez		3	Atomistic Simulation of Materials	0581.5221
B	Prof. Ilan Goldfarb	Introduction to MSE	3	Processes at Single-Crystal Surfaces	0581.5222
Materials Engineering					
A	New Recruit (Prof. Isaac Garber, BGU)	Introduction to MSE, Mechanical Behavior of Materials	3	Friction and Wear of Materials	0581.5382
A	New Recruit (Dr. Chanan Gabai, IAF & Motorola)	Introduction to MSE, Mechanical Behavior of Materials, Corrosion Engineering (simultaneously)	3	Failure Analysis	0581.4381

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Materials Engineering					
A	Prof. Noam Eliaz	Chemistry 1,2, Introduction to MSE	3	Corrosion Engineering	0581.4311
A	New Recruit	Introduction to MSE, Mechanical Behavior of Materials	3	Materials for High-Temperature Applications	0581.5313
B	Dr. Ariel Ismach	Materials Science, Physics 2	3	Smart Materials	0581.5312
B	Prof. Rami Haj-Ali (ME)	Introduction to Elasticity Theory	3	Theory of Composite Materials	0540.6201

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Materials Characterization					
A	Dr. Zahava Barkay (WAMRC)		2	Scanning Electron Microscopy	0581.5332
A	Dr. Zahava Barkay (WAMRC)	SEM	1	Laboratory in Scanning Electron Microscopy	0581.5232
A	Dr. Yael Roichman (Chemistry)		2	Advanced Applications of Optical Microscopy	<u>0351.4611</u>
A	Dr. Yossi Lereah (WAMRC)		2	Transmission Electron Microscopy	0581.5233
A	Dr. Yossi Lereah (WAMRC)	TEM	1	Laboratory in Transmission Electron Microscopy	0581.5234
B	Prof. Yossi Rosenwaks (EE)		2	Nanoscale Characterization of Materials and Devices	<u>0510.7705</u>
B	Dr. Larisa Burstein (WAMRC)		2	Auger Electron Spectroscopy and X-Ray Photoelectron	0581.5235

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Materials Characterization					
B	Dr. Larisa Burstein (WAMRC)	AES/XPS	1	Laboratory in Auger Electron Spectroscopy and X-Ray Photoelectron	0581.5236
B	New recruit	Introduction to Probability and Statistics, Physics 2, Materials Science	4 (3)	Non-Destructive Testing (NDT)	0581.5331
Processes and Devices					
A	Prof. Yosi Shacham (EE)	Electronic Devices (recommended)	3	Technologies of Micro- and Nano-Electronics	0512.4700
A	Prof. Gil Rosenman (EE)	Electronic Devices	4 (3)	Solid State Devices	<u>0512.4704</u>
A	Prof. Emanuel Peled (Chemistry)		2	Fundamentals of Electrochemical Technology	<u>0351.3311</u>
B	Prof. Yael Hanein (EE)	Introduction to Physics of Semiconductors	4 (3)	Introduction to Micro-Electro-Mechanical Systems	0512.4702

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Nanosciences and Nanotechnologies					
A	Prof. Yael Hanein (EE)		2	Nanoelectronic Devices	<u>0510.7703</u>
A	Dr. Ariel Ismach		3	Synthesis, Properties and Applications of Low-Dimensional Materials	0581.5251
B	<u>0321.4824</u>		3	Introduction to Nanoscience and Nanotechnology	<u>0351.4034</u>
B	Dr. Eran Sela (Physics)		3	Mesoscopic Physics and Nano Materials	<u>0321.4813</u>
Materials in Biology and Medicine					
A	Prof. Noam Eliaz	Introduction to MSE, Polymers, Ceramics, Composites, Corrosion Engineering	3	Biomaterials	0581.4313

The Materials Science and Engineering MSc Program

Elective Courses (at least 12 hours in thesis track, 22 hours in project track)

Semester	Lecturer	Prerequisites	Hours	Name	Course #
Materials in Biology and Medicine					
A	Dr. Roy Beck-Barkay (Physics)		3	Biopolymer Physics	<u>0321.4824</u>
A	Prof. Ehud Gazit, Prof. Felix Frolow, Prof. Gerald Cohen, Prof. Judith Rishpon (Life Sciences)		3	Physical Methods in Biology - Principles and Applications	<u>0453.4105</u>
B	Prof. Meital Zilberman (BME)	Biomaterials OR Introduction to MSE	3	Drug-Eluting Biomedical Devices	<u>0553.5332</u>
B	Prof. Meital Zilberman (BME)	Biomaterials OR Introduction to MSE	3	Natural-Based Polymers for Biomedical Applications	<u>0553.5335</u>
Materials in Energy Systems					
A	Dr. Brian Rosen		2	Introduction to Electrochemical Methods and their Applications in Materials for Energy Systems	0581.5271
B	Prof. Yossi Rosenwaks (EE)	Advanced Physics of Semiconductors	2	Photovoltaic Solar Energy Conversion	0510.7701

The Materials Science and Engineering MSc Program

Supplementary Courses (2-4 courses)

Semester	Lecturer	Hours	Name	Course #
A	Dr. Oswaldo Dieguez	4	Materials Science	0581.3121
A	Prof. Ilan Goldfarb	4	Mechanical Behavior of Materials	0581.3181
A	New Recruit	4	Momentum, Heat and Mass Transfer (for Materials Engineers)	0581.4121
A	Prof. Haim Diamant (Chemistry)	6	Thermodynamics	<u>0351.2202</u>
A	Dr. Alon Bahabad (EE)	4	Introduction to Semiconductor Physics	<u>0512-2507</u>
B	Prof. Ilan Goldfarb	4	Introduction to Materials Science and Engineering	0581.2111
B	Dr. Doron Klefch (ME, External)	4	Mechanics of Solids	0555.2407
B	Prof. Zvi Naor (Life Sciences)	5	Biochemistry for Chemistry Students	<u>0351.2809</u>
B	Prof. Israel Goldberg (Chemistry)	3	Crystallographic Introduction to Structural Chemistry	<u>0351.3104</u>

The Materials Science and Engineering MSc Program

- Materials Science and Engineering Program (0581): 2002-2009
- Materials and Nanotechnologies Program (0582): 2009-2014
- Materials Science and Engineering Program (0581): 2014-

- Number of graduates (ceremony):

0581

2005 – 11

2006 – 8

2007 – 5

2008 – 14

2009 – 13

2010 – 7

2011 – 14

2012 – 2

2013 – 2

0582

2012 – 12

2013 – 16

Sum: 76

28

Overall: 104

The Materials Science and Engineering MSc Program

- Currently:
 - 2 in the old 0581
 - 10 in the new 0581
 - 68 in 0582

Total: **80 MSc** students are currently active in the Materials MSc Programs at TAU (excluding the 21 below).

- 21 have started in 2014/5

PhD Students

- Currently, at least 13 PhD students (10 females, 3 males)
- Some others have not paid their tuition yet