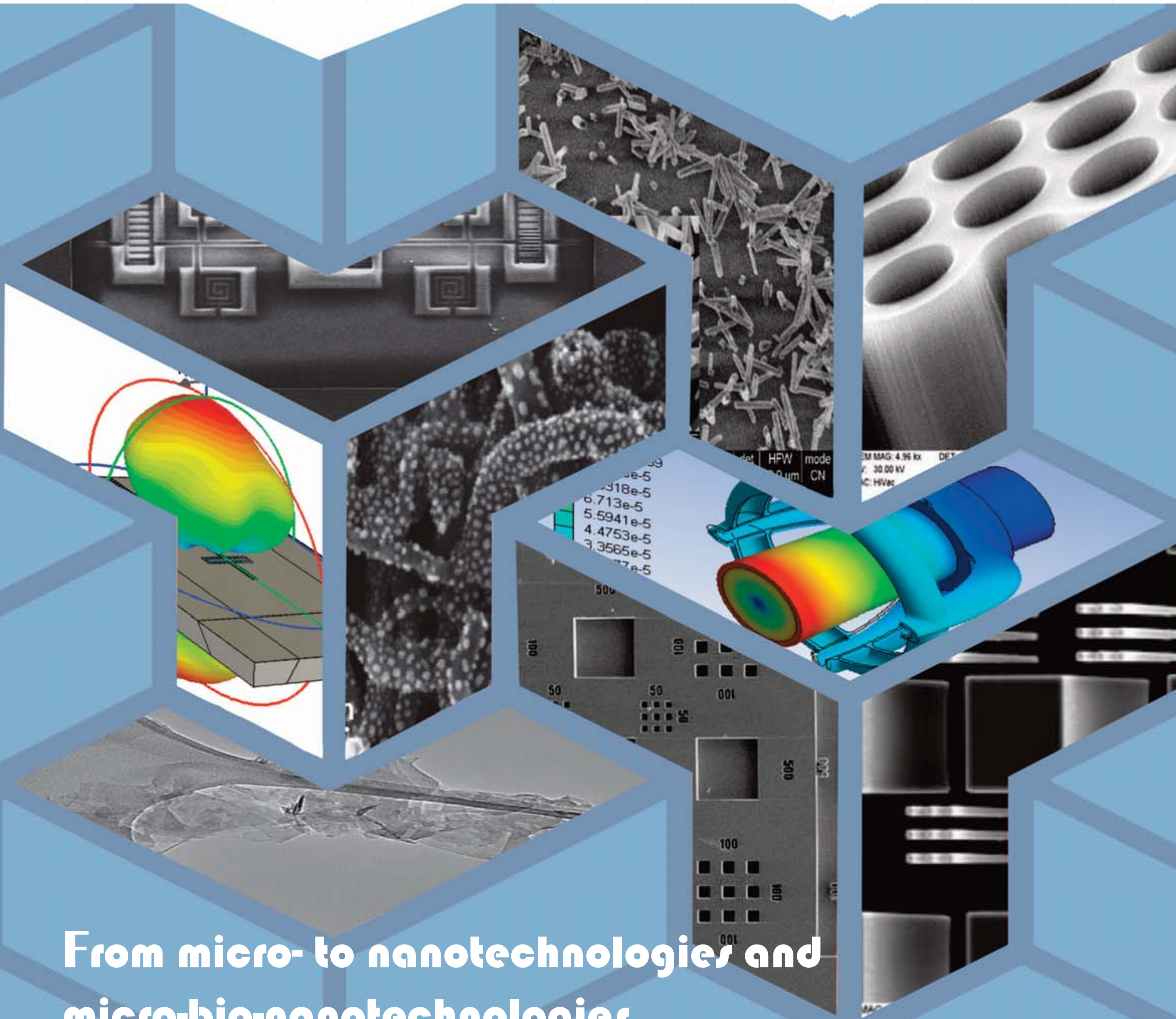
Ministry of Education and Research, Youth and Sport, Romania
National Authority for Scientific Research

MINISTERUL EDUCATIEI CERCETARII TINERETULUI SI SPORTULUI

National Institute for Research and Development in Microtechnologies
IMT Bucharest

Scientific Report 2011



From micro- to nanotechnologies and micro-bio-nanotechnologies

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National Institute for Research and Development in Microtechnologies
IMT Bucharest

SCIENTIFIC REPORT 2011

Research and Technological development and experimental infrastructure

Design: IMT Bucharest

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INTRODUCTION

About IMT

The present organization originates in the Centre of Microtechnology (founded in September 1991), then becoming the Institute for Microtechnologies (IMT) by a decision of the Romanian Government, in July 1993. The present **National Institute for Research and Development in Microtechnologies - IMT Bucharest** was set up at the end of 1996 from IMT merging with the former ICCE (Research Institute for Electronic Components).

The field of activity of IMT corresponds today to **micro- and nanotechnologies**. IMT is coordinated by the Ministry of Education, Research, Youth and Sports, through the National Authority for Scientific Research (ANCS). However, IMT acts basically as an autonomous, non-profit research company. As far as the participation to national and European projects is concerned, IMT is assimilated to a public research institution.
IMT became visible at the national level, especially by coordinating various projects financed from the National Programme MATNANTECH (New Materials, Micro and Nanotechnologies) (2001-2006), and then from CEEX (since 2005) and the 2nd National Plan (since 2007). Between 2003 and 2011 IMT was involved in more than 25 European projects in FP6 and FP7, as well as in other European projects from ENIAC, Eureka, Leonardo, ERANET etc. IMT houses a European Centre of Excellence financed by the EC (2008-2011) through the project MIMOMEMS (RF and Opto MEMS). In December 2009, the European Associated Laboratory (LEA) was inaugurated, with IMT -Bucharest, LAAS/CNRS Toulouse and FORTH, Heraklion. This LEA is acting in the field of RF MEMS/NEMS. The 2011 Report on Innovation placed IMT among the first five organizations (and the only national institute) as far as funding from EU programmes was concerned.

IMT- Bucharest displays a broad range of experimental and computing resources for micro- and nanotechnologies, from computer-aided simulation and design techniques, to characterization tools, fabrication equipments (including a mask shop), and testing equipments (including a reliability laboratory). Most of these resources are now grouped in the IMT centre for Micro- and NAnoFABrication (IMT-MINAFAB), a facility open for research, education and innovation. IMT-MINAFAB is certificated ISO 9001:2008, starting with June 2011. Information about the experimental facility IMT-MINAFAB can be found at http://www.imt.ro/MINAFAB .

About the present report

The Scientific Report 2011 starts with the organizational chart and continues with the Board of Directors and the basic figures about IMT in 2011. The personnel figures are rather stable in the last years, with no significant brain drain. In financial terms, the volume of activity of IMT in 2011 experienced a recovery to the level of 2008, the maximum before the economic crisis, dramatically reducing the financing of the research.

The second part is devoted to the presentations delivered by IMT laboratories for research and development (R&D). These research groups, rather stable during the relatively short history of IMT, are presenting their assets, as well as the results of the main ongoing projects (including international ones) during 2011. Brief presentation of other activities as: education, organization of scientific events, important visits are highlighted. A list of main scientific publications concludes the report.

Other information about IMT

Apart from scientific research and technological development, IMT is active in technology transfer and innovation, as well as in education and training. Since 2005, IMT includes an autonomous Centre for Technology Transfer in Microengineering (CTT-Baneasa), and in June 2006, a Science and Technology Park for Micro- and Nanotechnologies (MINATECH-RO) was set-up by a consortium with just two partners: IMT (housing most of the park area), and University "Politehnica" of Bucharest. The facilities provided to a few companies in the park (including Honeywell Romania) are: rooms for working points, priority of access to scientific and technological services provided by IMT, as well as the possibility to install their own equipments in the technological area of IMT.

IMT is open for educational activities in cooperation with universities: undergraduate, M.Sc. and Ph.D. studies, and also for "hands-on training". IMT was active in a Marie Curie training by research network and also in Leonardo programme and in "Eurotraining". Since October 2009, IMT is covering fully a number of disciplines in the new M.Sc. programme, organized by the University "Politehnica" of Bucharest (PUB). Since 2010, IMT is coordinating a programme of postdoctoral studies in micro- and nanotechnologies, financed from structural funds (2010-2013).

IMT is organizing the Annual Conference for Semiconductors (CAS), an IEEE event (CAS 2011 was the 34th edition), now largely devoted to micro- and nanotechnologies. IMT is also organizing within the Romanian Academy the "National Seminar for Nanoscience and Nanotechnologies" (the 10th edition - in 2011). The institute is co-editing (in English) the series of volumes Micro- and Nanoengineering", in the Publishing House of the Romanian Academy (19 volumes until 2011).

Prof. Dan Dascalu, *Former CEO and President of the Board*

Human resources, funding sources, investments

At IMT – Bucharest work research scientists, engineers, technicians and supporting teams.
IMT has become in the last years an attraction for valuable researchers through the new infrastructures, the multitude of European projects and opening of new positions.

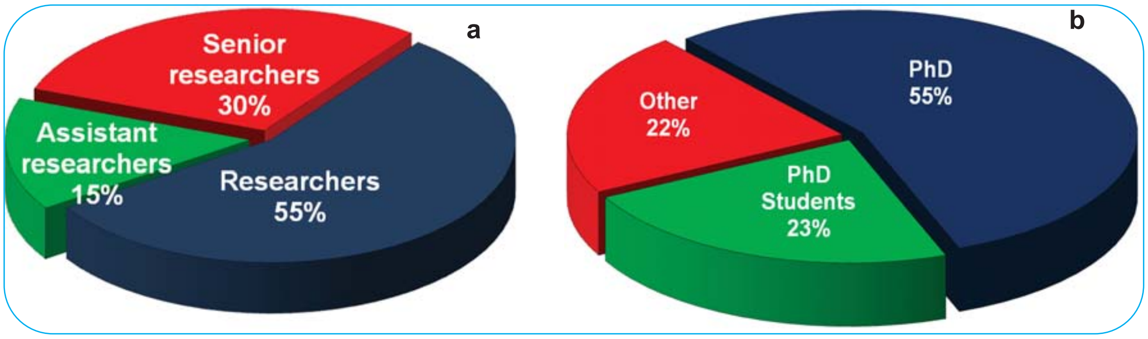


Fig 1 - Researchers active in IMT (74)

Figure 1 (a, b) provides information about the number and distribution of researchers active in IMT in 2011 (74 persons). 30% of them are senior reserchers and 15% are young assistant reserchers. Compared with 2010 the people own a PhD or being a PhD students is higher. This figure has doubled in the last years due to both existing and new personnel (hired in the last interval). 8 from the 23 new doctors (i.e. 35% of total) obtained their Ph.D. in Universities abroad (Europe, U.S.A., Singapore and Japan). The average age of people involved in scientific research is 43.

Fig.2 gives information about the total number of specialists active in IMT in 2011 (109 people): researchers and engineers providing technical services. Their background is shown in Fig.2. The male (59) - female (50) number is relatively balanced.

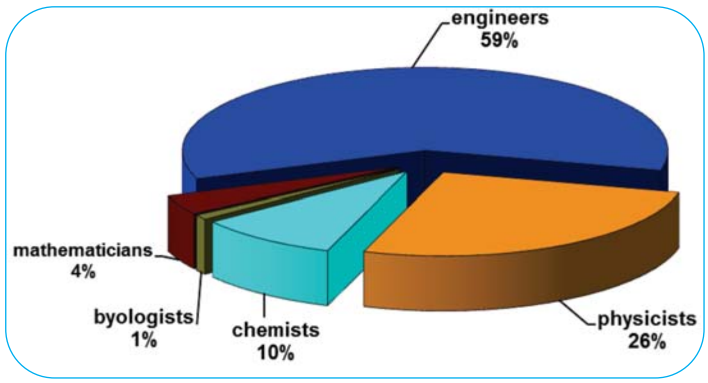


Fig. 2 Background of researchers and technical staff providing technical services

Funding sources and investments

Fig. 3 present the funding sources in 2011, excluding investments from various contracts.

As can be seen the funding comes from different sources: national R&D programs (competitive funding, through open calls): 37%.

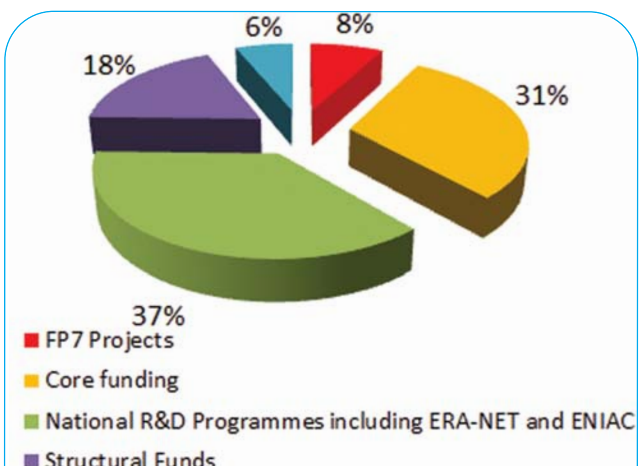


Fig. 3 Funding sources in 2011

This percent includes also the funding from related FP7 projects as ENIAC (Nanoelectronics) and ERA-NET projects, where IMT is partner. 18% comes from Structural Funds and 31% are provided by core funding (public money available to national institutes for R&D, since 2003).

Figure 4 shows the evolution of the last years.

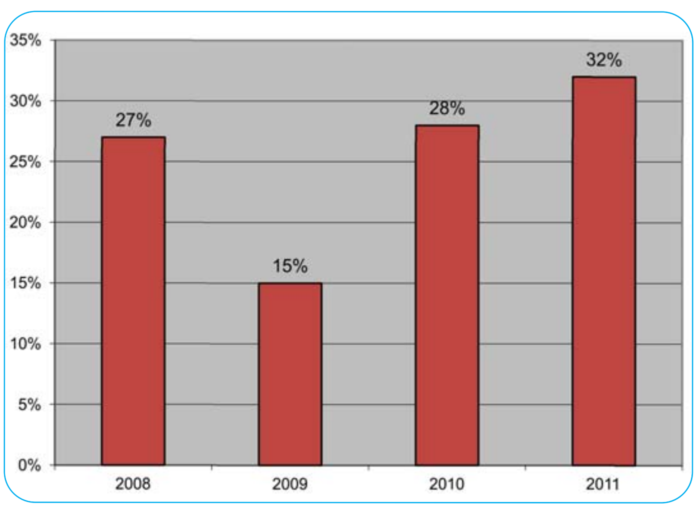


Fig. 4 Core funding evolution in the last 4 years, as percent of the turnover of the previous year

Human resources, funding sources, investments

The next graph (fig. 5) presents the structure of international projects running in 2011 in IMT-Bucharest: FP7, related FP7 (ENIAC, ERA-NET) and Bilateral). The value refer to the total funding of these projects.

Acquisition strategy aimed to ensure a complete R&D cycle for micro-nano fabrication: design-modeling-simulation, basic and advanced processing, complex characterization, device/system integration, reliability testing (fig 6). Next figures (7 and 8) provide information about the investments of 2011 and the evolution in the last period. For 2011 an improvement can be remarque, related to the number and value of the new acquisitions.

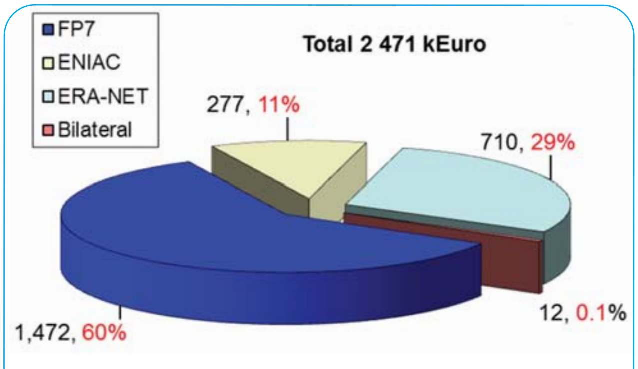


Fig 5: Total value of running international projects in 2011

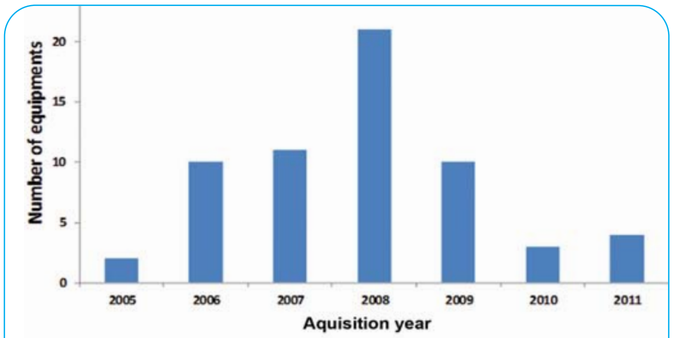


Fig 6 Dynamics of equipment acquisition between 2005-2011

Fig 7

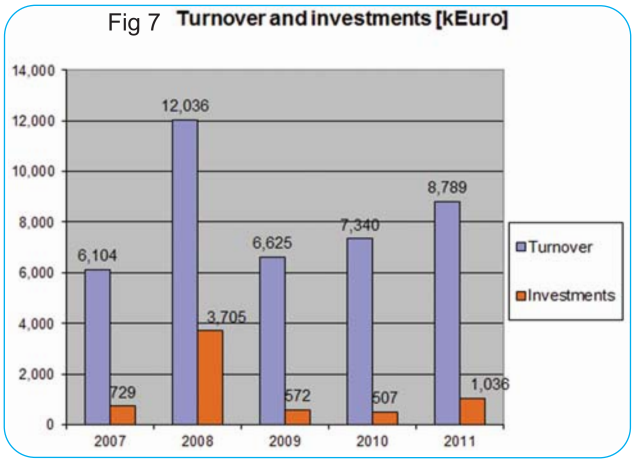
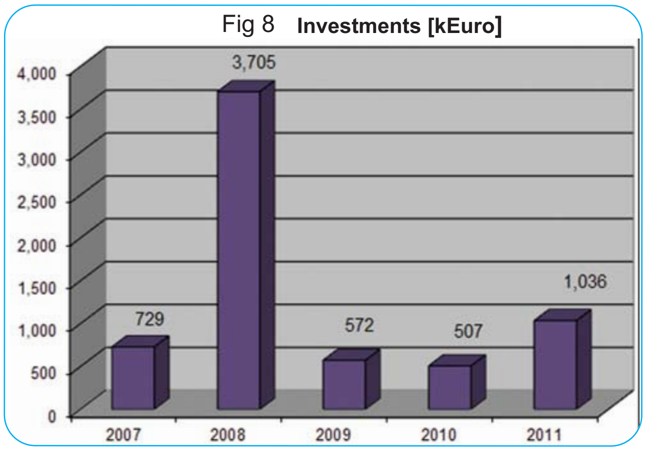


Fig 8



A new source of financing: structural funding

Project Title: "Microfluidic Factory for "Assisted Self-Assembly" of Nanosystems" - MICRONANOFAB

Project thematic area: Innovative materials, products and processes

Operational programme: POS CCE

Priority Axis 2 – Research, Technological Development and Innovation for Competitiveness

ID/COD SMIS/No.: 665/12609/209/20.07.2010

Duration of contract: 36 months (July 2010- July 2013)

Operation: O.2.1.2 "Complex research projects fostering the participation of high-level international experts"

Grant: 7.071.000/5.900.000 lei

Scientific manager: Dr. Ciprian ILIESCU (cipi_sil@yahoo.com)

Contact person: Acad. Dan DASCALU (dan.dascalu@imt.ro)

The fundamental objective of this project is the realization of a prototype of an integrated microfluidic system able to dose, encapsulate and deliver different chemicals for medical treatment. The idea is to develop some microfluidic technological platforms, under the form of flexible and modular technologies such that with the same modules to perform different tasks like transportation, manipulation, and structural analysis of biological samples.

The new equipments acquired in the frame of the project: Deep Reactive Ion Etching (Oxford Plasma Technology), Andoing bonding (Suss MicroTech) and - Refractometer for layer thickness measurements (Mikropack) are presented by the Micro and Nanofluidics Laboratory .

Project Title: "Research center for integrated systems nanotechnologies and carbon based nanomaterials" - CENASIC (ID 905/28.09.2010; SMIS COD 14040)

Priority Axis 2: "Competitiveness via research, technological development and innovation"

Intervention field: D.2.2 „Investments in CDI infrastructure and development of administrative capability"

Operation: O2.2.1. Developing the available C-D infrastructure and creating a new C-D infrastructure.

Financing unit: The increase of economic competitiveness (POS CCE)

Period of time: September 2010- September 2013 (36 months); Grant: 20.000.000 RON

Project manager: Dr. Lucian Galateanu (lucian.galateanu@imt.ro)

The objective is the creation of a new center within IMT. The center will have modern facilities and laboratories designed for the development of new research areas with high application potential, in concordance with EU models and strategies. The mission of the CENASIC Center is to become a national and European excellence centre in the area of applied research in integrated micronanotechnologies using carbon based materials.

A new source of financing: structural funding

Project Title: “Human resources development through postdoctoral research in micro and nanotechnologies domain” (ID: POSDRU/89/1.5/S/63700)

Priority Axis 1: Education and training in support for growth and development of a knowledge based society

Intervention field: 1.5 Doctoral Post-doctoral Programme for research support.

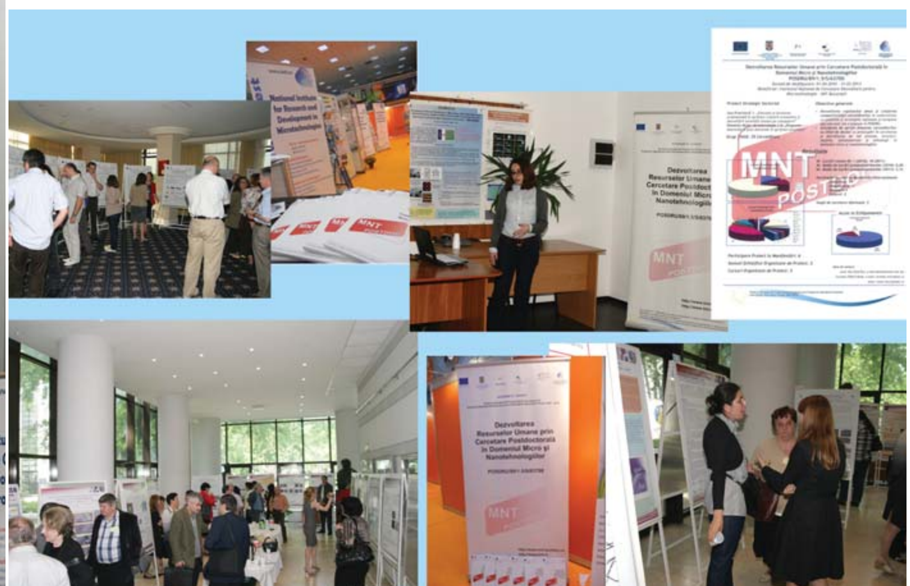
Financing unit: Sectoral Operational Programme Human Resources Development 2007-2013 (SOP HRD)

Period of time: April 2010 – March 2013 (36 months); Grant: 10.072.499 RON

Contact data: Acad. Dan Dascalu (dan.dascalu@imt.ro) Coordinator; **Corneliu Trisca-Rusu** (corneliu.trisca@imt.ro) Deputy coordinator.

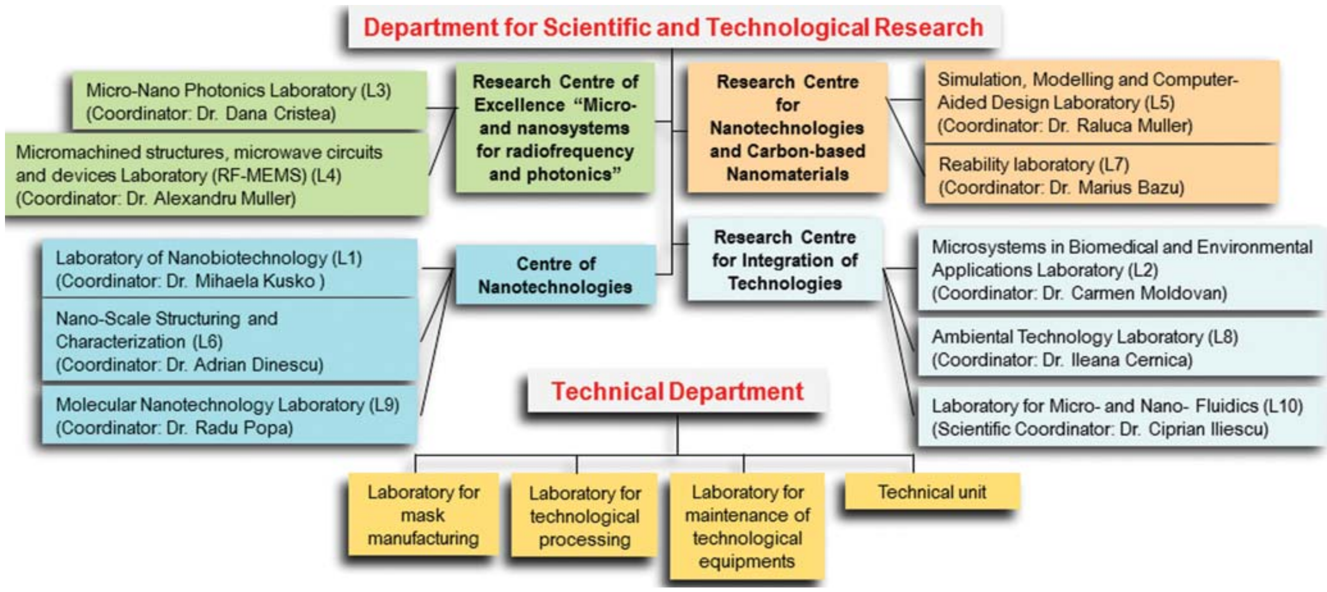
This project is providing financial support to 35 postdoctoral researchers, through grants for scientific research in Romania, traineeships abroad, and attendance to scientific events, in a postdoctoral programme for the micro- and nanotechnologies domain. These 35 postdoctoral students are grouped along seven research directions, supervised by seven professors. The directions are (1) Micro and nanosystems for biomedical applications; (2) Intelligent Sensors, Micro traductors with application in energy, environment and agriculture; (3) Radio-frequency micro-electro mechanical systems, RF-MEMS; (4) Opto-electro- mechanical micro-(nano)systems, MOEM(N)S; (5) Thin films deposition for micro and nano-systems; (6) Advanced materials for micro-nanosystems; (7) Membrane systems for micro-nanosystems;

Most of the research scientists are from National Institute for Research and Development in Microtechnology. Other postdoctoral positions have been granted to researchers from National Institute for Research and Development Electrochemistry and Condensed Matter – INCEMC Timisoara (partner of IMT in the above projesct); National Institute for Laser, Plasma & Radiation Physics (INFLPR); “Ilie Murgulescu” Institute of Physical Chemistry (Romanian Academy); University POLITEHNICA of Bucharest; Tehnical University of Cluj Napoca; Transilvania University Brasov; University of Pitesti; S.C. DDS Diagnostic SRL; S.C. METAV-Research Development S.A.



During 2011 the postdoctoral researchers of POSDRU project published an important number of paers in ISI journal and presented communictaions at prestigious conference3. 3 postdoctoral researchers participated at research internships at European Universities or Research Institutes. The scientific activities are supported by research infrastructure of IMT-Bucharest (AFM, SEM, EBL, XRD, etc), INFLPR, University „Politehnica” of Bucharest etc. The POSDRU project organised 2 dedicated courses, of which one co-organised with Swiss Foundation for Research in Microtechnology - FSRM (Switzerland). Also POSDRU project organised 2 Scientific events in order to present the results and scientific activities of the postdoctoral researchers.

Organization: Scientific and Technical Departments



Prof. Dan Dascalu was the founder and the director (CEO) of the Centre for Microtechnology (1991), then of the Institute of Microtechnology (July 1993), and finally (since November 1996) of the National Institute for Research and Development in Microtechnologies (IMT-Bucharest). His mandate came to and end in June 2011. Since then, he is the Coordinator of the Centre for Nanotechnologies and President of the Coordinating Board of IMT-MINAFAB. Dan Dascalu is full member (academician) of the Romanian Academy (of Sciences). He is the author of "Transit-time Effects in Unipolar Solid-State Devices" and "Electronic Processes in Unipolar Solid State Devices" (both published by Abacus Press, Kent, U.K., 1974 and 1977) as well as of many technical papers published in scientific periodicals or conference proceedings. Dan Dascalu is an expert representing Romania in the NMP FP6 and FP7 Programme Committee (since 2002), in the "mirror group" for the European Technological Platform for Nanomedicine and in the Governing Board ENIAC-JU (public-private partnership in nanoelectronics).

Raluca Müller received the M.Sc (1978) in Electronics and Telecommunications from "Politehnica" University of Bucharest, Romania and PhD in Electronics and Telecommunications, from the same university.

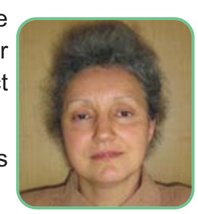
From 1978-1994 she was Research Scientist with ICCE-Research Institute for Electronic Components, Romania; since 1994 she is with IMT. She is *Scientific Director* starting with 2009 and acting as ***General Manager*** startig with July 2011. Her main scientific interests include design, and technological processes (nanolitography) for microelectronic devices, integrated optics, microsensors and microsystems. She is author and co-author of more than 80 scientific papers.

Mircea Dragoman was born in Bucharest in 1955. He graduated the "Politehnica" University of Bucharest, Electronic Faculty, in 1980. He received the doctoral degree in electronics in 1991.

Mircea Dragoman is a senior researcher I at the IMT-Bucharest, he is working in the laboratory "Microsystems and micromachined circuits for microwaves- (RF MEMS)" where he designed and characterized a series of circuits in the microwave and millimeter range. He was Director of Centre for Research and Technologies Integration and currently is the president of the Scientific Council. He has published 208 scientific papers, 117 ISI papers. The papers are dedicated to the following areas: nanoelectronics, microwaves, MEMS, optoelectronics. He is co-author of several books.

Radu Cristian Popa received a MSc in Electrical Engineering (Applied Electronics) from the Polytechnic University of Bucharest (1989), and a PhD in Quantum Engineering and Systems Science at University of Tokyo (1998). He was assistant professor at the Polytechnic University of Bucharest (1991-1995), and Senior Researcher at the Science Solutions Intn. Lab., Inc., Tokyo (1998-2003), where he conducted competitive industrial research in numerical modeling and analysis of complex phenomena and devices. 2003-2006, he was scientific associate at the University of Tuebingen, Germany and then became Development Director at Neurostar, GmbH, Germany, designing and developing hardware and software solutions for functional neurosurgery and neuroscience. Radu Popa joined IMT Bucharest in 2007 and is presently director of the Center for Integrated Systems Nanotechnologies And Carbon Based Nanomaterials. Main scientific interests include atomistic analysis of electronic transport in molecular junctions in the framework of the rational design paradigm for molecular scale electronics.

Marin Nicolae received the M.Sc (1972) in Electronics and Telecommunications from "Politehnica" University of Bucharest, Romania and in 1998 PhD in Electronics and Telecommunications, from the same university. He has extensive background in manufacturing/design semiconductor devices, characterization, electrical circuit simulation, debugging, evaluation and product monitoring. He is Technical Director starting with September 2009.



Domnica Geambazi graduated in 1979 the Bucharest Academy of Economic Study. She was appointed Financial Director in 2009 (delegated as Financial Director since 2001).

Experimental Facility- IMT-MINAFAB

Constant and coordinated investments in the experimental infrastructure have been a main priority of IMT- Bucharest. These investments allowed the institute to officially launch in April 2009 a renewed, state-of-the-art research infrastructure. The technical and administrative user interface of this new, open facility is the IMT-centre for **MIcro- NANOFABrication11 (IMT-MINAFAB, www.imt.ro/MINAFAB).**

IMT-MINAFAB operates several clean-room areas and specialized laboratories - totaling a surface of almost 700 sqm. - and modern equipments worth more than 8M euro; some of them are unique at national and regional level. Since June 2011, the services and administrative activities of the centre are SR EN ISO 9001:2008 certified by TÜV Thüringen e.V. IMT-MINAFAB manages one of the very few class 1.000 clean rooms currently running in Romania, and represents the sole concentration of spaces with high purity air and of state-of-the art research equipments for micro-nanotechnology at national level.

This aggressive investment program has enabled IMT to radically extend its R&D capabilities, leading to participation in more demanding international projects (FP7, ENIAC) and to new contacts and collaborations with multinational companies operating in Romania (Honeywell, Infineon) and with various leading international partners.

Main categories of equipments are: **Micro-nanofabrication**: microlithography and special patterning; nanolithography; special material deposition; chemical deposition; physical deposition; dry (deep) etching; thermal processing; chemistry. **Analysis and characterization:** SEM; SPM; XRD; NSOM; SECM; nanomechanical characterization; WLI profiling; voltammetry; EIS; UV-Vis-IR absorption; nanoparticle characterization; on-wafer pA-range electrical probing. **Testing and reliability:** climatic chambers for combined stress tests; mechanical vibration testing; mechanical, thermal shock testing. **HPC for numerical analysis** (modeling, simulation, design): multiprocessor platform, multi-OS, virtualization.

Main categories of services: technological services for development of micro-nano systems and devices; microscopy, analysis and characterization of surfaces, crystals, micro-nanostructures; design, modeling and simulation for microsystems and devices (coupled physics, optics, etc.); complex services for RDI.

Detailed information can be found on the institute webpage: www.imt.ro/MINAFAB, as well as in the IMT **Services Brochure "Your reliable partner: IMT Bucharest"** [http://www.imt.ro/brosura_imt_bucuresti_2009.pdf] and in this report, in the lab presentation sections.

European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors, MIMOMEMS

Laboratory of Micro-Nano Photonics

Mission: Research and development activities in the field of micro/nano-photonics and optical MEMS focused on the development of micro/ nano structures based on new materials and processes and photonic integrated circuits based on heterogeneous integration technology; development of materials, technologies and components for optical MEMS.

Main areas of expertise: - **modeling and simulation** of micro and nano photonic structures; development af simulation tools
• **new materials** for micro/nano opto-electro-mechanical systems integration (functional polymer, hybrid organic-inorganic nano-composites, transparent semiconducting oxides), and related fabrication processes (including mixed technologies);
• **passive and active micro-nano-photonic structures**
• organic optoelectronics
• **hybrid or monolithic integrated photonic circuits and MOEMS** (including heterogeneous platforms) for optical communications, interconnects and optical signal processing;
• **Micro-optics** - design and fabrication based on replication techniques
• optical and electrical **characterization** of materials and devices

European Projects: ✓ **FP7**
• Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology-IP priority NMP
• European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices-CSA-programme capacities
✓ **MNT EraNet Project**
• Multifunctional Zinc-Oxide based nanostructures: from materials to a new generation of devices (MULTINANOWIRES)

National Projects:
• Development of soft lithography techniques for micro and nano-photonics- National Program "Partnership"
• Development of processes and devices based on oxidic and polymeric thin layers for transparent Electronics and Optoelectronics- National Program "Partnership"
• Multifunctional molecular architectures for organic electronics and nanotechnology- theoretical and experimental studies- National Program "Ideas"

Research team has multidisciplinary expertize and is composed of 6 senior researchers (5 with PhD in optoelectronics, materials for optoelectronics, microsytems, physics, chemistry), 2 PhD students (with background in physics and electronics), 1MSc student.

Specific facilities:

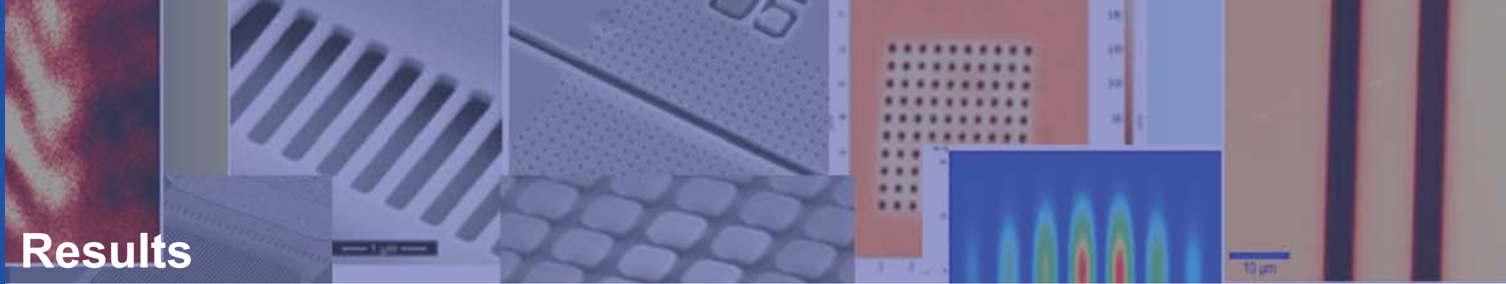
Modeling and simulation:
• **Opti FDTD 9.0** - design and simulation of advanced passive and nonlinear photonic devices
• **OptiBPM 10.0**- design of complex optical waveguides, which perform guiding, coupling, switching, splitting, multiplexing and demultiplexing of optical signals in photonic devices
• **OptiGrating**- design software for modelling integrated and fiber optical devices that incorporate optical gratings
• **Opti-HS**-components and of active devices based on semiconductor heterostructures
• **LaserMod** analysis of optoelectronic devices by performing electrical and optical analysis of III-V and other semiconductor materials.
• **3Lit-3D** micro-optical elements
• Zemax (new)

Characterization:
• spectrophotometers for UV-VIS-NIR and IR spectral range;
• spectroscopic ellipsometer
• High Resolution Raman Spectrometers LabRAM HR
• Alpha300S System-combines combining the characterization methods of Scanning Near-field Optical Microscope (SNOM), Confocal Microscopy (CM) and Atomic Force Microscopy (AFM)
• experimental set-up for optoelectric characterization in UV-VIS-IR spectral range of optoelectronic and photonic components, circuits

Technology: Lab with glove box, spinner, hot plates, oven for preparation and deposition of nanocomposites and organic layers.

Laboratory Head: Dr. Dana Cristea (dana.cristea@imt.ro)

Dr. Dana Cristea obtained the MSc in Electronics (1982) and PhD in Optoelectronics and Materials for Electronics from "Politehnica" University, Bucharest, Romania. From 1982 until 1994 she was a research scientist in the Department of Optoelectronics and Sensors from the Research & Development Institute for Electronic Components, Bucharest, Romania. Since 1994 she has been a senior researcher in the National Institute for R&D in Microtechnologies (IMT- Bucharest), Romania, head of Laboratory of Micro/Nanophotonics since 1997 and head of Department for Multidisciplinary Research between 2002 and 2008; since 1990 she has also Associate Professor at "Politehnica" University, Bucharest, Faculty of Electronics. Her main research activities are in the fields of optoelectronics and photonic integrated circuits, optical MEMS, new nanostructured materials for photonics, chemo and bio-sensors, micro-optics. She has been authored more than 80 publications in international scientific journals and conference proceedings. She is also a reviewer in Romanian and international scientific journals . Dr. Dana Cristea has coordinated more than 20 national projects, has participated in several FP6 projects (WAPITI, 4M, ASSEMIC), and is currently involved in two FP7 projects (FlexPAET, MIMOMEMS).



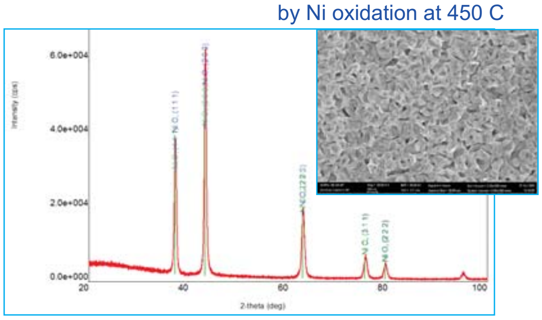
Results

Transparent electronics

• Transparent conductive oxide

p -type NiO prepared by thermal oxidation of Ni thin layer

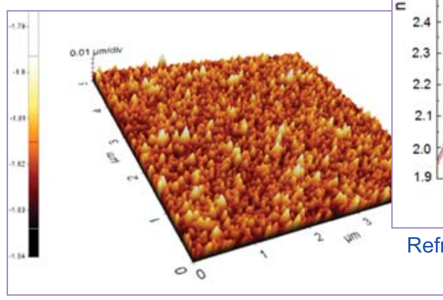
SEM image of NiO film obtained by Ni oxidation at 450 C



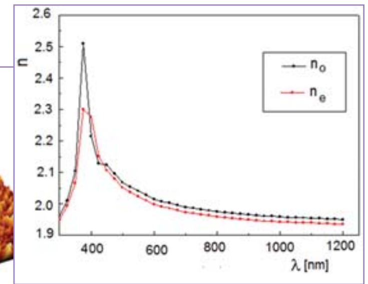
XRD spectrum of NiO

p type ZnO (ZnO:N) obtained by PLD

cooperation with INCDFLPR

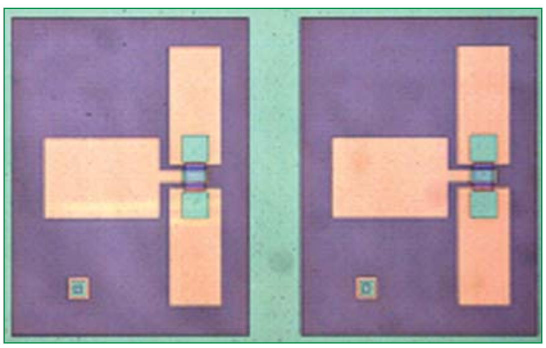


3D AFM image of ZnO:N deposited on glass substrate

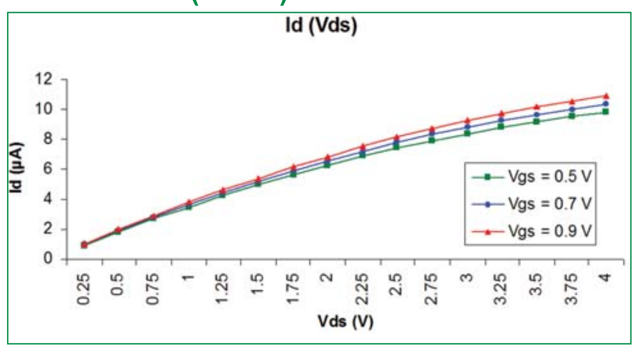


Refractive Index of p-ZnO:N layers

• Transparent Thin Film Transistors (TTFT)



Optical image of the ZnO-TTFT with channel length of 80 µm



I-V characteristics of the transparent ZnO-TTFT

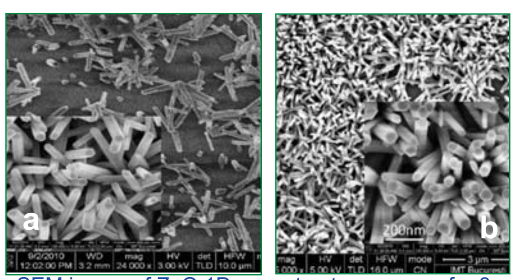
PN II project, contract no: 12128/2008- Development of processes and devices based on oxidic and polymeric thin layers for transparent Electronics and Optoelectronics (ELOTRANSP).

Contact person: Dr. Munizer Purica (munizer.purica@imt.ro)

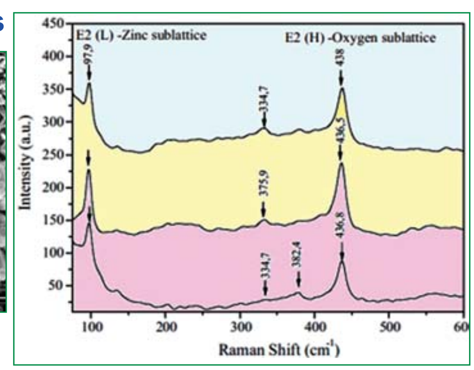
TTFT structures on two inch quartz substrate, through which the underlying text is clearly visible.

• Zinc-Oxide based nanowires

One dimensional ZnO nano-structures were grown on glass substrate using two-step solution-based process: substrate seeding with ZnO nanoparticles or sol-gel derived ZnO thin layer (step I) followed by ZnO nanostructures growth (step II). ZnO nanowires were grown in equimolar aqueous solution of zinc nitrate hydrate and hexamethylenetetramine ([Zn2+]:[HMT] = 1:1), at temperatures in the range 70–90 °C.



SEM image of ZnO 1D nanostructures grown for 3 h at 90 °C from a solution of 0.25 M on seeded glass substrate: a) seeded with ZnO nanoparticles ; b) on sol-gel derived ZnO thin film.



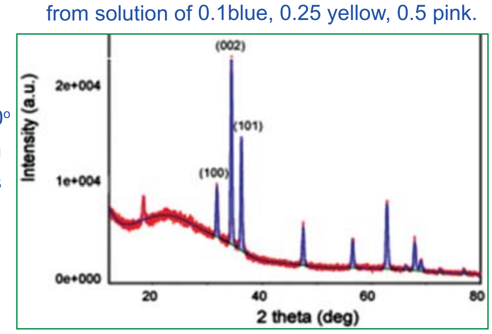
Micro-Raman spectra of ZnO nanowires grown from solution of 0.1blue, 0.25 yellow, 0.5 pink.

Cooperation with Univ "Dunarea de Jos" Galati.

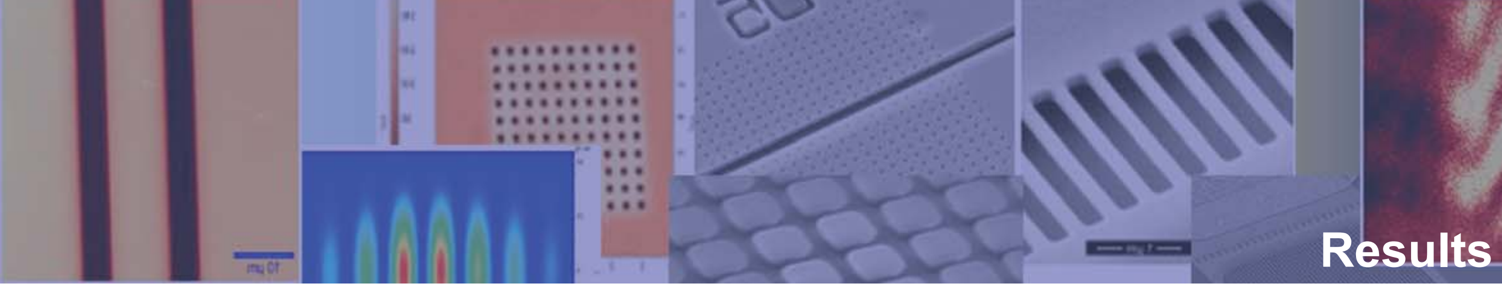
The obtained ZnO nanowires/nanorods were structurally and morphologically characterized by scanning electron microscopy, Raman spectroscopy and X-ray diffraction.

MNT EraNet Project Multifunctional Zinc-Oxide based nanostructures: from materials to a new generation of devices (MULTINANOWIRES)

XRD pattern pf ZnO nanowires grown at 90° C for 3h from solution on seeded substrates with ZnO nanoparticules



Contact person: Dr. Munizer Purica (munizer.purica@imt.ro)



Results

Isocyanate functionalized graphene / P3HT based nanocomposites for electronic devices

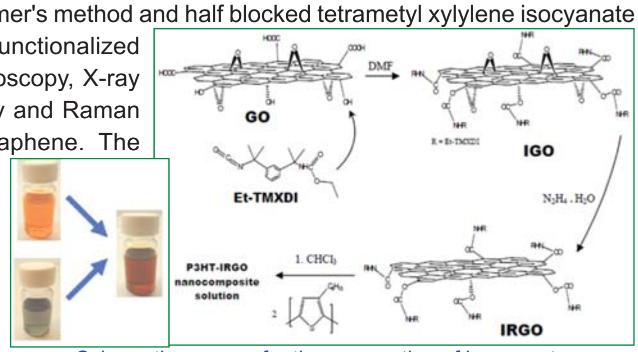
We developed a method for the preparation of isocyanate functionalized graphene –regioregular poly 3-hexyl tiophene (rr-P3HT) nanocomposites is presented. Graphite oxide preparedby the Hummer's method and half blocked tetrametyl xylylene isocyanate (Et-TMXDI) are the precursors for the new obtained isocyanate functionalized graphene. Fourier transform infrared spectroscopy, UV-Vis spectroscopy, X-ray diffraction, Atomic force microscopy, Scaning electron microscopy and Raman spectroscopy were used to characterize the functionalized graphene. The isocyanate functionalized graphene facilitates the self-assembling of P3HT polymer in highly oriented nanowires.Thin films of functionalized graphene - rrP3HT nanocomposites obtained by spinning and dip coating processes were investigated and used for organic field effect transistors (OFETs).

• Solution processable isocyanate functionalized graphene/P3HT nanocomposites are useful for spinning and dip coating processes.

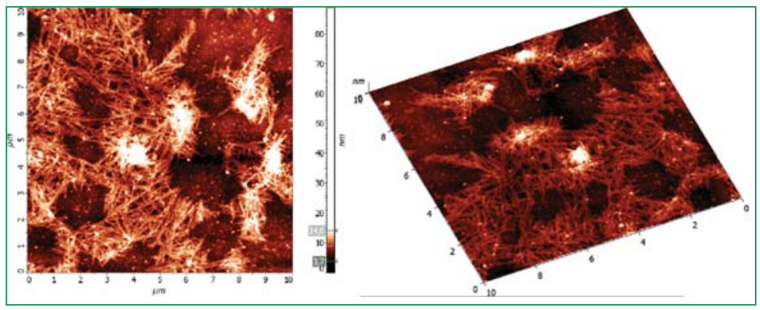
• IRGO/P3HT nanocomposites materials exhibit good dispersability and high storage stability.

• The fabrication process is simple and compatible with silicon technology.

• The IRGO improve p- p stacking of P3HT nanowires leading an improvement of mobility from 0.02 $cm^2V^{-1}s^{-1}$ for P3HT based OFETs to 0.1 $cm^2V^{-1}s^{-1}$ for IRGO-P3HT based OFETs



Schematic process for the preparation of isocyanate functionalized reduced graphene oxide nanocomposites



AFM images (topography) of diluted chloroform/dichlorbenzene solution of IRGO/P3HT deposited on Si substrate; ***P3HT nanowires have a radial orientation with center in IRGO flake***

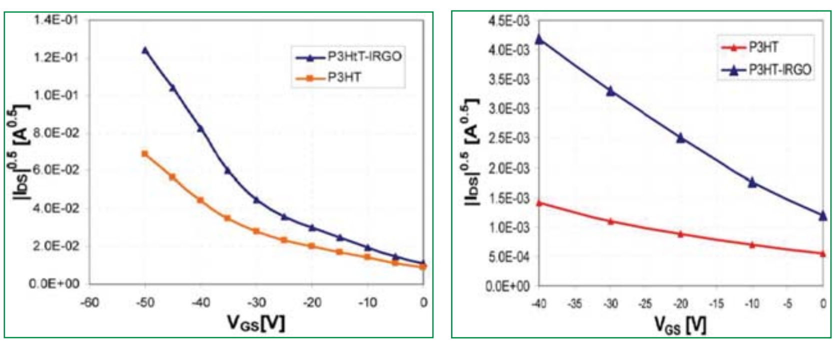
PN II project (2009-2011) -Program Ideas „Multifunctional molecular architectures for organic electronics and nanotechnology- theoretical and experimental studies". Contract No. 617/2009

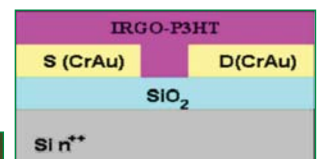
Graphene/P3HT based OFET

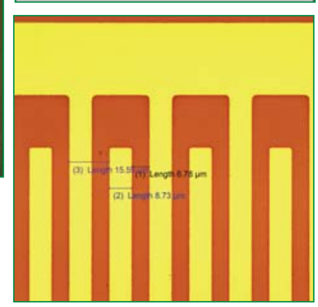
Substrate (gate): high coductivity Si; ***Gate dielectric:*** SiO_2 300nm-thick

Interdigitated gold electrodes for drain and source (bottom contact configuration).

Active layer: spin-coating IRGO-P3HT solution in chloroform DCB in glove box under N2 athmosphere + annealing (160°C for 15 minutes in the oven under nitrogen).



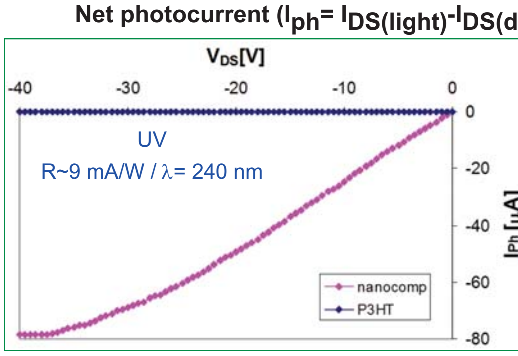


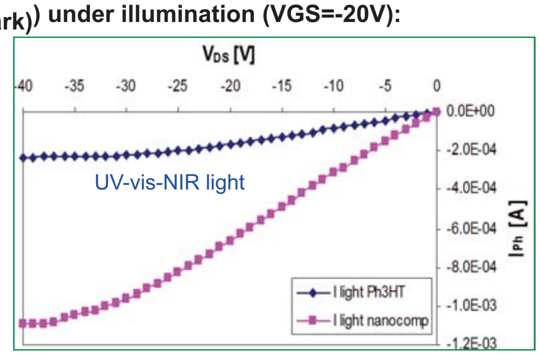


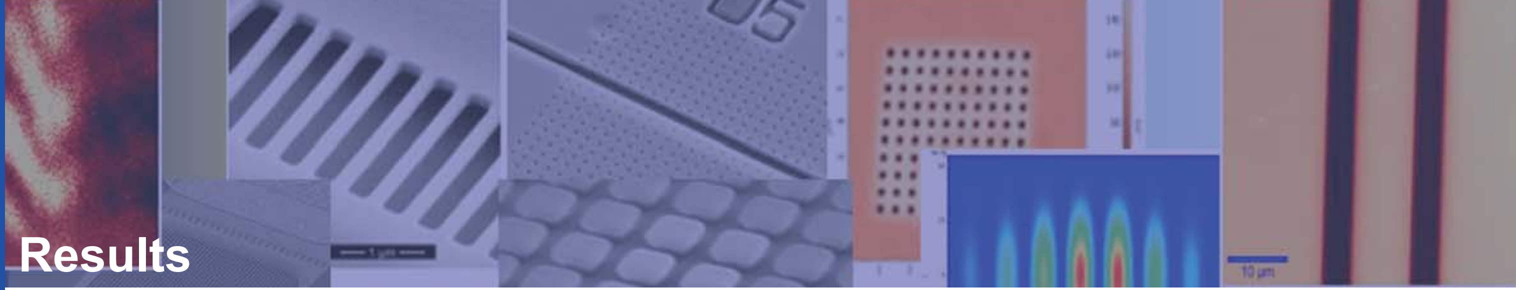
Examples of plots of the square root of saturation source-drain current as a function of the gate voltage VGS for FETs based on P3HT and P3HT–IRGO nanocomposite: (a) FET with IDT electrodes, L= 8 µm, W=72.75 mm; (b) FET with L=30 µm, W = 3mm.

Net photocurrent (I_{ph}= $I_{DS(light)}$-$I_{DS(dark)}$) under illumination (VGS=-20V):

PN II project (2009-2011) -Program Ideas „Multifunctional molecular architectures for organic electronics and nano-technology, theoretical and experimental studies". Contract No. 617/2009

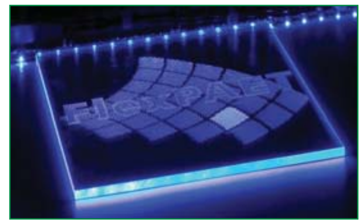






Results

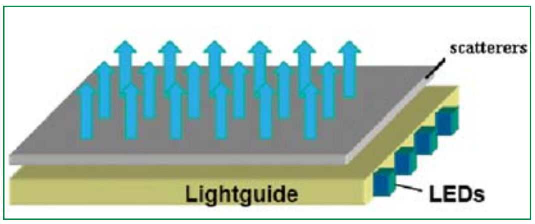
FP7 Project
Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology



Grant agreement no.: 214018 (IP, FP7, NMP-2007-3.5-2)
Coordinator: Fraunhofer Institut fur Produktionstechnolgie (Germany).
Partners: Oy Modines Ltd. (Finland), Zumtobel Lighting GmbH (Austria), CEA LITEN (France), Gaggione (France), Eitzenberger Luftlagertechnik GmbH (Germany), Johann Fischer Aschaffenburg Prazisionswerk GmbH & Co (Germany), Datapixel S.L.(Spain), Innovalia (Spain), Temicon GmbH (Germany), IPU (Denmark), IMT-Bucharest (Romania), Fundacion Privada Ascamm (Spain)
Contact person for IMT: **Dr Dana Cristea,** dana.cristea@imt.ro

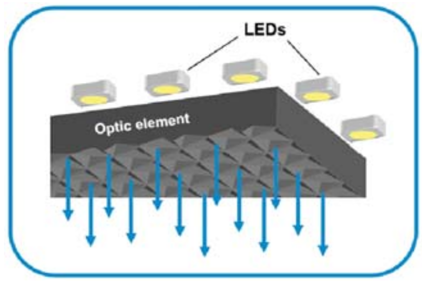
Project aim: development of a process chain and of the ***machine for adaptive embossing of large area masters for diffractive optical elements.***

Applications



backlight technology

light ceiling



IMT Role

• **Optimization of the embossing process for large area diffractive optical elements**

A software programme was developed to autonomously determinate the necessary rework on the substrate surfaces. It will also calculate the stamping positions, and communicate the results with the system control. After every finished iteration cycle, the performance will be re-measured and potential further rework will be determined by the optimisation algorithm. This process will continue until the element performance matches all design requirements. (fig 5).

The first step in the optimization process was to build a mathematical model that serves as base of the optimization algorithm. Then we developed three methods for the optimization software

The first one is a **deterministic method** which consists in obtaining analytical expressions to find the appropriate spatial distribution of scatterers placed at the bottom of the light guide plate necessary to have an uniform irradiance of the edge-lit backlight system.

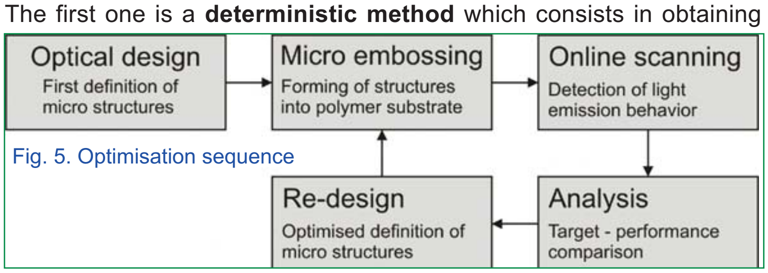
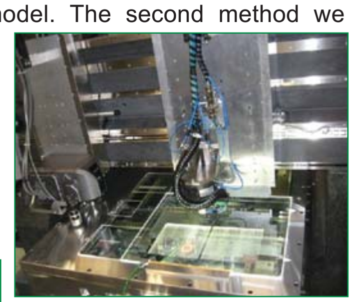


Fig. 5. Optimisation sequence

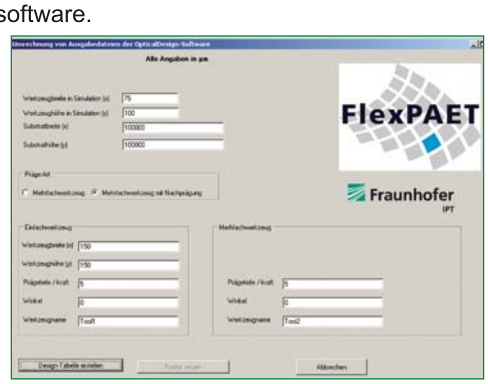
The second method consists in the optical measurements of a series of preliminary test structures with the distribution of scattering realized according to the mathematical model. The second method we proposed is step by step adaptive embossing algorithm.

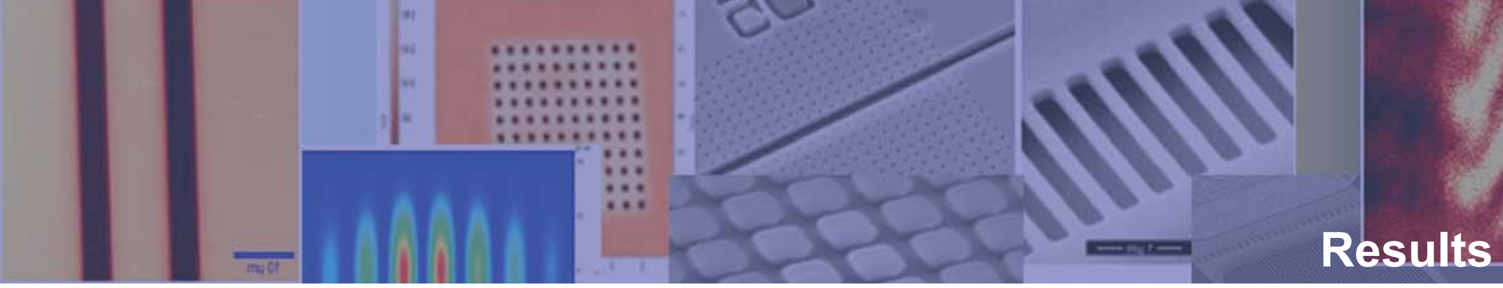


The third method consists in the combination of the aforementioned methods, a coarse embossing performed using a preliminary design with scattering elements distributed according to an approximated density function and a local optimization done with the step by step adaptive embossing algorithm. It represents the best compromise in terms of optical measurements accuracy as well as the computational resources. Based on these methods, a software program was developed and integrated into the machine software.

Two optimized demonstrative structures- 200x200 mm^2 have been embosed on the machine. These structures will be replicated by the partners.

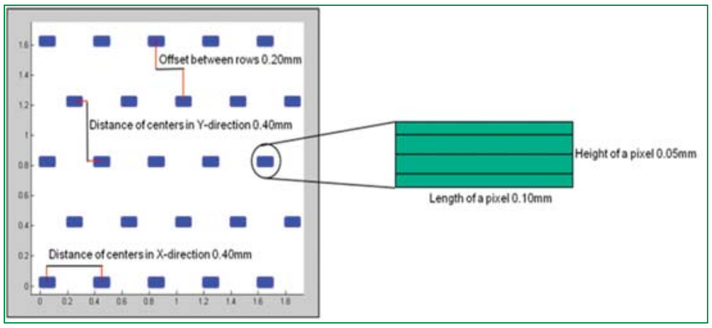
• cooperation with Fraunhofer IPT in the **development of the of software tool** for data processing and **CAM-interface** that includes optimization software, processing of mathematical functions for one-dimensional density distribution, processing of design data of ray-tracing files)



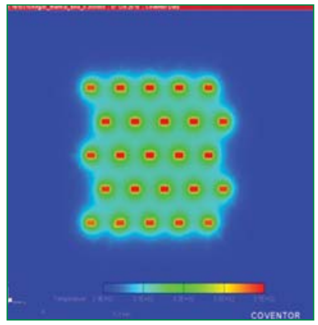


FP7 Project
Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology

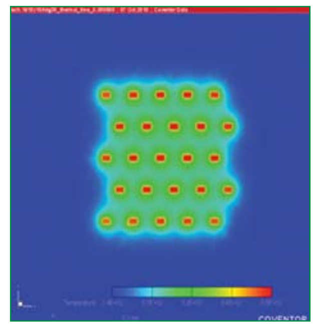
• **Thermal transient analysis of the step-embossing process for large area DOEs**
(Cooperation with Simulation, Modelling and Computer Aided Design Laboratory)
Simulations with CoventorWare software for thermal transfer of the embossing steps for complex Ni tools in a polymeric substrate: Temperatures in the PMMA for the tool with 25 pixels at 0.3s –1st embossing step



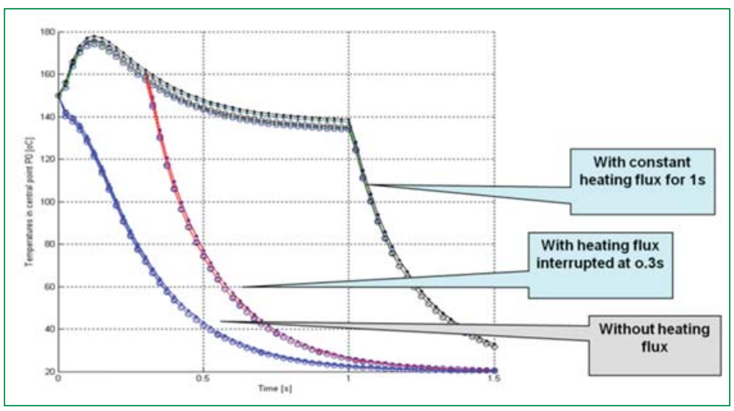
Multi-pixel tool lay-out



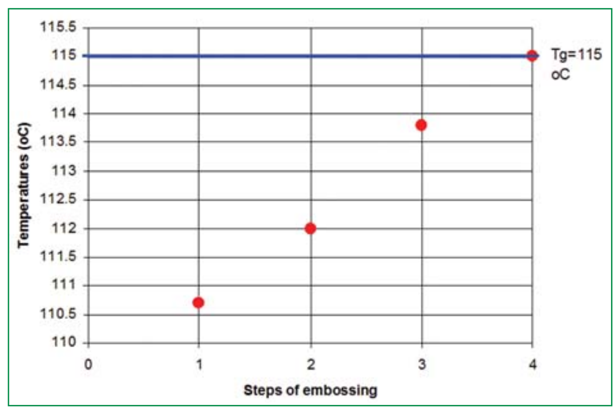
With air cooling



Without air cooling



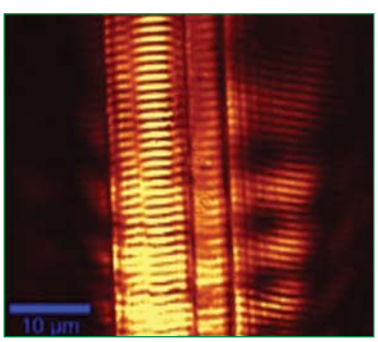
Temperatures in central point P0 of the central pixel



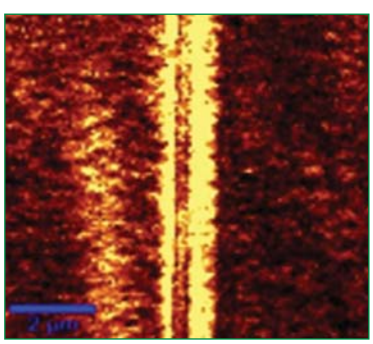
Temperature at 0.1s for the 25-pixel tool in a point at 10 µm distance from the border od the central pixel

Characterization of photonic waveguides by Scanning Near Field Optical Microscopy (SNOM)

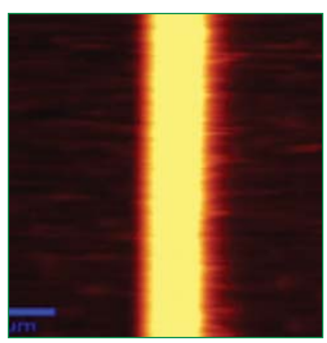
• upgraded to perform **photon scanning tunneling microscopy** for mapping the evanescent field of various photonic components. (placing on the microscope's scanning stage of an xyz nanopositioner for optical coupling between the optical fiber and the investigated photonic or plasmonic system)



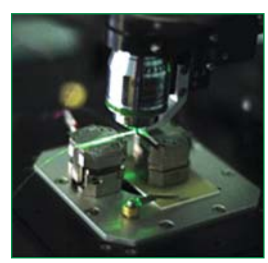
Evanescent field in a wide dielectric waveguide measured with SNOM working in **photon scanning tunneling microscopy (PSTM)**



Evanescent field in a dielectric loaded plasmon polariton waveguide measured with SNOM working in **photon scanning tunneling microscopy (PSTM)**



AFM image of a dielectric loaded plasmon polariton waveguide acquired simultaneously with the SNOM image



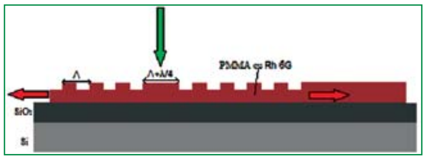
SNOM upgrade by placing on the microscope's scanning stage of an xyz nanopositioner

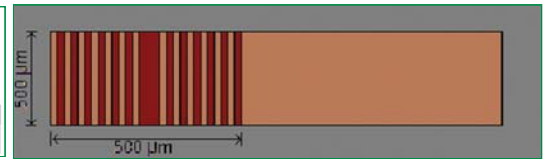
Contact persons: Dr. Cristian Kusko (cristian.kusko@imt.ro),

Results

Dye laser with Bragg grating on Rh6G doped PMMA

The Bragg grating with Λ in the range 256-270 nm was obtained using 3D electron beam lithography in low contrast electronoresit (PMMA 35K)





Fabrication process:

• **DUV lithography** for waveguide patterning (PMMA doped with Rh6G)

• **3D EBL** in low contrast electronoresit (PMMA 35K) for the Bragg grating with L in the range 256- 270 nm

The device will be integrated in microfluidic systems for biosensing applications

IMT core program Convert- project **PN 09 29 02 05**- cooperation with Microphysical characterization laboratory (EBL, SEM).

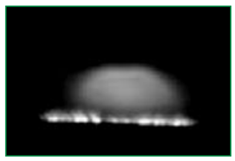
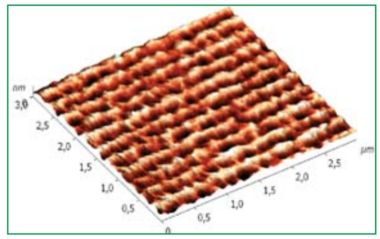
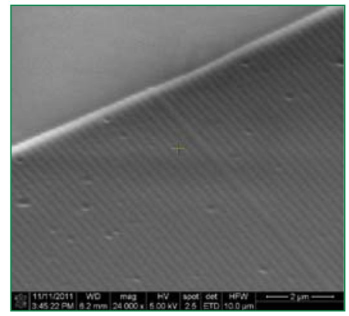


Image of the output light

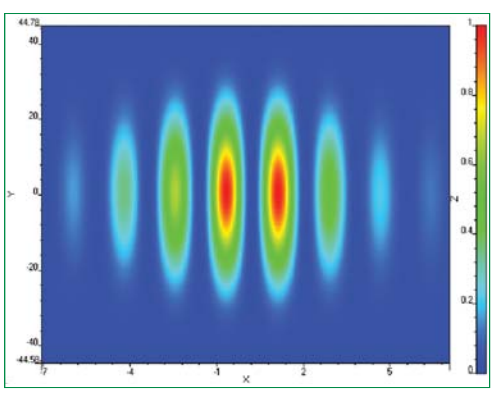




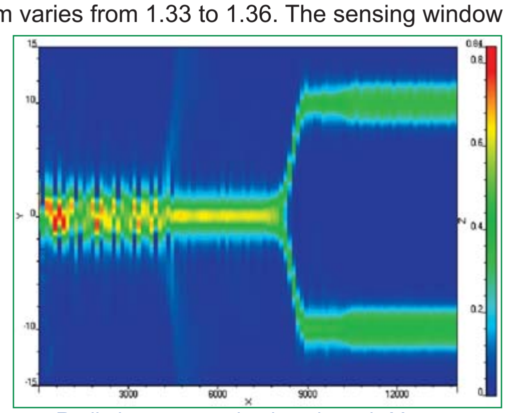
SEM (a) and AFM (b) images of the Bragg gratings patterned on the top of Rh6G-PMMA waveguides

Design of microphotonic sensors for biomedical and or environmental applications

Photonic integrated sensor on silicon substrate based on the configuration of Young interferometer is simulated with Beam Propagation Method. The core and cladding materials of the photonic sensor are polymeric materials. This sensor works for the detection of the surrounding medium refractive index variation. From the far-field fringe displacements it has been obtained that their position shift with 118 microns if the refractive index of the analysis medium varies from 1.33 to 1.36. The sensing window length is 400 microns, the reference and sensing waveguides are placed 20 microns from each other and the distance between Young interferometer and the sensing element is 10 mm. The interfringe distance is about 315 microns.

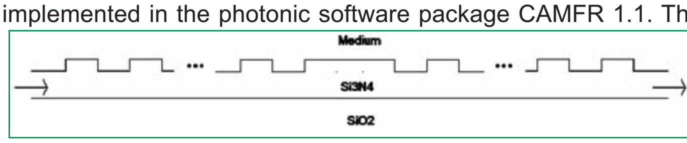


Simulated far field pattern



Radiation propagation in polymeric Young interferometer

A photonic integrated circuit refractive index sensor based on the Fabry- Perot interferometer has been proposed. The high reflectance mirrors are defined by Bragg gratings. The variation of the transmission spectrum with the refractive index of the medium is calculated with planar mode expansion method implemented in the photonic software package CAMFR 1.1. The shallow Bragg gratings are made by etching the waveguide core on a few tens nm depth. For obtaining a high reflectivity a hundred grating periods are considered for each mirror.



Schematic diagram of Fabry-Perot sensor with Bragg grating

Postdoctoral grants POSDRU/89/1.5/S/63700

SERVICES OFFER:

Modelling, simulation, CAD

• modelling, simulation CAD for active and passive micro/nano-photonic devices and micro-optics.

• concept & design studies, development of new tools (customized) especially for "linking" different commercial software to offer a coupled simulation (opto-electro-mechanical analysis) for optical MEMS and sensors

Characterization

• spectral ellpsometry of the nanometric thin films and multilayered structures from different materials –dielectrics, conductive oxides, polymers, semiconductors:

• Raman spectroscopy for physical and chemical material analysis of solids, liquids and solutions

• Near field optical microscopy: transmission, reflection, collection, fluorescence

• Confocal microscopy: transmission, reflection, fluorescence, can be upgraded with a Raman spectrometer;

• Atomic force microscopy: contact and AC – Mode

• Optoelectrical characterization of devices

Laboratory of Micromachined Structures, Microwave Circuits and Devices

• Main areas of expertise
• European Projects
• Research Team
• Specific facilities

The laboratory is one of the promoters of the RF – MEMS topics in Europe. The lab has coordinated the FP4 **MEMSWAVE** project (one of the first EU project in RF MEMS) nominated in 2002 for the Descatres prize. It has participated in the FP6 network of excellence "**AMICOM**" (2004 -2007) with new and original results obtained in cooperation with key players in the European research in this topic (LAAS–CNRS Toulouse, VTT Helsinki, FORTH Heraklion). The laboratory is now involved in the **MEMS-4-MMIC** FP7 Strep, **NANOTEC** FP7 IP and **SMARTPOWER** FP7 IP.

The laboratory is coordinating (together with the microphotonics Lab) the FP7 "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" **MIMOMEMS**. Since 2009 the laboratory is member of **LEA "Smart MEMS/NEMS Associated Lab"** together with LAAS-CNRS Toulouse and FORTH Heraklion.

Main areas of expertise: • Development of a new generation of circuits devoted to millimeter wave communications based on the semiconductor (Si, GaAs, GaN) micromachining and nanoprocessing;
• Design and manufacturing of micromachined, passive circuits elements, monolithically and hybrid integrated receiver front-ends based on silicon and GaAs micromachining;
• Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN, GaN);
• Microwave devices based on carbon nanotubes;
• Microwave devices using CRLH materials (metamaterials);
• MEMS and NEMS technologies developement;
• New design tools for microwave ciruits design based on modern mathematical tools;

European Projects:

• **MIMOMEMS** - FP 7, REGPOT call 2007-1 "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" (2008-2011);
• **MEMS-4-MMIC** - FP7-ICT-2007-2, No.204101-"Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration", (2008-2010);
• **SMARTPOWER** - FP7-ICT-2011-7, No 288801, "Smart integration of high power electronics for industrial and RF applications" Coord Thales Research&Technology, France, 2011-2014;
• **NANOTEC** - FP7-ICT-2011-7, No 288531 - "Nanotechnology for Adaptive Communication and Imaging Systems based on RF-MEMS"-, Coordinator Thales Research & Technology, France, 2011-2014;
• **ENIAC JU projects:**
• **MERCURE** (ENIAC-2009-1) "Micro and Nano Technologies Based on Wide Band Gap Materials for Future Transmitting Receiving and Sensing Systems" (2010 – 2012);
• **NANOCOM** (ENIAC-2010-1) "Reconfigurable Microsystem Based on Wide Band Gap Materials, Miniaturized and Nanostructured RF-MEMS" (2011 – 2013);
• **MNT-ERANET** "MEMS Based Millimeterwave Imaging System" acronym MEMIS (2010-2012);

✓ **International bilateral cooperations**

• The laboratory has bilateral governmental cooperations with University of Pretoria, South Africa and with Korea Electrotechnology Research Institute, Korea.

National Projects:

• In the IDEAS programme, all three proposed projects were successful: *"Nanoelectronic devices based on grapheme for high frequency applications"* (coordinator Dr. M. Dragoman), *"Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices"* (coordinator Dr. A. Muller) and *„Millimeter-wave Front-End for Imaging in Security and Medical Applications"* (coordinator Dr. D. Neculoiu). The three years projects started in October. 2011.
The laboratory had finished five Partnership (PN II) projects, three Capacities (PN II) projects, three CEEX projects as coordinator, two CEEX projects as partners and four projects in the MINASIST+.

Awards: Finalist of the Descartes Prize 2002 of the EC for the coordination of the MEMSWAVE Project, Romanian Academy Prize "Tudor Tanasescu" for "Micromachined circuits for microwave and millimeter wave applications MEMSWAVE".

Research team has multidisciplinary expertise in physics and electronics of microsystems and is composed of 11 senior researchers (9 of them with PhD in physics, electronics, microwave and chemistry), one PhD in electronics and two master students.

Specific facilities:

Computers and software for microwave electromagnetic simulations (IE3D, Fidelity and CST software packages); "On wafer" measurement system in the 0.1 -110 GHz range (microwave network analyzer Anristu in Karl SUSS Microtec Probe Station), Frequency Syntesizer Agilent up to 110 GHz; Spectrum Analyzer Anritsu up to 110 GHz; Tektronix digital serial analyzer DSA8200 with TDR module; Keithley Semiconductor characterization system, Optical profiler WLI – Photomap 3D; Millimeter wave power-meter in 0.1 – 40 GHz range, Measurement accessories.

Results

Laboratory head: Dr. Alexandru Müller (alexandru.muller@imt.ro)

M. Sc. in Physics at Bucharest University (1972) and PhD in Physics at Bucharest University in 1990;

Competences: Silicon, GaAs and GaN micromachining and nanomachining: manufacturing of RF MEMS components and circuits, technological process in GaAs MMICs, manufacuring of microwave passive membrane supported circuits (1997-European priority), micromachined inductors, filters and antennae, monolithically as well as hybrid integrated receiver front end modules, acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of WBG semiconductors (AlN , GaN).

Dr. Müller is the coordinator of the European project FP7 REGPOT (2008 – 2011) "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors"MIMOMEMS - Project No 202897

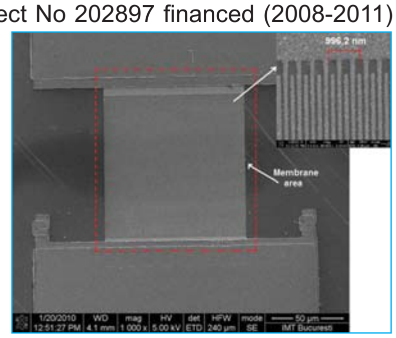
Dr. Müller has coordinated the **European Project FP 4 MEMSWAVE (1998-2001)**, and was the leader of the Romanian team in the FP6 NoE AMICOM and member of the Board of Directors of this project He is member of Micromechanics Europe Workshop and MEMSWAVE workshop steering committees. He is member of IEEE and EuMA. Dr Muller is member of PhD Jury in Politechnica Univ. Bucharest and Univ. Paul Sabatier/LAAS Toulouse. Co-editor of the Micro and Nanoengineering Series (Romanian Academy). He had invited papers at important European conferences. He has more than 150 contributions in books and international journals/conferences.

Dr. Müller is finalist of the Descartes Prize competition 2002 of the European Community with the MEMSWAVE Project, Romanian Academy Prize "Tudor Tanasescu".

Main achievements:
FP7 Project MIMOMEMS

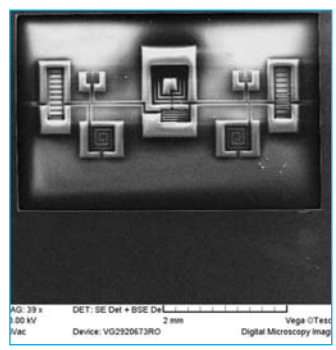
European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" (MIMOMEMS), project No 202897 financed (2008-2011) through the "Regional potential" part (REGPOT call 2007-1) of the European Framework Pogramme (FP7) (www.imt.ro/mimomems)
Co-ordinator: Dr. Alexandru Muller, alexandru.muller@imt.ro

The overall aim of the MIMOMEMS project was to bring the research activity in Radio-Frequency (RF) and Optical-MEMS at the National Institute for R&D in Microtechnologies (IMT-Bucharest) to the highest European level and create a European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems (MEMS) for Advanced Communication Systems and Sensors.



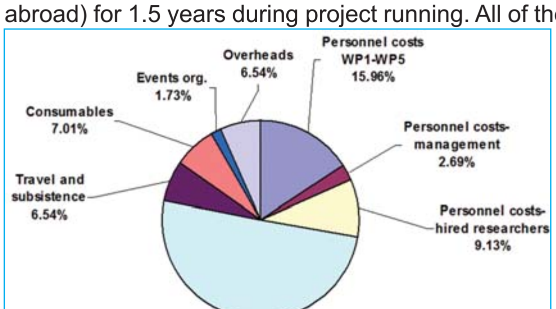
GaN membrane supported UV photodetector (A Muller, G. Konstantinidis, A. Dinescu et all, Thin Solid Films 520 (2012) pp 2158-2161)

This big FP7 project (1.1 MEUR) has facilitate a strong development of the microwave lab team in terms of human potential (3 Post docs, now permanent staff, hired), upgrade research equipment, funding mobilities for: (i) preparing new FP7 and FP7 related projects proposals. Results: 6 winning projects: 2 FP7 Integrated Projects (SMARTPOWER and NANOTEC both 2011-2014); 2 ERA- NET and 2 ENIAC projects, (ii) new research topics development in cooperation with twining partners (FORTH Heraklion and LAAS Toulouse)-Results: State of the art results published in high ranked ISI journals have been obtained in cooperation with FORTH Heraklion and LAAS CNRS Toulouse in GaN based acoustic devices for GHz applications.



SEM photos of the WLAN 5200 filter bottom view (A. A. Muller, D. Neculoiu, A. Cismaru, P. Pons, R. Plana, D. Dascalu "Novel micro-machined lumped bandpassfilter for 5.2GHz WLAN applications" Int J Electron Commun AEU (Elsevier) 65, 2011, 1050-1053)

The project costs
The project claimed for 1,042,757 EUR. Six months after the end of the project costs have been already approved by the EC. It is clear that the most important amount of funds was devoted to equipment acquisition which was a major target of the project.
An important contribution was devoted to hire the three Post Doc scientists (two of them from abroad) for 1.5 years during project running. All of them are now included in the permanent staff of the Institute. Research mobilities (38 stages coming to Romania from abroad for common work in the labs, training stages and participation at the CAS conference and the 2 workshops and 83 stages abroad of Romanian scientists (to work in twining partners labs, to disseminate at Conferences the scientific results of the work) have been granted by the MIMOMEMS project. Personnel costs have been partially used to participate at the preparation of 20 project proposals.



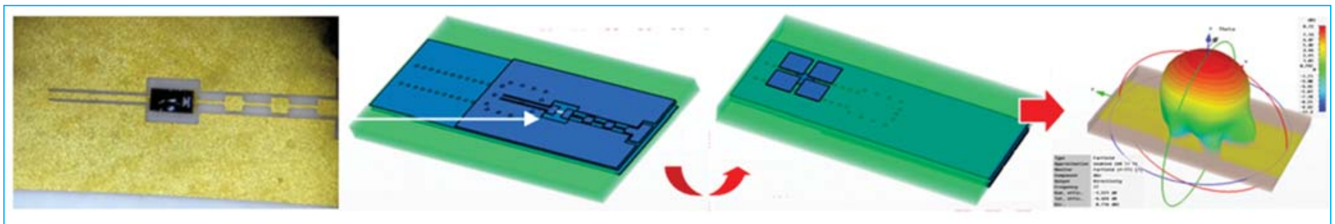
Cost breakdown for the MIMOMEMS project (post-calculation)

FP7 Project MEMS-4-MMIC

"Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration" acronym MEMS-4-MMIC, FP7-ICT-2007-2, No.204101. STREP project financed (2008-2012) through the ICT Challenge 3: Components, Systems and Engineering, Micro/Nanosystems of the European Framework Pogramme, FP7.
Coordinator: R. Baggen, IMST GmBH
Partners: IMST GmbH, Germany, Swedish Defence Research Agency- FOI, Sweden, Technical Research Centre of Finland-VTT, Finland, OMMIC, France, **National Institute for research and Development in Microtechnologies-IMT Bucharest, Romania,** Institut d'Electronique de Microélectonique et de Nanotechnologie, IEMN, France.
Contact person for IMT: Dr. Dan Neculoiu, dan.neculoiu@imt.ro

The **MEMS-4-MMIC** project aims at **the integration of RF-MEMS switches onto Monolithic Microwave Integrated Circuits (MMIC)** creating highly integrated multifunctional building blocks for high-value niche applications. RF-MEMS is an essential building block of next-generation smart systems that are characterised by cost-effective designs, compact build-up, high performance, flexibility and configurability. IMT is involved in the design and characterization of K-band frequency millimeter wave circuits.

IMT results in 2011

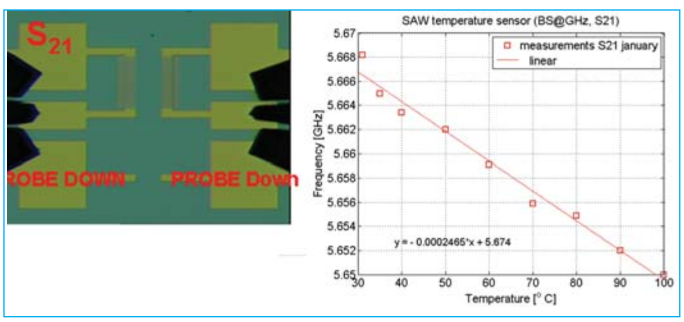


77 GHz receiver designed by IMT Bucharest and processed at VTT Finland [A. C. Bunea, M. Lahti, D. Neculoiu, A. Stefanescu, T. Vaha-Heikkila, Investigation of Substrate Integrated Waveguide in LTCC Technology for mm-Wave Applications, Proceedings of Asia – Pacific Microwave Conference, Melbourne December 2011]

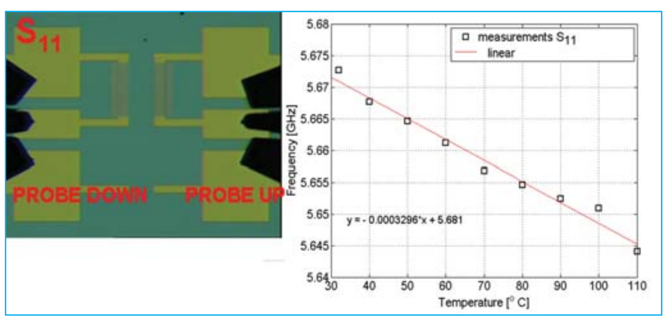
FP7 IP SMARTPOWER (2011-2014)

Responsible of IMT team Dr. Alexandru Muller

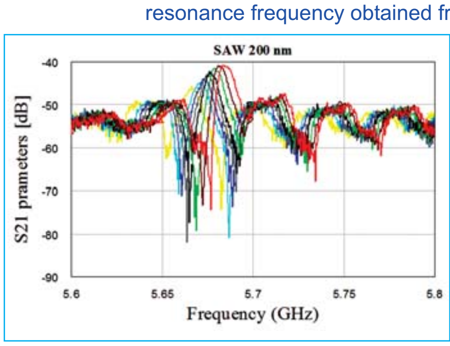
This project started in September 2011 and the IMT team involved in the manufacturing of a GHz SAW based temperature sensor, which will be integrated with an HPA and LNA. Work will be performed in cooperation with FORTH Heraklion and Thales TRT the coordinator of the IP. The sensing system will be placed close to the MMIC in a radar developed by Thales Systemes Aeroportuare to measure the temperature which has to be read far from the radar. Preliminary determinations for the frequency shift for the SAW sensor have been done already.



The SAW structure and the temperature dependence of the resonance frequency obtained from S_{21}

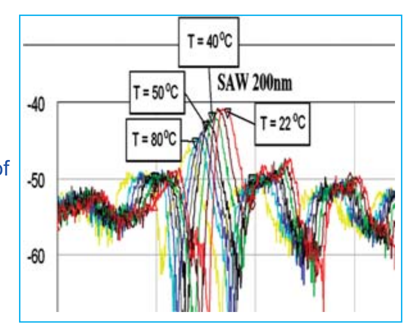


The SAW structure and the temperature dependence of the resonance frequency obtained from S_{11}



The variation of S_{21} parameter vs temperature for the SAW structure used as sensor (left)

Detail with the peak region from the variation of S_{21} parameter vs temperature(right)



Results

FP7 IP NANOTEC (2011-2014)

Responsible of IMT team Dr. Alexandru Muller

This project started in September 2011 and is coordinated by Thales TRT In this project IMT will be involved in design and characterization of 94 GHz front ends manufactured on GaAs and SiGe. IMT will be also involved in characterization MEMS and NEMS based millimeter wave switches.

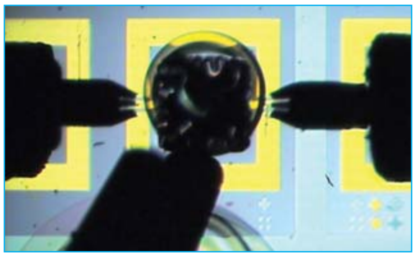
ENIAC Project MERCURE

Coordinator: Thales TRT France,

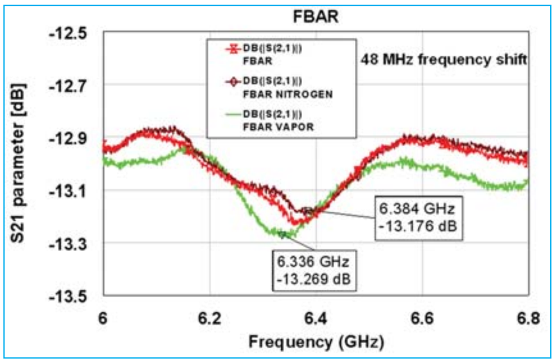
Partners: Thales Systems Aeroportes France, VIA Electronic GmbH, Germany, IMT-Bucharest, FORTH Heraklion, TopGaN Ltd, Poland, Univ Warsaw, Poland, SHT, Sweden

Contact person for IMT: Dr. Alexandru Müller, alexandru.muller@imt.ro

IMT results for the humidity sensor structure:



The coated FBAR structure during S parameter measurements



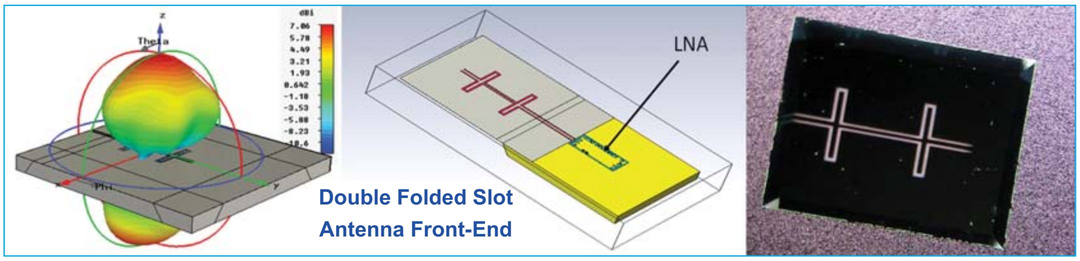
S parameters results for a FBAR structure coated with polymer (red in surrounding humidity, brown dry nitrogen flow and green after water spray)

MNT-ERANET " MEMS Based Millimeterwave Imaging System" acronym MEMIS

Coordinator: LAAS Toulouse; Partners IMT-Bucharest, VTT Helsinki

IMT involvement: design, simulation and characterization of micromachined millimeter wave circuits and monolithic and hybrid integrated receiver front-ends.

Contact person for IMT: Dr. Dan Neculoiu (dan.neculoiu@imt.ro)



National Project PN2 - IDEAS – "Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices " 2011-2014

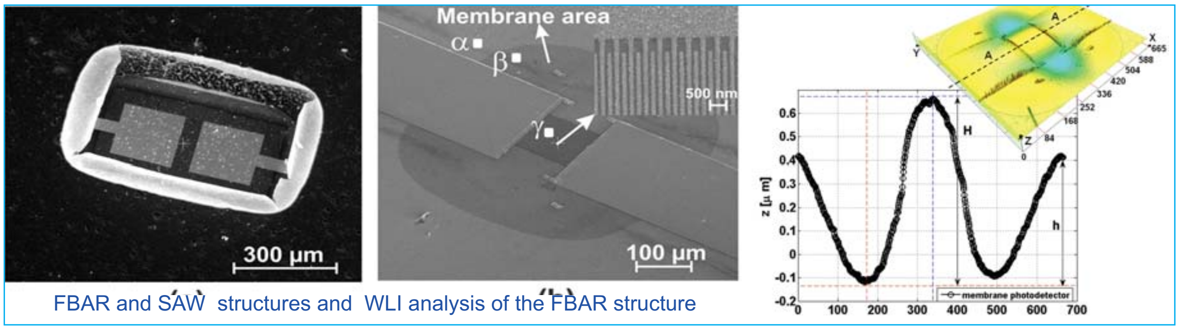
Project leader: Dr. Alexandru Muller (alexandru.muller@imt.ro)

The main target of this project consists in the development of new technologies, based on micromachining and nanoprocessing of GaN/Si, in order to manufacture innovative devices, having performances representing state of the art:

(i) GaN membrane supported UV photodetectors, with IDT (interdigitated transducers) having fingers and interdigits about 100nm wide, devoted to applications where backside illumination is necessary,

(ii) GaN based SAW structures working in a frequency range reaching the X band, using IDTs with digits and interdigits 100-150nm wide,

(iii) the integration of a nano-processed SAW structure with a membrane supported UV photodetector in a novel SAW assisted photodetector structure



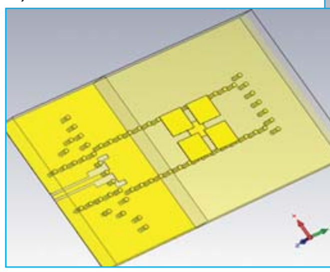
FBAR and SAW structures and WLI analysis of the FBAR structure

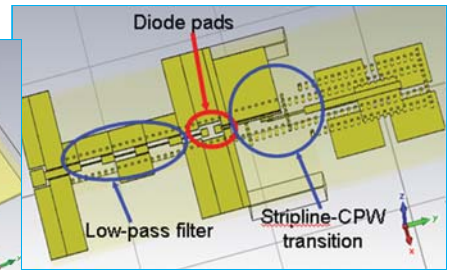
National Project PN2 - IDEAS – "Millimeter-wave Front-End for Imaging in Security and Medical Applications " 2011-2014

Project leader: Dr. Dan Neculoiu (dan.neculoiu@imt.ro)

Main objectives of the project:

1. Advanced electromagnetic (EM) modeling and optimization of high performance antennas and antenna arrays;
2. Improvement of the detector element;
3. Technological processing: silicon micromachining and substrate integrated waveguide (SIW) fabrication;
4. EM modeling and experimental characterization of different materials;
5. Hybrid integration of the LNA and Schottky diodes with the antenna front-end.

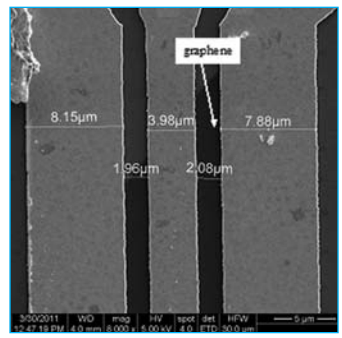




FBAR and SAW structures and WLI analysis of the FBAR structure

National Project PN2 - IDEAS – "Nanoelctronic devices based on graphene for high frequency applications" 2011-2014

Project leader: Dr. Mircea Dragoman (mircea.dragoman@imt.ro)

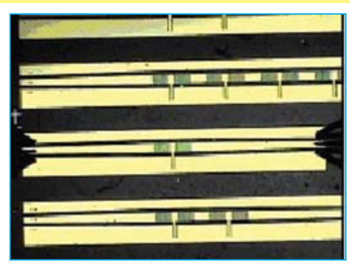


The project will explore the graphene devices for ultrafast communications beyond 60 GHz. Similar to the famous Moore law, the Edholm law states that the need for higher bandwidths in wireless communications will double every 18 months. Today, for the wireless LANs, the carrier frequencies are around 5 GHz and the data rates are 110-200 Mb/s. However, according to Edholm law, wireless data rates around 1-5 Gb/s are required in few years from now. This means that the carrier frequencies for wireless communications should become higher than 60 GHz. However, in this bandwidth the devices and circuits able to form a wireless link at room temperature are very scarce. This limitation is due to relative high charge scattering rate and relative low mobilities encountered in all semiconductors at room temperature. So, in few years the ever increasing demand for ultrafast wireless communications will not be fully satisfied using the existing semiconducting technologies. To solve this expected bottleneck , we propose a radical solution which consists in using other materials and circuit configurations to fulfill the clear tendencies indicated by Edholm law. More specifically, we intend to design, fabricate and test miniaturized devices which work beyond 60 GHz based on graphene. Why graphene? Graphene has mobilities which are greater by orders of magnitude compared to compound semiconductors. Even in the worse situation when graphene is deposited on silicon dioxide the typical room temperature mobility is 2-3 times higher than that of silicon. So, graphene is a good candidate for new and innovative devices that will work beyond 60 GHz. This is expected to fulfill the high demand of ultrafast nanoelectronic devices.

New direction - Millimeter Wave CRLH devices on silicon substrate

Dr. Gheorghe Sajin (gheorghe.sajin@imt.ro)

The direction is illustrated by a CRLH filter structures designed and analyzed, using an appropriate software. Each CRLH cell was obtained with CPW interdigital capacitors and CPW short ended inductive transmission lines. The devices were processed using an one mask process on silicon substrate for future integration in a more complex microwave circuit. Measurements on fabricated devices demonstrates a good correspondence between the simulation results and the experimentally obtained data.

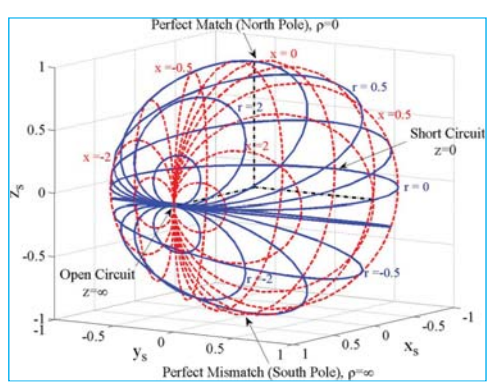


Band pass filter (BPF) with one, two and four CRLH cells

G. Sajin, S. Simion, F. Craciunoiu, A. C. Bunea, A. Dinescu, M. Zamfirescu, L. Neagu, R. Dabu, (2010), ***Millimeter Wave Metamaterial Band-Pass Filter by Femtosecond Laser Ablation,*** Proceedings of European Microwave Conference, Paris, France, 26 Sept. – 01 Oct. 2010, pp. 1393 – 1396, ISBN 978-2-87487-015-6.

New direction - New methods for microwave circuits design, based on modern mathematical tools

A 3D Smith chart which can be used for the design for all passive and active circuits, has been developed by PhD student Andrei Muller (PhD since Oct 2011). Using the concepts of extended complex plane, inversive geometry and Riemann sphere the generalized Smith Chart can include all the complex loads in the reflection coefficient plane.



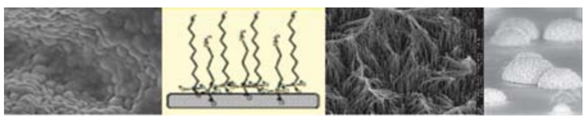
3-D spherical Smith Chart obtained after performing the stereographic projection
[**Andrei A. Muller**, Pablo Soto, Dan Dascalu, Dan Neculoiu and Vicente E Boria, " A 3D Smith Chart based on the Riemann Sphere for Active and Passive Microwave Circuits", IEEE Microwave and Wireless Comp. Lett, vol 21 no 6 pp 286-288, 2011]

Center for Nanotechnologies (CNT-IMT) under the aegis of Romanian Academy

Laboratory of Nanobiotechnology

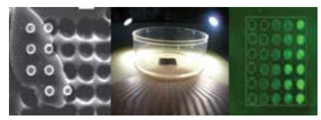
The **Nanotechnology Laboratory** was established since the foundation of IMT in 1996 and from that point a constant evolution has been taken place: it was affiliated to the Romanian Academy in 2001 and represented the base of the IMT's Center for Nanotechnologies (**http://www.imt.ro/organisation/research%20labs/L1/index.htm**).
The laboratory **mission** can be defined as research, development and education in **nano-bio-technologies.**
Main areas of expertise can be classified as:
- fabrication of functional nanomaterials / nanostructures, study, control and tuning of their properties towards applications, together with appropriate surface functionalization methods;
- advanced characterization techniques for nanomaterials and thin films envisaging further improvement of their properties to find the optimal solutions for the device' design and also, more recently, addressing the health risks of these new nanomaterials and the associated industrial nanoproducts, in order to underpin their safe use.
- multilevel systems, (N)MEMS devices and sensors, for applications in many interdisciplinary areas, from biomedicine (optoelectronic biosensors) to energy harvesting (miniaturized fuel cell devices such as clean energy sources).
More specifically:

FUNCTIONAL NANOMATERIALS



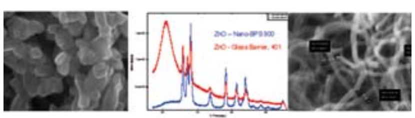
Preparation and characterization of
• metallic / semiconducting nanoparticles;
• polymeric multilayer structures;
• Si based nanocomposite materials, looking also to appropriate surface functionalisation.

NANOMEDICINE



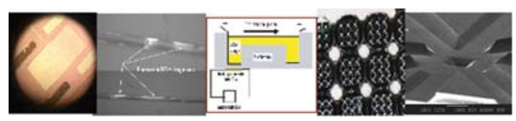
• **drug delivery:** Si based integrated devices and nanoSi based microcarriers
• **diagnosis:** DNA and protein biochips designed in microarray technology

NANO-TOXICOLOGY



• **nanoparticle and nano-product analyses** in the different stages of their life cycle;
• **development of standard methods and protocols** for risk and life-cycle assessment of engineered nanomaterials, going forward to validation of measurements and test methods, for reliable reference methods

NANO-TOXICOLOGY



Design and fabrication of:
• **opto-electrochemical sensors** for biological investigations, environment monitoring, food quality control;
• **lab-on-chip platforms targeted in nanomedicine;**
• **integrated hybrid micro-DMFC;**
• **integrated systems for drug releases;**

The ***research team*** has a multidisciplinary expertise and is formed of **6** senior researchers with a background in physics and chemistry, **3** young researchers (with a background in physics and engineering).

Laboratory head: Dr. Mihaela Kusko
(mihaela.kusko@imt.ro)

She obtained BSc (1998) and PhD (2006) in physics / nanotechnology from Bucharest University and since 2011 is the head of Laboratory of Nanotechnology.
Her main research activities are in the field of nanobiotechnologies, from study of nanomaterials and nanostructures to their integration in complex NEMS / MEMS devices. The foreseen applications cover a broad area, including silicon based devices for drug delivery, miniaturized fuel cells, optoelectronic biosensors and lab-on-a chip systems for diagnosis. She coordinated national funded ideas project and also partnership projects. Since 2011 she is the leader of the Romanian team in the FP7-NMP-LARGE Collaborative Project “Development of reference methods for hazard identification, risk assessment and LCA of engineered nanomaterials - NanoValid” (2011-2015).
Moreover, from 2009 she coordinates activities of master course:„Micro and nanotechnologies for medical applications” included in the program of “Electronics and Medical Informatics” specialisation from University „Politehnica” Bucharest.

Results

The laboratory has contributed to the development of new experimental and characterization laboratories in the IMT-MINAFAB (most of them installed from 2008 to now):

■ ***High resolution SmartLab X-ray diffraction system*** (Rigaku, Jp. ~ 400 kEuro) from **Experimental X - ray Laboratory – MINAFAB**;

■ ***Steady state and life time fluorescence spectrometer*** (Edinburgh Instr. ~75 kEuro) and ***DelsaNanoC-size and Zeta Potential measurement system*** (Beckman Coulter ~ 65 kEuro), part of the **Experimental laboratory for nanoparticles – MINAFAB**;

■ ***PARSTAT Electrochemical Impedance Spectrometer*** (Princeton Applied Research ~ 25 kEuro) and

■ ***Scanning electrochemical microscope*** (HEKA~100 kEuro) from **Experimental Laboratory of Biohybrid Interface Characterization – MINAFAB**.

Ongoing projects:

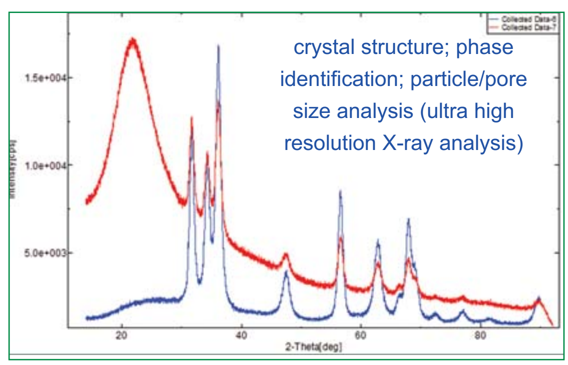
The first one was **„Development of sustainable solutions for nanotechnology based products based on hazard characterization and LCA - NanoSustain" – Acad. D. Dascalu** (2010-2013), ongoing *collaborative Small or medium-scale focused research project* (THEME 4 NMP - Nanosciences, Nanotechnologies, Materials and new Production Technologies and THEME 6 Environment, including Climate Change), focused on developing innovative solutions for the sustainable design, use, recycling and final treatment of nanotechnology-based products.

The quality of research has determined including us in the following *Large-scale integrating Collaborative* ***project*** **(THEME NMP.2010.1.3-1 Reference methods for managing the risk of engineered nanoparticles) "Development of reference methods for hazard identification, risk assessment and LCA of engineered nanomaterials – NanoValid" - Dr. M. Kusko** (2011 – 2014) which has started in November 2011, and aims to go forward to validation of measurements and test methods, for reliable reference methods development, in cooperation with international standardization bodies and the concerned industry.

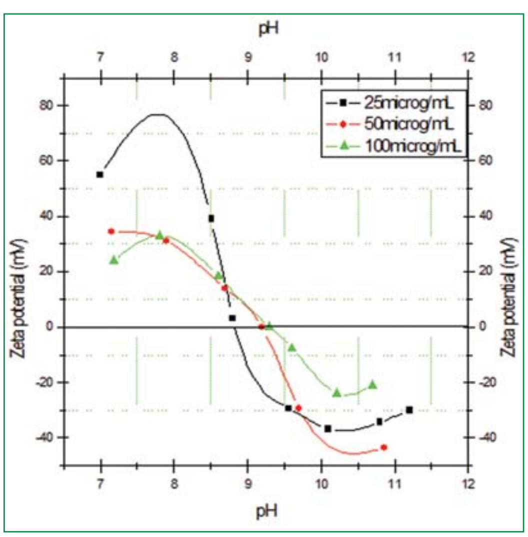
2 POST-DRU Projects, 4th Research Area – MEMS/NEMS devices

▮ "3D architecture based on nanometric elements on Si for cellular electrophysiology" PostDoc project M. Kusko (2010-2012)

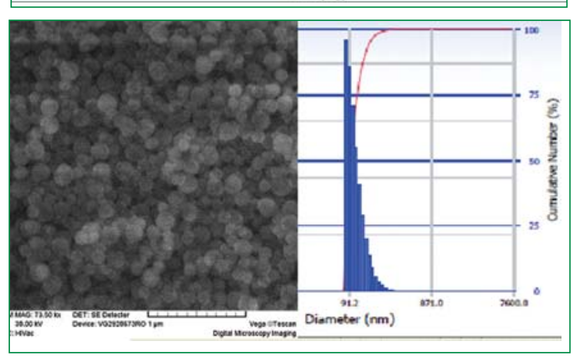
▮ "Silicon micro-ribbons for ultimate single-molecule sensing applications" - PhD project A. Iordanescu (2010-2012)



crystal structure; phase identification; particle/pore size analysis (ultra high resolution X-ray analysis)



hydrodynamic diameter (dh) and surface charge distributions as function of dispersion media



TiO_2 water dispersion dh=109.1 nm PI=0.198

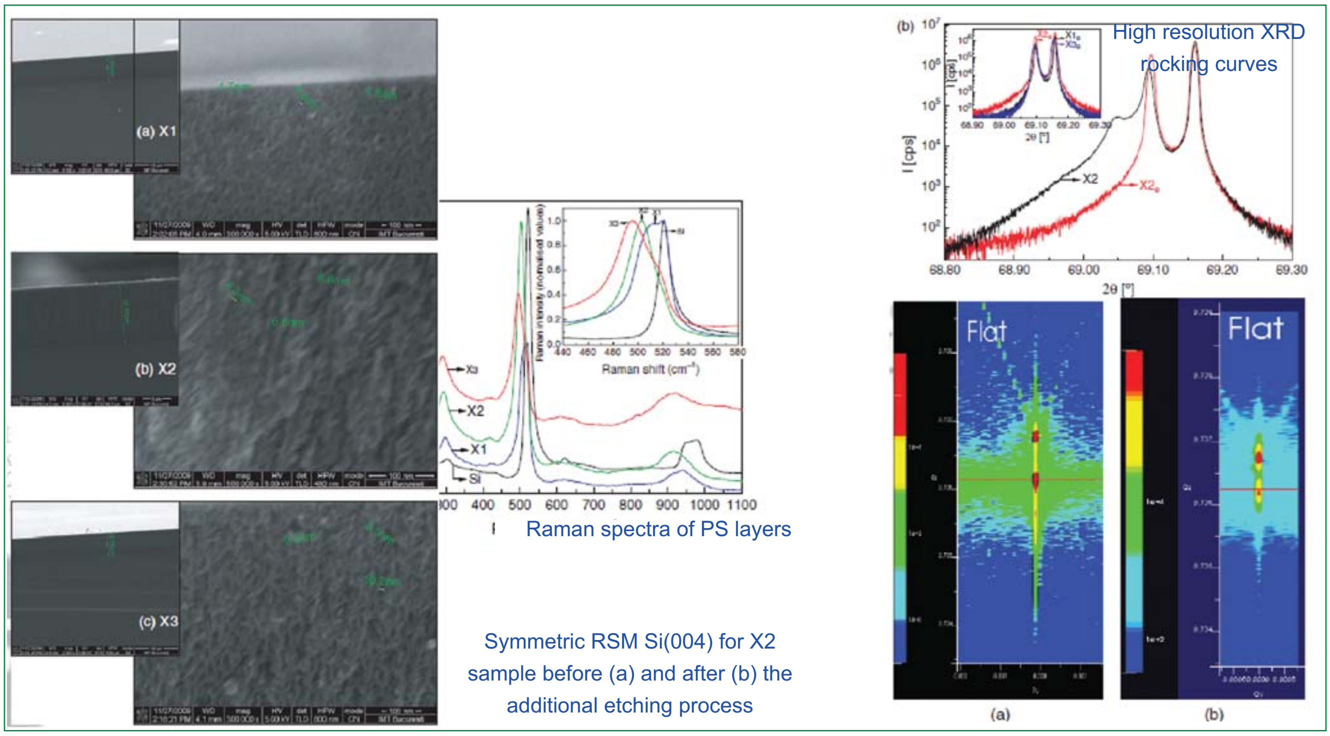
Results

Journal of Nanoscience and Nanotechnology
Vol. 11, 9136–9142, 2011

Nanostructure and Internal Strain Distribution in Porous Silicon

Mihaela Miu*, Mihai Danila, Irina Kleps, Adina Bragaru, and Monica Simion

Porous silicon (PS) layers with different degrees of porosity have been fabricated and their nanostructure has been investigated using complementary methods as FE–SEM (field emission scanning electron microscopy), SAXS (small-angle X-ray scattering), and Raman spectroscopy. Correlation of these results with strain analyses is also required for envisaged applications in MEMS technology. Symmetrical and asymmetrical rocking curves obtained by high-resolution X-ray diffraction completed with reciprocal space maps (RSMs) explain the features observed in Raman spectra: the PS film in-depth contains two layers—bulk and highly strained superficial layer, between them being a graded strain layer.



High resolution XRD rocking curves

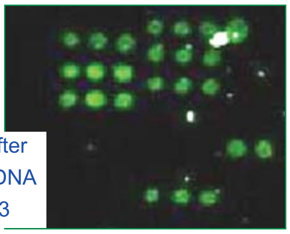
Raman spectra of PS layers

Symmetric RSM Si(004) for X2 sample before (a) and after (b) the additional etching process

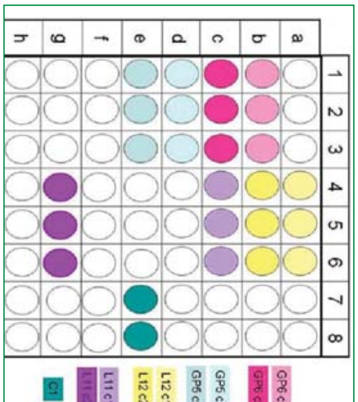
Journal of Nanoscience and Nanotechnology
Vol. 11, 9102–9109, 2011

Using Nanostructurated Silicon Support in Microarray Technology

Monica Simion[1,*], Lorand Savu[2], Antonio Radoi[1], Mihaela Miu[1], and Adina Bragaru[1]



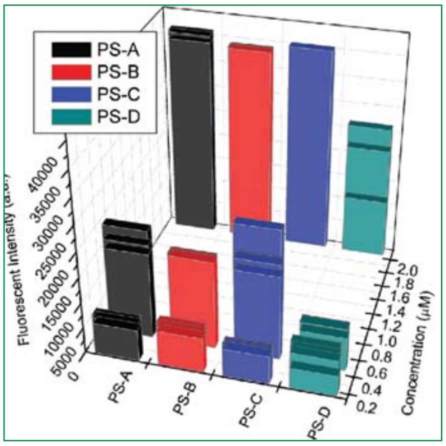
Scanned image after hybridization with DNA labeled with Cy3

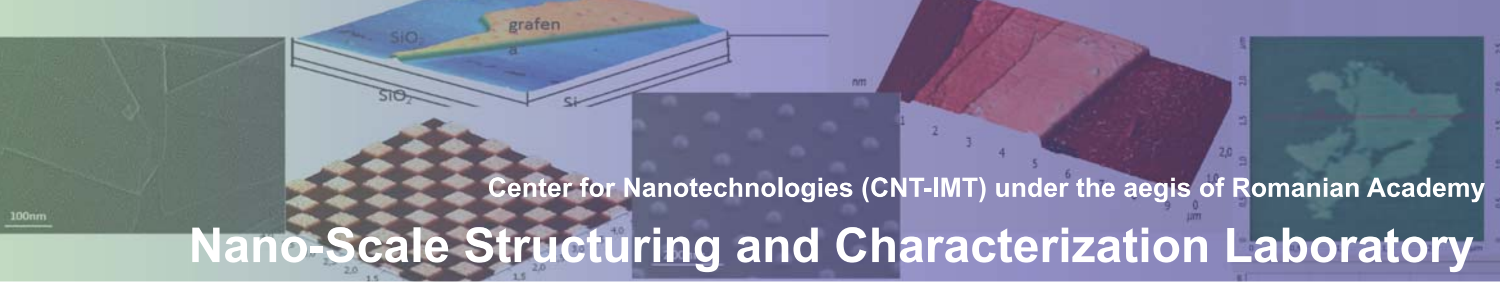


Design for microarray technology

Here we report the preparation and evaluation of nano-porous silicon surfaces for HPV detection based on DNA micro-array technique. Two different surfaces based on similar porous structure chemically modified in order to efficiently immobilize ss-DNA specific for HPV viruses were investigate.

We performed HPV DNA microarray hybridizations with human DNA probes labeled with fluorescent Cy3. DNA samples were selected from patients infected with HPV viruses confirm by diagnosis methods.





Nano-Scale Structuring and Characterization Laboratory

Mission: Research and development in the field of characterization and structuring methods for materials and processes at micro and nano scale. Application of high resolution surface investigation techniques to solve engineering problems at these scales, especially investigation of correlations between technological process parameters-structure and structure-properties in order to obtain materials for specific applications etc. The laboratory is the first one in Romania developing research and providing services for nanolithography, using the Electron Beam Lithography technique.

Main areas of expertise: Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Electron Beam Lithography (EBL), Optical Microscopy.

Research team: is composed of 3 senior researchers with background in Physics and Electronic Engineering, an early stage researcher with background in Chemistry and 2 MSc students in Electronics.

Specific facilities:

• **Multifunctional Scanning Probe Microscope Ntegra Aura (NT-MDT Co.).**
Features various operating modes (AFM, STM, EFM, MFM, SKPM, Conductive AFM etc); Could be operated in different environments (ambient, controlled gaseous, liquid, low vacuum); Built-in capacitive sensors; Scanning by head; Scanning by sample; STM head; Module for electrical measurements.
Scan range: 100x100x10 μm, noise level, X,Y: 0,3 nm, Z: 0,06 nm, non-linearity in X, Y with closed-loop sensors < 0.15 %.

• **FEI Nova NanoSEM 630- Ultra High resolution Field Emission Gun Scanning Electron Microscope** - This SEM delivers very high resolution surface information at low accelerating voltages and can be widely used in many applications: nanotechnology, materials analysis, semiconductor technology, quality assurance, life sciences. It features SE and BSE detectors in chamber and TTL, also LV BSE detector and high resolution SE detector for low vacuum working mode, true eucentric sample stage with encoder, charge compensation technique (water vapors).

• **SEM - TESCAN VEGA II LMU** - General Purpose Scanning Electron Microscope with thermionic electron gun (tungsten) which is able to achieve 3 nm resolution at 30 kV accelerating voltage. For electrostatic charge compensation it is able to work in low vacuum (nitrogen) up to 150 Pa.

• **EBL - Raith Elphy Plus** - pattern generator for Electron Beam Lithography, attached to a FEI SEM. Features: 6 MHz high-speed pattern generation hardware, 16 bit DAC vector scan beam deflection, 2 ns writing speed resolution.

• **Raith e_Line - Electron beam lithography** and nanoengineering workstation. It is a versatile electron beam lithography system having complied with the specific requirements of interdisciplinary research at nanoscale. The main features are: thermally assisted field emission gun, laser interferometer stage with 100 mm by 100 mm travel range and 2 nm resolution achieved by closed-loop piezo-positioning, modules for nanomanipulation, EBID and EBIE. Minimum achievable line width is better than 20 nm, stitching accuracy 40 nm and overlay accuracy 40 nm.

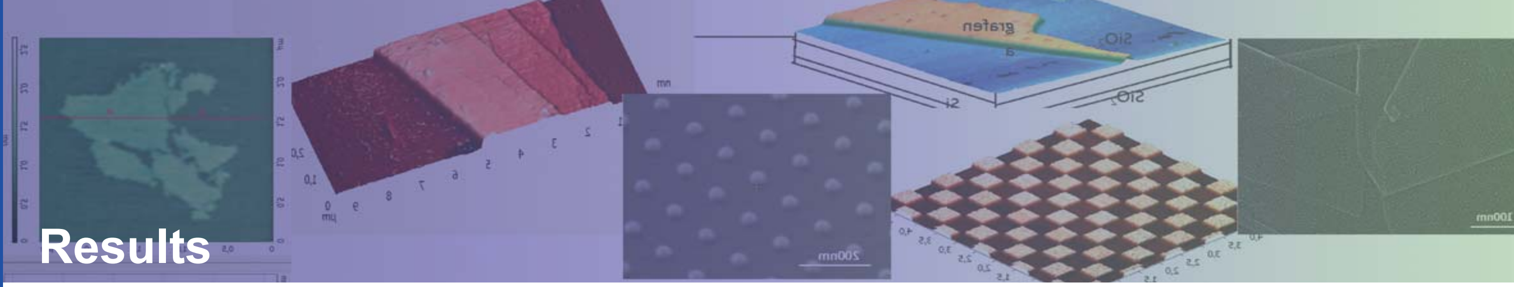
• **Nano Indenter G200 (Agilent Technologies Inc.)**
Nanomechanical characterization equipment operating by instrumented indentation and scratch testing. It provides access to various mechanical properties of small-volume samples, such as thin films. Module for continuous stiffness and dynamic measurements (e.g. polymers). Methods compliant with ISO 14577 and ASTM 2546.
Maximum load: 500 mN, load noise floor: 100 nN, max indentation depth: 500 μm, displacement noise floor: 1 nm, position accuracy: 1 μm.

Laboratory Head: Dr. Adrian Dinescu (adrian.dinescu@imt.ro)

Dr. Adrian Dinescu obtained the M.Sc. degree (1993) in Solid State Physics and the PhD degree (2010) in physics, both from University of Bucharest. Between 1993 and 1997, Adrian Dinescu was with the National Institute for Research in Electronic Components, working in the field of optoelectronic devices fabrication.

Since 1997 he is with IMT-Bucharest where he is currently involved in micro and nanoscale characterization using FE-SEM and in structuring at the nanoscale using Electron Beam Lithography. His expertise also includes materials processing and device fabrication.

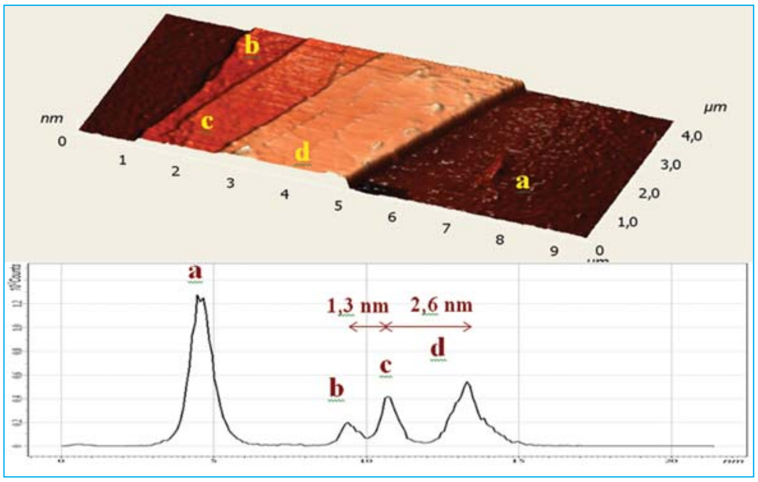
Currently he is the head of Nano-Scale Structuring and Characterization Laboratory. Dr. Adrian Dinescu coordinated 8 national research projects and was the coordinator from the Romanian part of the FP-7 STREP project - CATHERINE. He co-authored about 25 papers in refereed international journals.



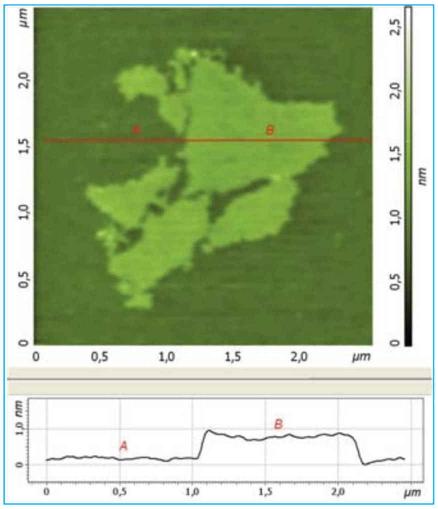
Results

SPM-based experimental studies of graphene materials

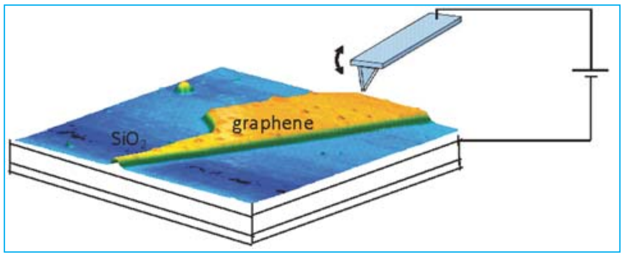
High-resolution imaging of SLG and FLG on SiO_2 and mica substrates provided insight into graphene morphology at nm scale and its peculiarities due to manufacturing and processing conditions. The pertinence of AFM-based measurements of graphene thickness was assesed by comparison to other analytical techniques.



Folded FLG graphene on SiO_2 substrate together with its height histogram

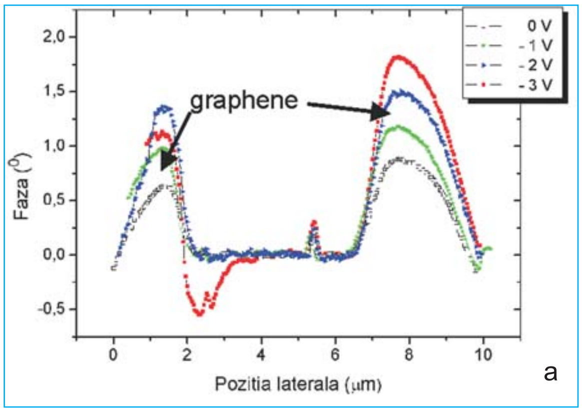


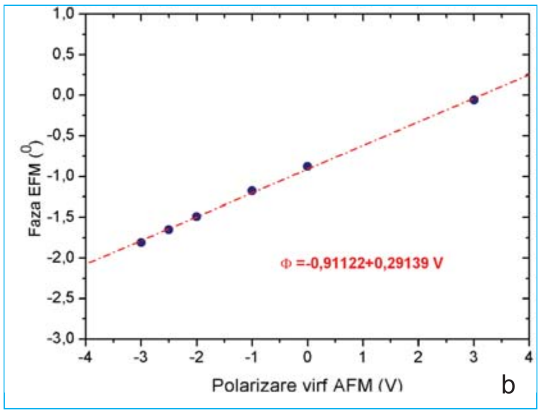
Graphene oxide flake on mica substrate and height profile on the marked red line



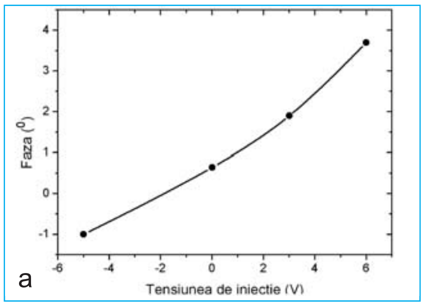
The experimental set-up in EFM measurements of graphene

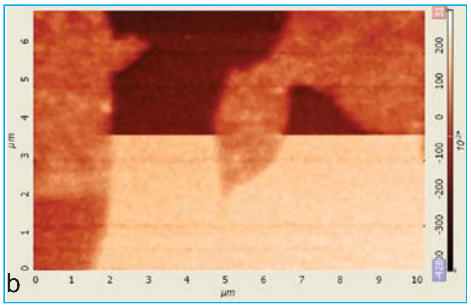
SPM studies of SLG and FLG graphene allowed to prove the presence and assign the sign of the residual charge on graphene surface. In particular, EFM studies revealed that previous exposure to electron beam in SEM induce a strong charging effect on graphene. A series of experiments aimed at controlled charge injection on graphene surface and probing of the transferred charge by EFM-based techniques.

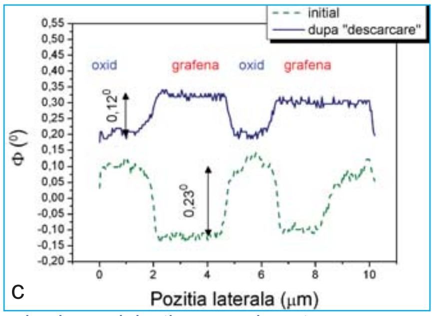




Graphene flake EFM measurements:
(a) average profile at several values of the tip bias; (b) linear dependence of the EFM signal on tip bias

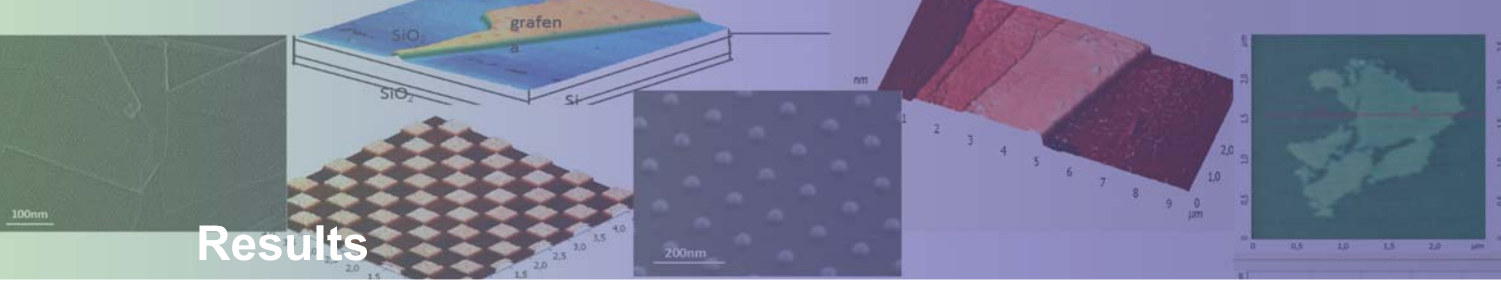






a) Magnitude of the charge induced on graphene surface as a function of tip bias in charge injection experiments
b,c) EFM signal before and after sudden electrical discharge of graphene through the AFM tip

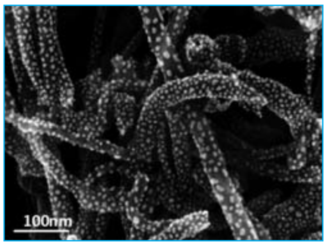
Project: National basic funding Project CONVERT +, PN II - (2009-2011)
Contact person: Phys. Raluca Gavrila, e-mail: Raluca.Gavrila@imt.ro



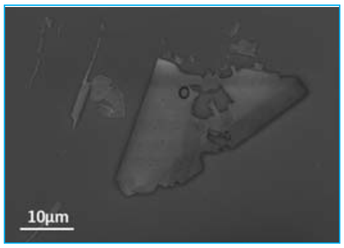
Results

High resolution – LV- SEM imaging

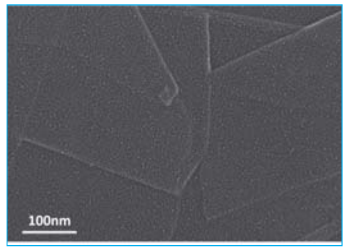
Low Voltage SEM (FEI Nova NanoSEM 630 and Raithe_Line) has been used to investigate a large variety of samples at the nano-scale. We are able to perform true surface imaging for low atomic number or non-conducting specimens without coating them with metal.



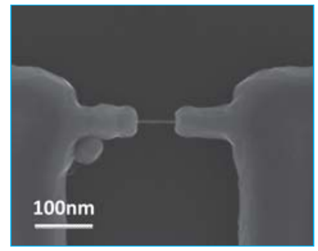
Gold decorated carbon nanotubes (HV=1kV)



Single graphene layer on silicon dioxide (HV= 200V)



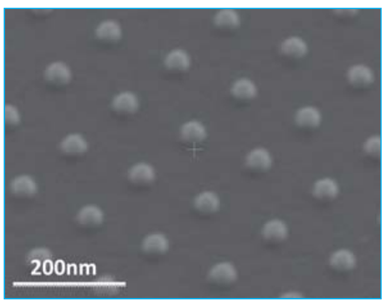
Gold decorated graphene nanoplatelets (HV=3kV)



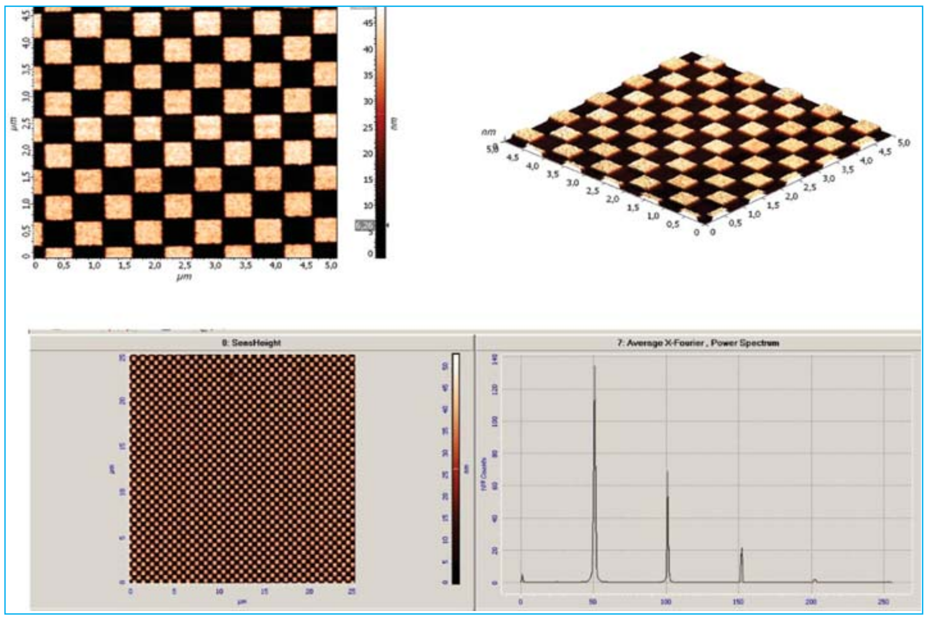
Silicon nanowire (HV= 10kV)

Nanoscale structuring using Electron Beam Lithography

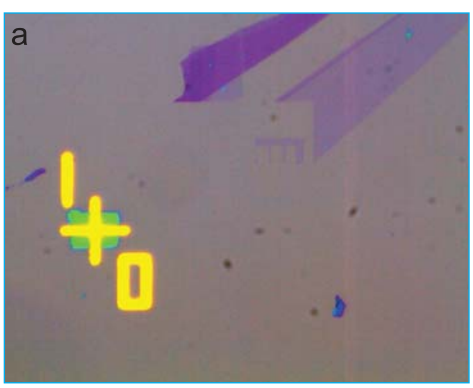
Combing the strengths (resolution and flexibility) of Gaussian beam electron beam lithography with some other nanofabrication technologies (wet and dry etching, thin film deposition and lift-off) we fabricated a variety of nanostructures with applications in photonics, SPM calibration, DUV lithography, microwave devices.

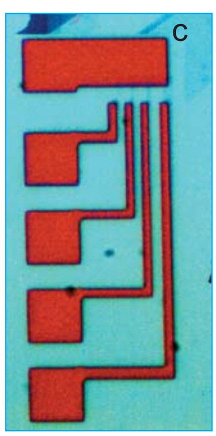


Tungsten nanodots deposited by EBID on silicon dioxide (equipment: Raith e_Line)

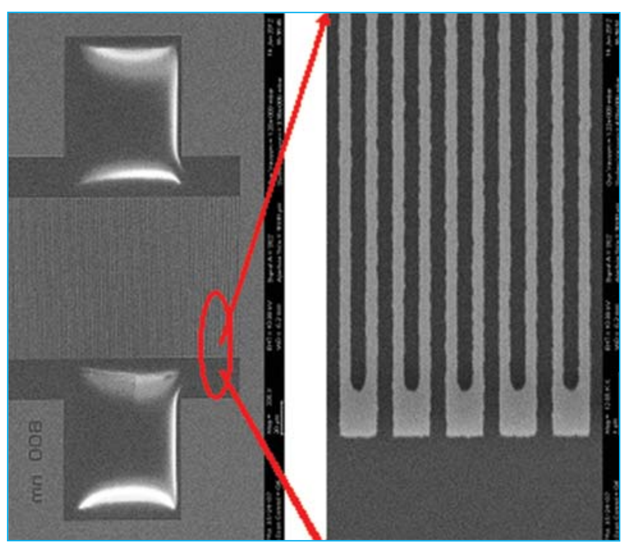


Gold on silicon structures for AFM calibration: 5µm, 2µm, 1µm and 500nm pitch





Nanofabrication of a graphene based back gated field effect transistor: a) patterning and RIE of a SLG e-beem;
b) SLG raphene ribbons;
c) the view of the graphene FET;



Chrome on glass mask for DUV photolithography - 300nm minimum line width

Contact: Dr. Adrian Dinescu, adrian.dinescu@imt.ro

Center for Nanotechnologies (CNT-IMT) under the aegis of Romanian Academy

Molecular Nanotechnology Laboratory

- • Mission
- • Main areas of expertise
- • Research Team

Mission: Based on its multidisciplinary background and experience, the Molecular Nanotechnology Lab aims towards major scientific achievements and recognition in the following areas:

• Functional integration of biological components (peptides, proteins, antibodies, DNA or DNA-like nucleotides and fragments etc.) with micro/nano processed inorganic structures

- creating new, application oriented, properties by physical and chemical modifications (physical processes, organic or inorganic doping).

- devising microsystems and devices using controlled manipulations and nano-bio assembly on surfaces, 1D and 0D materials.

- developing structures and methods for molecular detection and identification, based on optimally integrated electrical, chemical, optical effects.

• Investigation and control of physical and chemical properties of new nanomaterials

- carbon-based nanomaterials (CNT's, graphene, carbon dots etc.): synthesis, assembly and development of nano composites with optimal properties for energy harvesting, thermal and biomedical applications.

- development of materials and devices for optical and acoustic applications with micro- and nanostructuring technologies (e.g., DPN, DRIE, 3D printing).

- synthesis of new High-Tc superconductor materials in bulk or thin films and novel thin films of complex oxides with controllable morphological and electrical transport properties.

Our strategy is to create a unified experimental-theoretical framework, by combining techniques for preparation of substrates and low-dimensional materials as well as controlled molecular depositions, with methods of theoretical modeling and numerical analysis (first-principles quantum mechanics, molecular dynamics), with the final goal of uncovering the mechanisms for creating useful functional properties based on the interaction of (bio)molecules with micro/nano-objects and external fields. Current research in the lab focuses on developing innovative solutions for biosensors, functional composite nanomaterials, and molecular identification based on electronic transport phenomena in nanostructures.

Main areas of expertise: • Experimental nano- and microtechnology of organic and inorganic materials: cleanroom processes and chemical procedures for molecular electronics; design, fabrication, characterization and simulation of MEMS and biosensors; synthesis and characterization of carbon based functional materials; synthesis and characterization of doped crystals (thin films of complex oxides and high-temperature superconductors).

• Advanced characterization of electronic materials: characterization of surface doping profiles with local probes; interaction of surface waves with micro-structured surfaces.

• Modeling, simulation and analysis of quantum, microscopic and macroscopic phenomena in organic and inorganic materials and systems: electronic structure and optical properties of crystals, molecules and low dimensional nanostructures by ab-initio and empirical methods; quantum transport in nanostructures; ab-initio molecular dynamics; dielectric response of living cells and composites; plasmonic response of metallic nanoparticles; neuronal firing detection, signal analysis and data mining for functional neurosurgery; algorithms for image guided surgery.

Research team: The lab was established in 2009, but it gained critical mass between 2010 and 2011, when 6 researchers out of its current 8 members joined the team construction. The lab team consists from 3 physicists, 3 chemists and 2 engineers. All members are PhD graduates and the average age is 38.

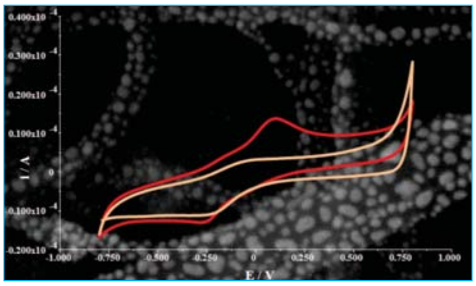
Laboratory Head: Dr. Radu Popa (radu.popa@imt.ro)

Radu Cristian Popa received a MSc in Electrical Engineering (Applied Electronics) from the Polytechnic University of Bucharest (1989), and a PhD in Quantum Engineering and Systems Science at University of Tokyo (1998). He was assistant professor in Electrical Engineering at the Polytechnic University of Bucharest (1991-1995), and Senior Researcher at the Science Solutions Intn. Lab., Inc., Tokyo (1998-2003), where he conducted competitive industrial research for various Japanese corporations, companies and universities, mainly in numerical modeling and analysis of complex phenomena and devices. 2003-2006, he was scientific associate at the University of Tuebingen, Germany and then became Development Director at Neurostar, GmbH, Germany, designing and developing hardware and software solutions for functional neurosurgery and neuroscience systems for brain microelectrode exploration and electrophysiological recording, and medical imaging.

Radu Popa joined IMT Bucharest in 2007 and is presently director of the Center for Integrated Systems Nanotechnologies And Carbon Based Nanomaterials. Main scientific interests include atomistic analysis of electronic transport in molecular junctions in the framework of the rational design paradigm for molecular scale electronics.

Research highlights

NADH electrochemical probe based on the use of carbon nanotubes decorated with nanosized (poly)crystalline gold

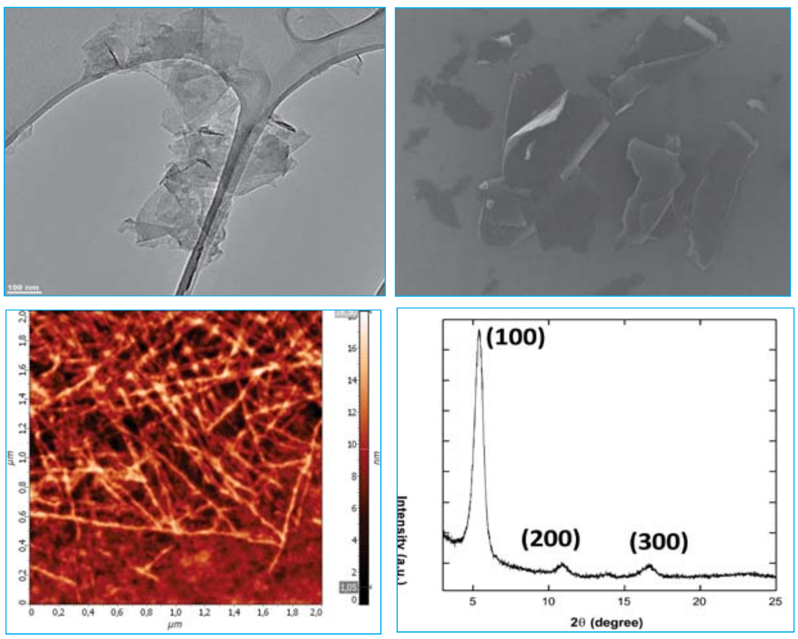


CNT's with nanosized sputtered gold used as modification material for glassy carbon electrodes. Optimized electrochemical detection of NADH.

The importance of NADH as a cofactor in naturally occurring enzymatic reactions, as well as the potential applications in NADH based biosensors are key aspects in the bio-electro-analytical research field. Direct electrochemical oxidation of NADH to its corresponding NAD+ at the bare/unmodified electrodes is highly irreversible, requires working applied potentials greater than 0.8 V, and proceeds with coupled side reactions, poisoning the electrode. Multiwalled carbon nanotubes with nanosized sputtered gold were used to modify a glassy carbon electrode. The oxidation of NADH begins at negative potentials (around – 100 mV vs. Ag/AgCl), and the anodic peak potential, corresponding to the irreversible oxidation of NADH, is found at + 94 mV.

Contact: Dr. Antonio Radoi (antonio.radoi@imt.ro)

Synthesis of Graphene for Bulk Heterojunction Organic Photovoltaic Cells

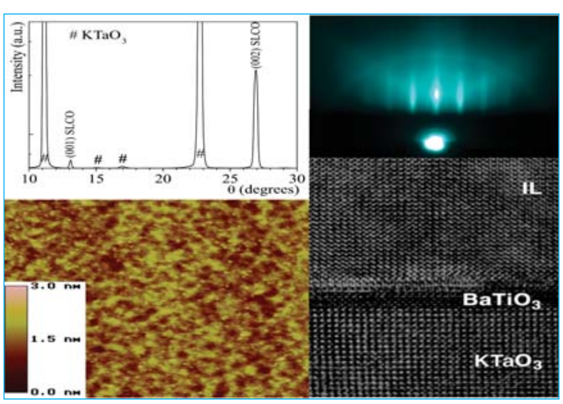


Due to its higher electron mobility than fullerene derivatives and to its tunable energy level through controlling its size, number of layers and functionalization degree, graphene is a good candidate for the acceptor material in intermixed bulk heterojunction solar cells if we carefully control the donor-acceptor interface and the nanoscale morphology of the conjugated polymer within the photo active layer such that the charge separation and transport to the electrodes will be effectively achieved. Graphene nanosheets (GN) with lateral size of hundreds of nanometers and thickness of 10 to 60 nm have been synthesized by solution phase exfoliation of graphite in organic and aqueous solvents at high temperatures and pressures.

SEM and AFM images of graphene nanosheets (GN) obtained by liquid phase exfoliation. GIXRD patterns of P3HT:GN (0.8 wt% GN) film.

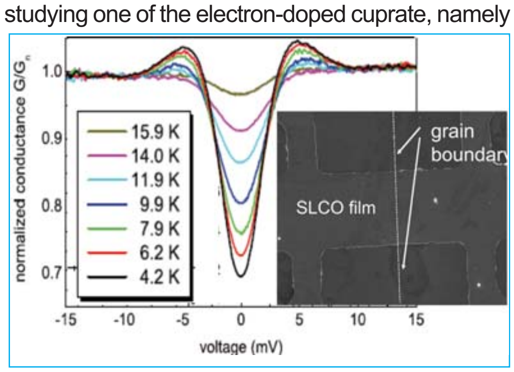
Contact: Dr. Monica Veca (monica.veca@imt.ro)

Studies on the microscopic mechanism of superconductivity



Sr0.85La0.15CuO2 thin film grown by pulsed laser ablation on KTaO3 (001) substrate: XRD, RHEED, AFM and TEM data.

Apart from their promising application potential, the copper oxide superconductors (HTSc) remain a challenge in solid state physics, due to the unknown microscopic mechanism of superconductivity in these materials. From the HTSc materials we are studying one of the electron-doped cuprate, namely Sr1-xLaxCuO$_2$ (SLCO), for x=0.15-0.175, in order to determine the order parameter symmetry in this system. For this, we have fabricated grain boundary junctions on 24° and 30° BaTiO$_3$-buffered SrTiO$_3$ [001] tilt symmetrical bicrystal substrates and studied their structural and transport properties. The success of this research may enable a variety of further studies on basic properties of the HTSc materials and the implementation of SIS tunnel junctions, SQUIDs, and superconducting transistors as key elements for superconductor electronic devices.



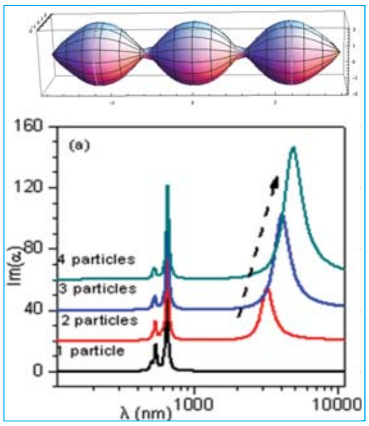
Sr0.85La0.15CuO$_2$ thin film grown by pulsed laser ablation on KTaO$_3$ (001) substrate: XRD, RHEED, AFM and TEM data.

Contact: Dr. Victor Leca (victor.leca@imt.ro)

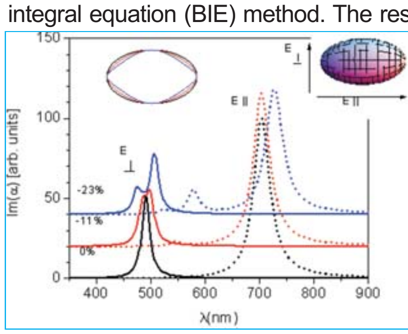
Research highlights

Theoretical analysis method to determine shape and cluster effects on localized surface plasmon resonances of metallic nanoparticles

Surface plasmon resonances appear in visible and infrared part of the electromagnetic spectrum at the interface between a dielectric and a metal whose real part of the dielectric constant is negative. In metallic nanoparticles (NPs) the surface plasmons are localized and termed as localized surface plasmon resonances (LSPRs). The LPRs in metallic NPs have been now studied extensively for more than a decade and induced a strong impetus in the development of the specialized Plasmonics field. The applications of Plasmonics span from sensing and waveguiding to optical nanocircuits for integration with electronics. In this research, LSPRs in spheroid metallic NPs were calculated by a boundary integral equation (BIE) method. The response to the incident electro-magnetic field and the NP polarizability are shown to depend on eigenvalues and eigenfunctions of the integral operator associated with BIE. The NP polarizability is conveniently expressed as an eigenmode sum of analytic terms when the Drude model of metals is used. The proposed polarizability projection method proved to provide good accuracy while offering a direct analytical basis for deterministic design of plasmonic nanostructures with desired properties. Shape and geometry effects of the spheroids and of clusters thereof are evaluated based on this accurate analysis method.



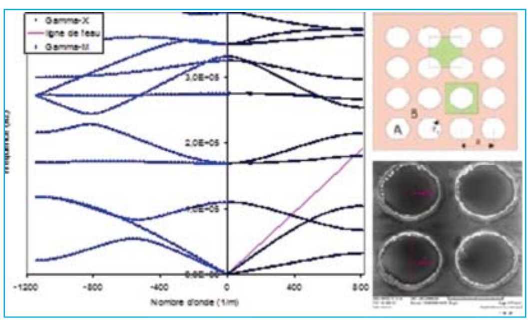
Spheroid cluster effect: emergence of a new resonance in IR due to the cluster junctions.



Spheroid shape effect: volume variation over 12% induces structural changes in the spectrum.

Contact: Dr. Titus Sandu (titus.sandu@imt.ro)

Phononic crystals for negative refraction of acoustic wave



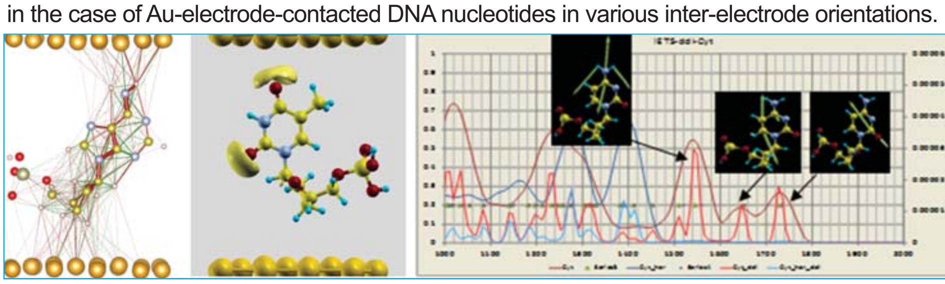
Phononic crystals are composite materials with absolute forbidden bands, made of a periodic arrangement of several elastic materials. We use numerical models for the study of negative refraction in phononic crystals. In a second stage, based on design and optimization of such structures, we fabricate and characterize their acoustic wave focusing properties.

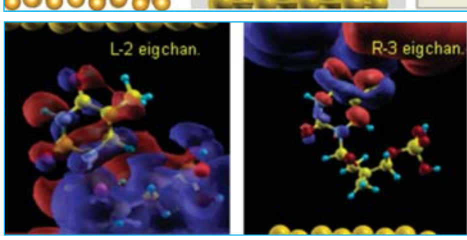
Dispersion curves of Lamb wave mode in 2D finite thickness $LiTaO_3$ structure.

Contact: Dr. Cristina Pachiu (cristina.pachiu@imt.ro)

Atomistic first principles analysis of elastic and inelastic electronic transport properties of DNA nucleotides in single molecule junctions

Detailed understanding of the phenomena related to coherent electron transport in molecular junctions is a fundamental pre-requisite in the efforts towards rational design in molecular scale electronics. Specifically, elastic and inelastic charge transfer is usually studied in metal-molecule-metal sandwiches to uncover the effects of molecular conformation/ orientation and electrode coupling, as well as of the energetic alignment of the frontier orbitals with the metal Fermi level. From these studies one could aim at drawing essential design principles for creating desired transmission functions (structure-function relationship), as well as for optimizing the contact chemistry for predictable and stable transport characteristics. In this context, we carried out a thorough analysis path using DFT+NEGF formalisms in the case of Au-electrode-contacted DNA nucleotides in various inter-electrode orientations. Our results include the decomposition of charge transfer in bond-currents, identification of donor sites for cation doping, inelastic transport spectra (simulation of IETS characterization), reconstruction of transmission eigenchannel wavefunctions. The next focus will be on studying junctions with other molecular families - specifically, conjugated molecules with incrementally complex conformations - aiming at drawing simplified design rules for function-structure rational design.





Theoretical, DFT+ NEGF based studies of electronic properties, elastic and inelastic transport, for DNA nucleotides in various inter-electrode orientations. Bond-currents, donor sites, IETS spectrum correlated with vibrational modes, transmission eigenchannels.

Contact: Dr. Radu popa (radu.popa@imt.ro)

Centre for Nanotechnologies and Carbon-based Nanomaterials

Simulation, Modelling and Computer Aided Design Laboratory

• Mission
• Expertise
• Main areas of expertise
• Research Team
• Specific facilities
• European Projects

Mission: research, development and application of **simulation and modeling techniques** oriented to collaborative research projects, education (short courses, labs for students: hands on training), **services** (enabling access to hardware and software tools) and consulting (design/optimization) in the field of micro-**nano-bio/info technologies. The lab plays a key role in supporting the research activities of other laboratories of IMT Bucharest.** Besides its main mission the lab is developing techniques for rapid prototyping from micro- to macro (up to centimetre size structures), **dip pen nanolitogrphy, MOEMS and MEMS micro-sensors** and investigate new **classes of advanced materials with application in nanodevices**.

Expertise:

• **design, simulation, development/optimization of MEMS/ MOEMS** components and devices (switches, cantilevers, bridges, membranes, microgrippers); mechanical, thermal, electrical and electrostatic, piezoelectric, **as well as coupled field** (static and transient) **analysis**;

• **modeling and simulation for multiphysics** problems;

• **design, modelling and simulations of microfluidic components and systems** for biomedical applications and micro-electronic fluidic systems (valves, pumps-with various actuation principle as electrostatic, piezoelectric, pneumatic, electroosmotic-cell reservoirs, microchannels, filters, mixers, heaters, etc.)-the microfluidic analyzes include: fluid dynamics in microstructures (general flow, fluid mixing, thermal analysis); electrokinetic flow (electrophoresis, electroosmosis);

• modelling of electronic structure of materials using **ab initio calculations**;

• **rapid prototyping**: design for and operation of 3D Printer based on selective laser sintering, 3D Printer;

• **design and manufacturing** of MOEMS and MEMS microsensors and microsystems;

• **characterization of physical phenomena** in wide band gap semiconductors (light emission, optical transitions, radiative-nonradiative centers, shallow and deep donors/acceptors, band gap tailoring);

Main areas of expertise:

▪ **Modelling, simulation** (mechanical, thermal, electrical and electrostatic, piezoelectric), **coupled field analysis and CAD of MEMS/NEMS;**

▪ **Development of Microfluidic structures and systems** (simulation, design and manufacturing) **for biomedical applications and micro-electronic applications;**

▪ **Development of new technologies for prototyping at micro-nanoscale;**

▪ **Synthesis, characterization and electronic structure simulation of nanostructured materials for functional opto-electronic and spintronic applications;**

Research team: The team has a multidisciplinary expertise in: mathematics, physics, electronics; he team is composed of 5 PhD, 2 PhD students, 2 physicists and 1 engineer.

Postdctoral positions in the frame of POSDRU project "Human Resource Development by Postdoctoral Research on Micro and Nanotechnologies", POSDRU/89/1.5/S/63700, 2010-2013:

● **Dr.Oana Nedelcu,** *Reserach activity "Theoretical models for coupled phenomena in microfluidics", domain: Micro-nanosystems for bio-medical applications BIO-MEMS;*

● **Dr. Eduard Franti,** *Research activity: Biomedical system for controlling artificial arms based on intelligent sensorial systems.*

Specific facilities - Specific software/hardware Tools:

• **COVENTOR 2011; • MATLAB 2011;**

• **ANSYS Multiphysics 12.1; • COMSOL Multiphysics 4.1**

• **Solidworks Office Premium 2008 ; • Mathematica 7;**

• **Origin PRO 8; • Visual Studio 2008 Pro;**

• **Dual IBM 3750 Server**, 8 quad-core Intel Xeon MP 2.93 GHz processors, 196 GByte RAM and 1 TByte HDD + 876 GByte external storage; • **Computer network for training.**

Services:

▪ **Optimization solution for increasing performances of MEMS and microfluidic;**

▪ **Microsystems design:** ***Layout 2D, Process Editor, build 3D models based on silicon technology*;**

▪ **Modelling and simulation of Micro-Opto-Electro-Mechanical Systems (MOEMS** Analysis include simulation for mechanical, thermal, electrical, electrostatic, piezoelectric, optical, electromagnetic and coupled field.

▪ **Modelling and simulation of microfluidic components and systems:** micropumps and microvalves with various actuation principles (electrostatic, piezoelectric, pneumatic, electroosmotic), microreservoires, microchannels, micromixers, microfilters. Microfluidic analysis include: fluid dynamics in microstructures (flow under pressure, thermal flow, fluid mixing), electrokinetics, bubble-drop, fluid-structure interaction.

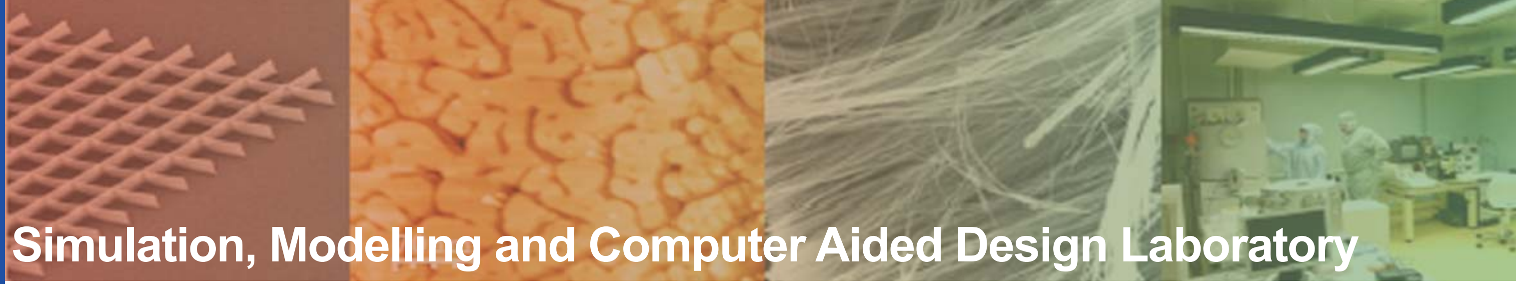
▪ **Consultancy** in computer-aided-design and microsystem simulation;

▪ **Assistance and training by research**: hands-on courses, access to computers and software.

Applications: MEMS (sensors, actuators, accelerometers), Optical MEMS, RF-MEMS, microfluidic microsystems as micropumps, micromixers, microfilters, reaction chambers used in lab-on-chips for pharmaceutical research, medical field (diagnosis, drug delivery), ink-jet devices.

• **Rapid prototyping**: design for and operation of 3D Printer based on selective laser sintering, 3D Printer based on single photon photopolymerization

• **Characterization of physical phenomena** in wide band gap semiconductors (light emission, optical transitions, radiative-nonradiative centers, shallow and deep donors/acceptors, band gap tailoring).



Simulation, Modelling and Computer Aided Design Laboratory

Teaching activities

■ Laboratories for students "Microsensors" Course, for students of the 4th year Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest

■ Courses and labs "Intelligent sensors and microsystems", for master students, Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest

International cooperation:

● **Related FP7: ENIAC "MotorBrain":** "Nanoelectronics for Electric Vehicle Intelligent Failsafe Powertrain" – ENIAC- (2011 -2014)

■ Coordinated by Infineon Technologies AG Germany

■ IMT- partner: coordinator of IMT Dr. G. Moagar-Poladian

● **FP7, IP: FlexPaet** - "Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology", IP NMP-2007-3.5-2, Contract no. 214018, (2008-2011)

■ Coordinated by Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V. Fraunhofer Institut für Produktionstechnolgie (IPT), Germany, Dr. Eng. Christian Wenzel

■ Partner L3 of IMT-Bucharest with the participation of **L5** (Mat. Rodica Voicu and Mat. Irina Stanciu)

● **Bilateral Cooperation with Institute of Applied Physics, Academy of Science of Moldova** (2010-2012): "Biochemical sensors based on nanoporous InP and metal nanpoparticles, obtained by MEMS/MOEMS techniques for electrical and optical measurements"

● **Bilateral cooperation Romania (NASR)-Japonia (JSPS)**, 2011-2012

Project: Nr.521/13.12.2011, NASR, Capacities, Module III.

● **Grant JSPS** (Japan Society for Promotion of the Science)

Grant: JASPS/RCI-2/ 11046, Nov.22, 2011, ID No. RC 21125003.

Cooperation IMT-Institute of Advanced Energy, Kyoto University

Research subject: **Experiment and Modeling of Physical Processes in Porous Silicon/Metal Systems.**

Other international cooperations

- **Universities:** a) "Johannes Kepler" University of Linz (Austria), for characterizing the piezoelectric properties of some polymer structures designed by us and realized at the 3D Printer based on selective laser sintering; b) University of Le Havre (France), for characterizing the acoustical properties of some structures develpoed at IMT-Bucharest and manufactured on the 3D Printer based on selective laser sintering (colaboration mediated by dr. Pachiu Cristina from IMT-Bucharest).
- **Companies:** Infineon Technologies AG (Germany), the project coordinator of the FP7 ENIAC MotorBrain project (see international projects above).

Other national cooperatios

- **Hospitals:** the "Bagdasar-Arseni" Neurosurgery Hospital (the single unit of this profile in Romania) for testing some surgical devices made at the 3D Printer based on selective laser sintering, surgical devices ordered by the surgeon.
- **Companies:** Infineon Technologies Romania for devising and making the demnonstrator of a torque sensor based on magnetic field measurement that be used in electric cars;

Laboratory Head: Dr. Raluca Muller (raluca.muller@imt.ro)

Dr. Raluca Müller received the M.Sc and PhD in Electronics and Telecommunications from "Polytehnica" University of Bucharest. From 1978-1994 she was researcher scientist with ICCE Bucharest; since 1994 she is with IMT-Bucharest. R. Müller is Head of the Simulation, Modelling and Computer Aided Design Laboratory.

Her main scientific interests include design and technological processes for sensors and actuators based on MEMS/MOEMS techniques, integrated optics, nanolithography. She was involved in teaching activities as associated professor at Univ. "Valahia Targoviste" and Master of Science courses at Univ. Politehnica Bucharest.

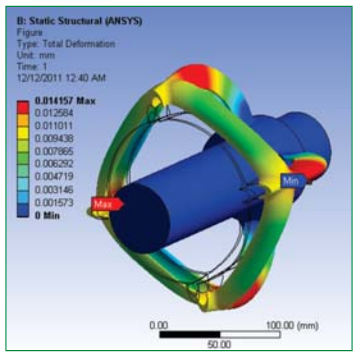
Raluca Muller was coordinator of an important number of national research projects and scientist in charge from IMT-Bucharest in international projects as: FP6 ASSEMIC- Marie Curie Training Network (2004-2007), FP6-PATENT (Modelling and Simulation cluster), Leonardo da Vinci- Microteaching (2005-2007),IPMMAN- CA (2006-2009). She is author and co-author of more than 80 scientific papers presented at conferences and published in journals (Sensor & Actuators, J. of Micromechanics and Microengineering, Appl.Optics., Journal of Luminescence, Thin Slod Films, etc).

INTERNATIONAL PROJECTS: Related FP7

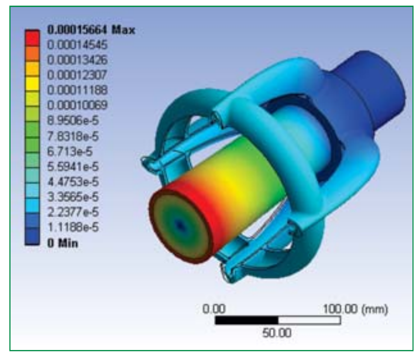
PROJECT TITLE: Nanoelectronics for Electric Vehicle Intelligent Failsafe PowerTrain, 2011 - 2014
ACRONYM: MotorBrain
Project type: ENIAC JU Eniac 01 / 2011 – Partner (Dr. Gabriel MOAGĂR-POLADIAN, gabriel.moagar@imt.ro)
Coordinator: Infineon Technologies AG (Germany)

Project objectives:
- Development of an intrinsic fail safe and fault tolerant highly efficient propulsion system based on electrical motor, novel power electronic packaging and advanced control systems.
- Development of fail safe and fault tolerant components and electronic (sub-) systems as a cross functional priority, which applies to all existing car electronics, and to all technologies to be developed in the above mentioned topics.
- Power and high voltage electronics and smart miniaturized systems for electrical cars.

Project objectives of IMT:
- Conceive of the torque measurement principle for the torque sensor with accent put on using magnetic sensors developed by Infineon Romania
- Modelling and mechanical and magnetic simulation of the sensor
- Transmission of requierements for the magnetic sensor to Infineon Romania
- Realization of the torque measurement system demonstrator



Total deformation as a consequence of centrifugal force (at a speed of 300 km/h)



Tangential deformation at a torque of 3 Nm (at a speed of 300 km/h)

Results: - A magnetic torque sensor was conceived, in two versions (static and dynamic);
- A version of the magnetic sensor was conceived, allowing a better signal processing;
- A version of a modified Wheatstone bridge was conceived;
- Other procedures (nanostructure-based and optical) are considered also for the torque sensor;

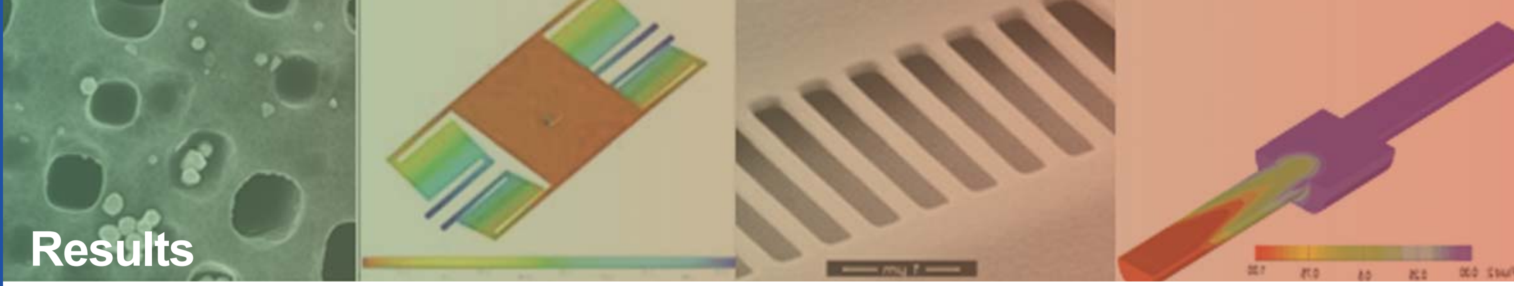
In the next figures are presentede simulation results of a part of the torque sensor, using ANSYS.
The above structure is a very stiff one because:
- The resonance frequency of the first oscillation mode (853,54 Hz at rest) varies only with 0,01 Hz when the car is running with 300 km/h;
- For the sixth oscillation mode the resonance frequency (1534,20 Hz) varies with 1,3 Hz under the same conditions;

NATIONAL Projects: Prospective research regarding rapid prototyping processes for applications in the field of micro- and nanosystems realization

Project Type: PNII - IDEAS 62 / (2011-2014)
Coordinator: IMT-Bucharest, **Project Manager:** Dr.Gabriel Moagăr-Poladian (gabriel.moagar@imt.ro)

Objectives: The objectives of the project are:
a) - prospecting for rapid prototyping (RP) techniques for making structures and devices at the micro- and nanoscale
b) - prospecting for RP techniques that lead to the creation of fully 3D nanostructures, especially at the sub-100 nm domain. By fully 3D nanostructures we understand, for example, a structure formed by two vertical nanopillars (diameter of 100 nm, height 1 micron, spaced at 500 nm) that are joined at their top by a bridge (diameter 100 nm, length 700 nm).

1) We identified the way in which optical interference lithography could be developed s to realize non-periodic patterns over the entire surface of a wafer. While non-periodic patterns can be reproduced on short distances (a method developed at Bell Labs several years ago) and then repeated over the wafer surface, our study shows that it is possible to control the process in such a way that the pattern be non-periodic over the whole wafer surface. The idea is based on the concept of absorption modulation masking and, as conceived up to now, is compatible with the g, h and i lines of the photoresists. Extension to 13,5 nm is under exploration.
2) We identified the possibility of modifying the fountain pen nanolithography so as be more accurate as regards edge quality and for being applicable also to the realization of 3D structures.
3) We have imagined a method for performing negative dip pen nanolithography, method that have to be tested in the next period.

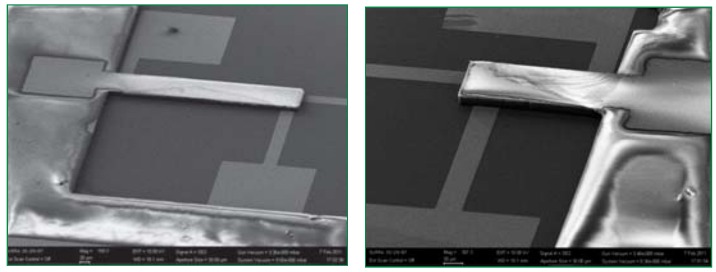


Results

NATIONAL Projects: MEMS sensors and actuators based on micro-cantilevers structures

Project Type: PNII - Cooperation– Contract No. 72-212/2008- INFOSOC (2008-2011);
Project coordinator: IMT Bucharest,
Project Manager: Dr. Raluca Müller (raluca.muller@imt.ro); **Partners:** INCD-SB, INCD-FLPR, National Research and Development Institute for Electrical Engineering- ICPE-CA, Technical University- Cluj-Napoca- UTCN.

We designed, simulated and obtained experimental results regarding microcantilevers, manufactured by surface micromachining, for switching applications.



SEM images of the experimental microswitch

National basic funding projects: Lab-on-Chip type microfluidic platforms integrated with microelectronics and optoelectronics components (2009-2011)

Dieletrophoretic microfilters: Two microfilters with different electrodes shapes were designed, simulated, fabricated and characterized. The electrodes geometry is an essential design step since it controls the non-uniform distribution of electric field and therefore dielectrophoretic mobility of particles and separation efficiency. New electrodes configuration having stairs geometry were proposed and compared to a classic configuration with castellated electrodes. Numerical simulation were performed using Comsol Multiphysics. The stairs geometry induces higher gradient of electric field in channel volume, leading to an increased DEP force in both fluid domain and increasing the separation effect.The microfilter can be integrated in more complex systems as microsensors or microfluidic-based lab-on-a-chip devices that need to manipulate, separate and detect biological particles (microorganisms, blood cells) in medical aplications. This work was done in the frame of national Core-Funding „**Lab-on-Chip type microfluidic platforms integrated with microelectronics and optoelectronics components** (2009-2011)" and the postdoctoral project „Theoretical models for coupled phenomena in microfluidics" under the contract number POSDRU /89/1.5/S/63700.

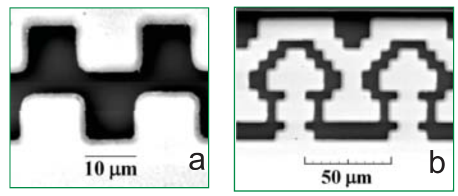


Fig. 1 SEM micrographs of electrodes deposed on the bottom of the channel (a) castellated electrodes (b) stairs electrodes

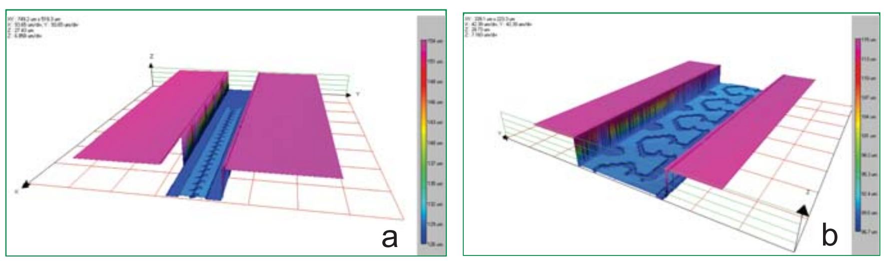


Fig. 2 3D images of the electrodes and channel (White Light Interferometer) (a) castellated electrodes (b) stairs electrodes

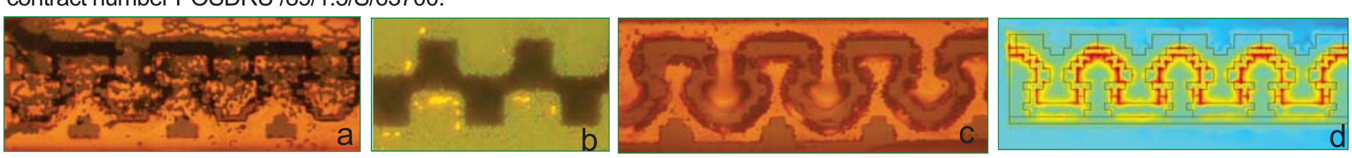
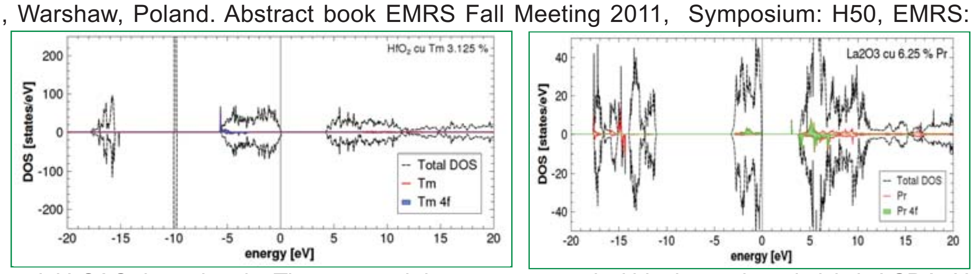


Fig. 2 Separation of 1 µm polystyrene microspheres: (a) particles aleatory arrangement before applying voltage on stairs electrodes (b) particles separated on castellated electrodes (c) particles separation on stairs electrodes; (d) particles distribution obtained by numerical simulations for channel with stairs electrodes

Sientific Results 2011 presented in conference papers and journals

► **"First principles study of the electronic structure of rare earth doped HfO2 and La2O3 thin Films"**, R. Plugaru, N. Plugaru E-MRS Fall Meeting 2011, Warshaw, Poland. Abstract book EMRS Fall Meeting 2011, Symposium: H50, EMRS: http://www.emrs-strasbourg.com/

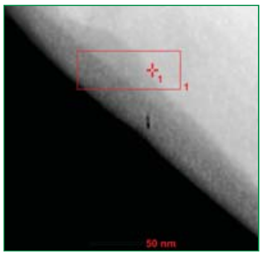


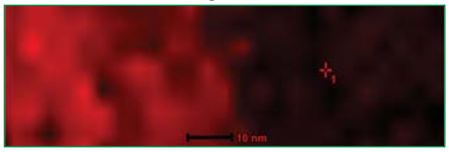
Computational materials modelling: • The effects of rare earth (Tm, Pr, Ga, etc.) doping of HfO_2 and La_2O_3 crystalline thin films were analysed on the calculated electronic structure. The computational studies were performed using an all electron full potential LCAO- based code. The rare earth ions were treated within the scalar-relativistic LSDA+U and the orbital magnetic moments were obtained in fully relativistic calculations.

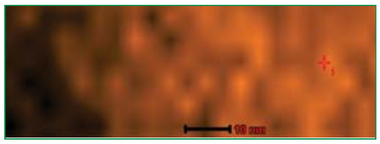
• The effects of the rare earth type and concentration on the band gap, the localization of the impurity states and the charge distribution at the monoclinic HfO_2 and hexagonal La_2O_3 films surface were investigated with respect to the film thickness and surface orientation. We assume that the rare earth ions enter substitutionally at the Hf or La lattice sites, in the concentration range 2-6 at.%.

Sientific Results 2011 presented in conference papers and journals

Micro-nanostructural and composition characterization of ZnO: Al doped films by SEM-EDX and HRTEM-EDX published in: ► E. Vasile, **R. Plugaru,** S. Mihaiu, A. Toader, Study of microstructure and elemental micro-composition of ZnO:Al thin films by scanning and high resolution transmission electron microscopy and energy dispersive x-ray spectroscopy, ROMJIST, Volume 14, Number 4, 2011, pp. 346–355 (2011).
► E. Vasile, R. Plugaru, S. Mihaiu, A. Toader, Micro-nanostructural and composition characterization of ZnO: Al doped films by SEM-EDX and HRTEM-EDX, CAS: 2009 International Semiconductor Conference Proceedings, pp. 383-386 (2011).



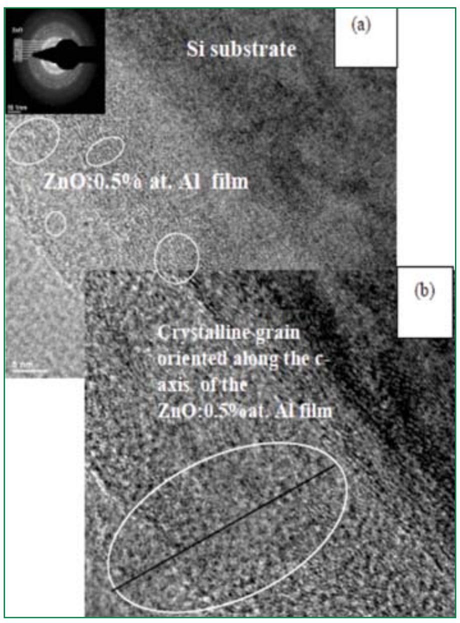


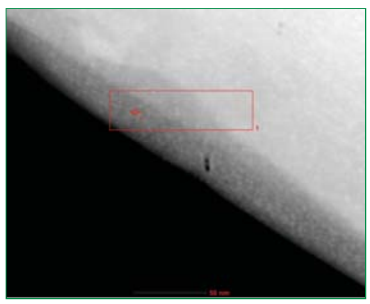


Cross section STEM image of ZnO:0.5% at. Al film with 10 layers on the Si/SiO_2 substrate and EDS mapping images of O, Zn, Al. (Refs.[1], [2]).

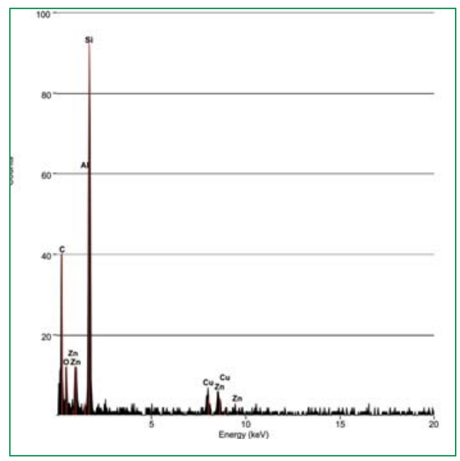
• The research was devoted to the preparation and characterization of ZnO: Al doped thin films for a large area of applications, such as transparent conductors, thin films transistors, UV detectors, solar cells.

• The assessment of the nanoscale composition and local distribution of elements at in the polycrystalline films of ZnO:0.5% and 5% at. Al doped thin films deposited by sol-gel process on Si/SiO_2 substrates.





STEM image of a cross section sample from ZnO:0.5 at. % Al film with 10 layers (a) and EDX spectrum recorded in the marked point from image (b).(Refs.[1], [2]).



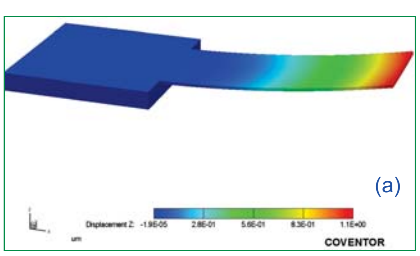
Cross-section bright-field TEM and SAED images of the ZnO:0.5%at. Al film with 10 layers on the Si/SiO2 substrate (a) and HRTEM image of a nanocrystalline grain c-axis oriented (b). (Refs.[1], [2]).

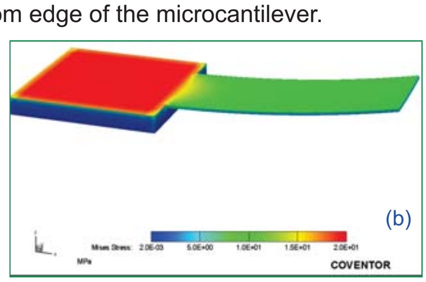
► ***"Investigation of dimensions effect on stress of bi-material cantilever beam"***, **R. Voicu, R. Muller,** M. Pustan Proceedings from the 34th International Spring Seminar on Electronics Technology, Slovakia, Tatranska Lomnica, pp. 461 – 465, 2011

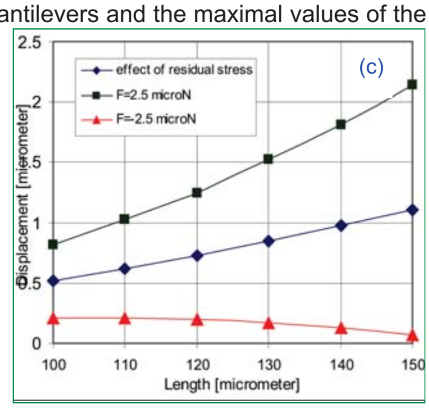
Two sets of microcantilevers with different lenghts varying between 100-150 μm and 60-80 μm with fixed width at 60 μm and 130 μm were analysed. An initial tensile stress of 20 MPa, was considerd, do to the gold deposition on the SiO_2 layer, which determined an upward deflection of the microcantilever and a small arching effect.

The dependence obtained by numerical studies of the variation of the lengths of the cantilevers and the maximal values of the displacements, due to the residual stress, were analysed. The induced stress, as a combination of the residual ones and the effect of the mechanical load produced by a force application, was linear and almost constant in both material layers. The stress increased when a force is applied on the bottom edge of the microcantilever.

This work was supported by the National Romanian Project PN II 72-212 (2008-2011).







Simulation results: a) Displacement of a microcantilever due to the residual stress of 20 MPa; b) Mises Stress of the cantilever in initial condition (tensile stress only); c) Displacements for the microcantilevers when varying the length for the cantilever with dimensions 150X60 μm

RELIABILITY LABORATORY

- Mission
- Main areas of expertise
- Bilateral Projects
- Research Team
- Specific facilities

Mission: Providing tools and expertise to improve the design & technology of sensors, actuators, microsystems, nanostructures and microelectronic components by assessing and building the quality & reliability in a Concurrent Engineering approach.

Main areas of expertise:

Reliability building: Design for reliability and testability - design for manufacture, Reliability monitoring & screening of micro and nanostructures, Burn-in and selection, Reliability of components used in harsh environment (nuclear, geology, automotive, aeronautics, etc.);

Reliability assessing: Accelerated testing of micro and nanostructures; Failure analysis & physics, Data processing & Reliability prediction, Behaviour of electronic components in harsh environment, Virtual prototyping;

Standardization: Certification, Qualification and periodic tests, Standards and other specifications.

Bilateral Projects:

Contractor of a bilateral project between Romania (IMT-Bucharest) and Slovakia (Techincal University of Kosice) "Time and stress degradation phenomena in lead-free solder joints", project (2010-2011).

Partner in international networks::

The Reliability Laboratory is in the Board of the Service Cluster EUMIREL (European Microsystem Reliability), aimed to deliver services in the reliability of micro and nanosystems, established in December 2007 by the NoE "Patent-DfMM" (other members: IMEC Leuven, Politecnico di Milano, Fraunhofer Institute Duisburg, 4M2C, CSL Liege, BME Budapest, Warsaw Technical University, QinetiQ, Lancaster University, Herriot Watt University, NovaMems, Baolab).

Research team The research team is formed by four persons: three senior researchers and a research assistant, all with background in microelectronics.

Specific instruments and equipment:

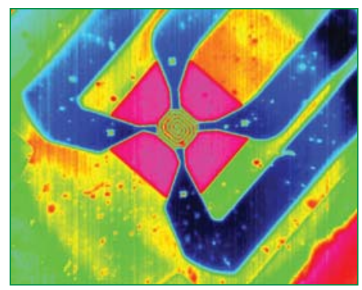
Reliability Laboratory contains the Laboratory for evaluating the quality of microtechnology products according to EU requirements (LIMIT), provided with modern equipment for:

Environmental testing: Constant mechanical acceleration, Vibration, Storage at temperature, Hermeticity, Mechanical shock;

Testing at combined stresses: Damp heat, Thermal cycling, Pressure + Temperature, Thermal stress + Electrical stress, Electrical stress + Thermal stress + Humidity + Vibrations, Electrical stress + Thermal stress + Pressure, Mechanical ("Tilting") + Thermal stress;

Electrical characterising at various temperatures: Keithley 4200SCS, Temptronic TP04300A-8C3-11 / Thermo Stream.

Thermal analyses: IR microscope SC 5600 + G3 L0605 / FLIR Systems.



Thermal map of an electronic system, obtained with IR microscope. The colour scale corresponds to the temperature: from blue (the lowest temperature), to red (the highest one).

From left to right: Marius Bazu, Lucian Galateanu, Dragos Varsescu, Virgil Emil Ilian

Laboratory head: Dr. Marius Bazu, (marius.bazu@imt.ro)

He received the B.E. and PhD. degrees from the University "Politehnica" Bucharest, Romania. Involved in device design, semiconductor physics and reliability issues. Recent research interests: methods for building, assessing & predicting the reliability of MEMS.

He developed in Romania the accelerated reliability tests, building-in reliability and concurrent engineering approaches. Leader of one European project (Phare/TTQM) on a building-in reliability technology (1997-1999), Member of the Management Board and workpackage leader and of the NoE "Patent-DfMM", FP6/IST (2004-2008). He is referent of the journals: Sensors, IEEE Transactions on Reliability, IEEE Transactions on Components and Packaging, IEEE Electron Device Letters and Microelectronics Reliability.

Recipient of the AGIR (General Association of Romanian Engineers) Award for the year 2000. Chairman/lecturer at international conferences: CIMCA 1999 and 2005 (Vienna, Austria), CAS 1991-2009 (Sinaia, Romania), MIEL 2004 (Nis, Serbia). Author of more than 120 scientific papers (IEEE Trans. on Reliability, J. of Electrochem. Soc), Sensors and contributions to international conferences (Annual Reliability and Maintainability Symp., Probabilistic Safety Assessment and Management Conf., European Safety and Reliability Conf., etc.). Co-author of three books about the reliability of electronic components, published by J. Wiley & Sons (2011), Artech House, in 2010 and Springer Verlag, in 1999.

RELIABILITY TESTS AND ANALYSES

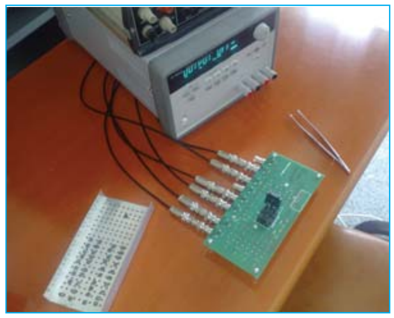
A large range of reliability tests were performed by the laboratory: environmental tests, reliability selections and electrical characterisation at continuous increasing temperatures.

Contact person: Virgil Emil Ilian (virgil.ilian@imt.ro)

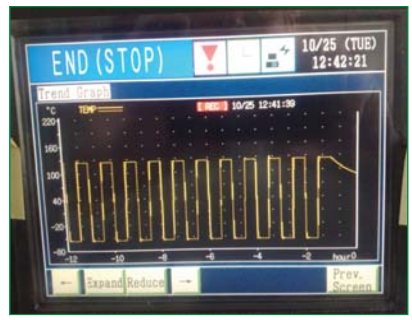
For the bilateral project between Romania (IMT-Bucharest) and Slovakia (Technical University of Kosice) “Time and stress degradation phenomena in lead-free solder joints”, project (2010-2011) tests at Thermal cycling and Damp heat (temperature + humidity) were performed.

Protoypes introduced in the equipment for Highly Accelerated Stress Test (HAST).

Control panel during testing at cycling damp heat (-40° / 85°C and 85%RH).



Measurement setup for the prototypes.



Testing sequence at thermal cycling (-55°C / +125°C / 30 minutes at each step, 20 cycles).

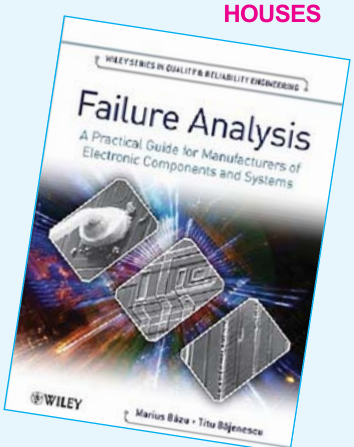
The Reliability Laboratory was solicited by the consortium (10 European partners) of FP7 project “Frequency Agile Microwave Bonding System (FAMOBS)”, led by Herriot Watt University (UK), to perform reliability tests for their protoypes: Thermal Cycling (-55 to 150C) for 500 cycles and HAST (Highly Accelerated Stress Test): 130°C (96h) and 85% relative humidity.

RELIABILITY SERVICES

The RELIABILITY LABORATORY provides a large range of services:

- **Testing at unique or combined (concurrent) stresses;**
- **Electrical characterization at various temperatures;**
- **Failure analysis and reliability data processing**, including calculation of failure rate and other reliability indicators with soft ALTA6 (ReliaSoft);
- **Training courses on:**
  - Quality & reliability assurance for semiconductor devices;
  - Reliability accelerated testing for MEMS;
  - Failure analysis at accelerated testing;
  - Characterisation of microelectronic devices and MEMS.
- **Consultance / technical assistence:**
  - Reliability analysis for all families of semiconductor devices;
  - Elaborating standards and other documents for various types of electronic components;
  - Qualification of semiconductor devices.

BOOKS AT PRESTIGIOUS PUBLISHING HOUSES



M. Bâzu, T. Băjenescu, ***Failure analysis. A practical guide for manufacturers of electronic components and systems***, J. Wiley & Sons, 2011, ISBN 978-0-470-74824-4.

You can trust us because:

… We have modern equipment, purchased in 2008-2009

15 machines purchased by Romanian projects for infrastructure development

… We know how to do things

More than 30 years in delivering high reliability electronic components and in reliability testing of microelectronic devices and electronic components

… We are included in European scientific networks

The Laboratory is member of the network “European Microsystem Reliability - EUMIREL”, aimed to deliver reliability services about micro- and nanosystems, established in 2007

Centre for Research and Technologies Integration

Microsystems for Biomedical and Environmental Applications Laboratory

- Mission
- Main areas of expertise
- Projects
- Research Team
- Specific facilities

The Mission: of the laboratory is research, focused on the development of microsensors (chemo, bio and mechanical sensors), microstructures and electrodes, microprobes for recording of electrical activity of cells and tissues, microfluidics and integrated technologies (silicon, polymers, biomaterials), signal processing, data acquisition and GUI's (Graphical User Interface) education in the field of micro chemo and biosensors (in cooperation with University "Politehnica" of Bucharest), and services in design, simulation and technology for bio, chemo and mechanical sensor applications.

Main areas of expertise:

Microsensors: Development of microsensors (chemoresistive, resonant gas sensors, accelerometers, microarrays, ISFET (Ion Sensitive Field Effect Transistors) sensors, electrodes for biological sensors, microprobes for recording of electrical activity of cells and tissues),

Microfluidic platforms – Microfluidic platforms simulation and realization of microfluidic platforms including tubes, microfluidic connectors, reservoirs and pumping system.

Technologies integration and sensors platforms – Integration of silicon sensors with microfluidic; Sensors array with data acquisition, signal processing and graphical user interface

Simulation and modelling - simulations / modelling, using MEMS–specific CAD software (CoventorWare, CADENCE)

Projects: Integrated Platform for Pesticides Detection (PESTIPLAT) – MNT ERA NET

The platform developed within PESTIPLAT will be used in food security monitoring (fruits, vegetables, drinking water, milk etc.) and agriculture research laboratories will be a user friendly tool able to perform fast measurements (10 minutes), to diagnose the pesticide presence, to alert and to record data for monitoring and statistical purposes, addressing important issues within the food security.

Consortium members:

-Coordinator: Carmen Moldovan (IMT-Bucharest), Romania

-Partnes: Romelgen SRL, Romania

HSG-IMIT c/o IMTEK, Germany;

- Scienion AG Research and Development, Germany.

BIOMICROTECH Miniaturized biosensor microtechnology for fast detection of contaminations from food

The goal of BIOMICROTECH project was the development of miniaturized biosensors technology integrated in microfluidic chips, for the detection in the ng/L domain of organophosphorus insecticides from food (milk, juices from fruits and vegetables) and water by involving the microtechnology techniques on silicon and microbiology techniques, accessible to project consortium. The biosensor is of single use, reproducible, mass production, low cost and has commercial value. Due to the small dimensions (hundreds of microns per chip) the integrated microbiosensors represent a rapid, selective and sensitive solution for direct determination of these kinds of contaminations.

Consortium members:

-Coordinator: Carmen Moldovan (IMT-Bucharest)

- Partners: "Politehnica" University, Bucharest;

National Institute for Public Health, Bucharest;

Romelgen SRL, Bucharest.

Research team: The research team is formed by 11 persons with **Electronics, Physics, Mechanics, Chemistry and Biology** background.

Specific instruments and equipment: the Laboratory has additional expertise o: **1. Ink Jet Printer** offering the capability to deposit droplets of fluid, in picoliters range, such as liquid silver or organic inks, on all types of surfaces, including flexible ones: PET (Poly-Ethylene-Terephthalate), PEN (Poly-Ethylene-Naphthalate) and Poli-Aniline (PANI) sheets.

2. VoltaLab 10 - Electrochemical Laboratory: PGZ100 All-in-one Potentiostat; VoltaMaster 4 Electrochemical Software

3. CNC (Computer Numerical Control) Miniature Machine composed of: • Smithy CNC Mill and Lathe

• EZ-Trol software for Smithy CNC with G and M codes, developed under the Ubuntu Linux environment.

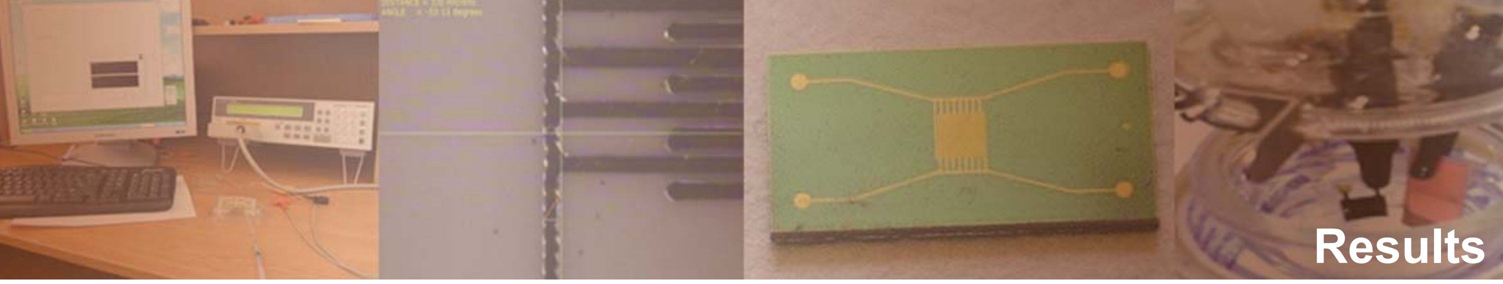
The CNC equipment is used for microfluidic components development and different mechanical interfaces manufacturing.

Picture of the CNC equipment

Laboratory head: Dr. Carmen Moldovan, (carmen.moldovan@imt.ro)

She graduated on Electronics and Telecommunications and she owns a PhD in Microsensors. She was responsible from IMT side in the TOXICHIP project, STREP (IST), for the development of temperature, pH sensors and O2 sensor integrated into a microfluidic platform for toxicity detection.

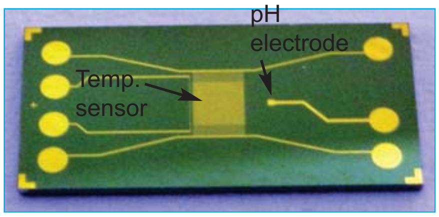
She was involved in the 4M NoE (NMP), working on demonstrators, in Ceramic cluster, having the goal to integrate a non-standard micromachining process into a ceramic substrate and in the Sensors and Actuators cluster, in INTEGRAMplus IP (IST), dealing with technology convergence and integration and virtual design and manufacturing. She is the coordinator of PESTIPLAT (MNT-ERANET project) and several national projects in the area of integrated sensors and microfluidic devices for pesticides detection and neural cells monitoring. She is a member of IEEE, and is a NEXUS Association Steering Committee Member. The scientific activity is published in more than 70 papers in journals, books and communications in Proceedings.



Results

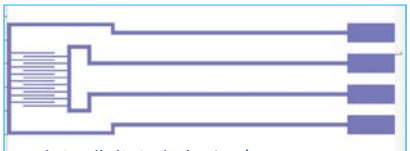
Microsensor technology

Gold and Platinum IDT based microsensors technology has been developed. The microsensors on silicon chip were dedicated to pesticide detection in food and monitoring of cell culture exposed to toxicants.



IDT, pH and temperature sensors on silicon chip

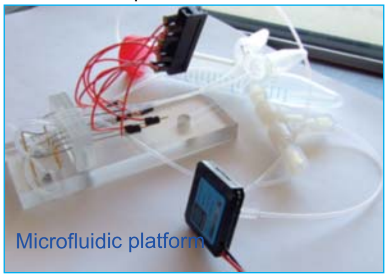
Technology of electrodes on paper substrate has been optimized



Interdigitated electrodes on paper

Microfluidic platforms fabrication

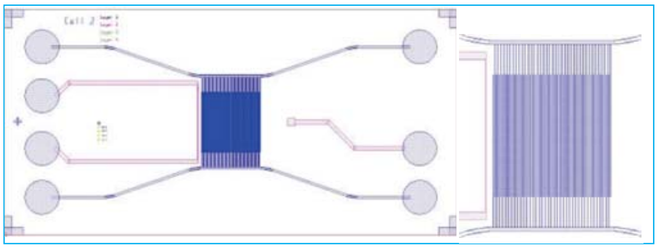
A micro fluidic platform with micro-pump, connectors, tubes, reservoirs is presenteded in the image below and has been realised for pesticides detection. On the base of platform, two fluidic wells are positioned hosting detection biosensors usually dedicated to biochemical reaction investigation.



Microfluidic platform

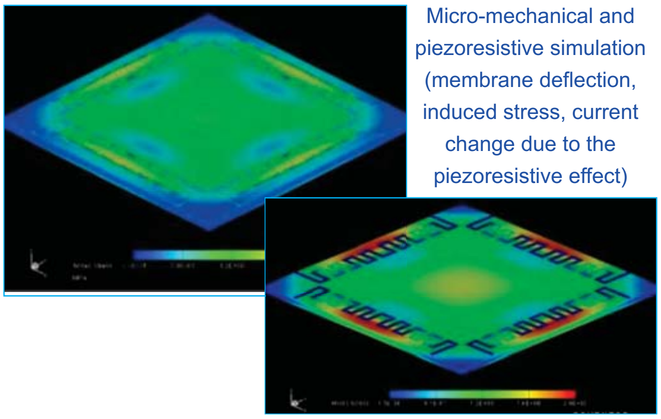
Design, Simulation and Modelling

Layout and mask design:

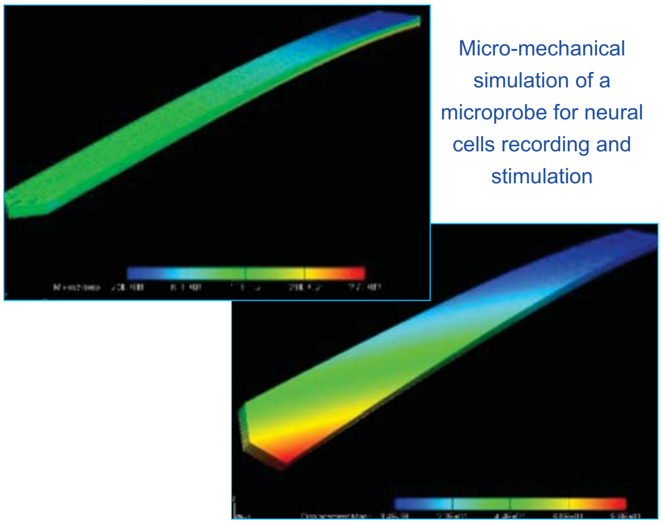


Layout design (and details) of an IDT based sensor with temperature and pH electrode

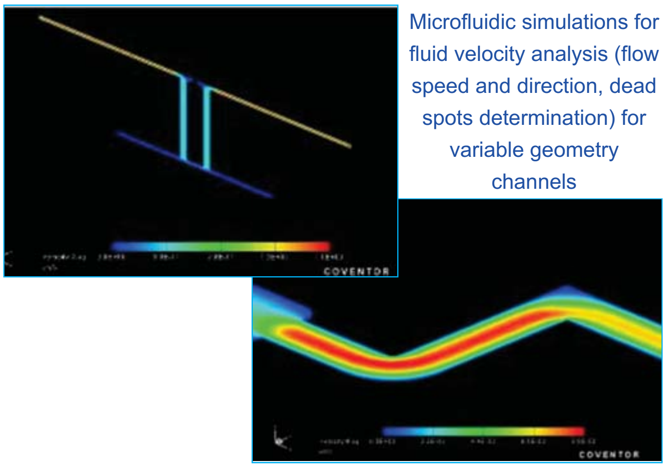
Simulation and modelling of MEMS structures:



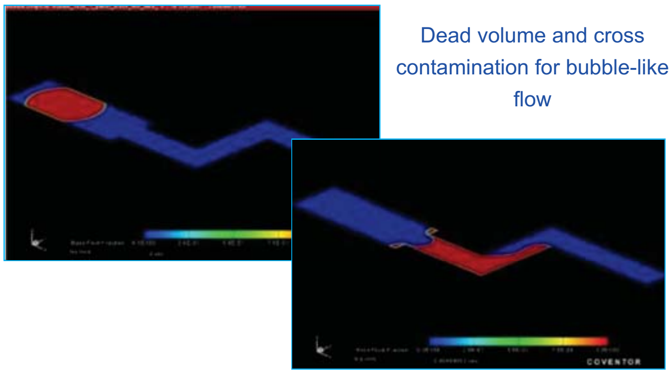
Micro-mechanical and piezoresistive simulation (membrane deflection, induced stress, current change due to the piezoresistive effect)



Micro-mechanical simulation of a microprobe for neural cells recording and stimulation



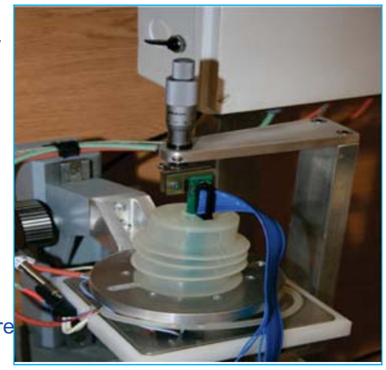
Microfluidic simulations for fluid velocity analysis (flow speed and direction, dead spots determination) for variable geometry channels



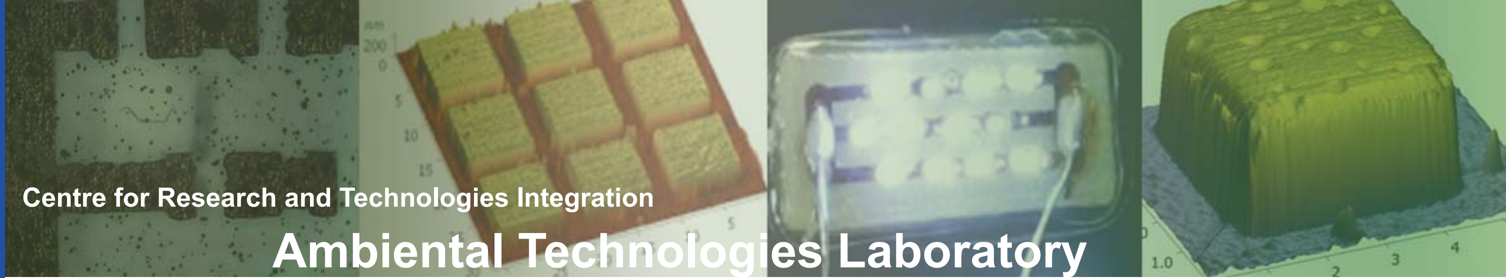
Dead volume and cross contamination for bubble-like flow

Technology integration and sensors platform

A bioplatform for electrical and optical monitoring of cell culture has been realised integrating pH, temperature, impedimetric sensors, microfluidic modules and miniaturized incubator for cells hosting.



Mini-incubator for monitoring cell culture including sensors, microfluidic module



Centre for Research and Technologies Integration

Ambiental Technologies Laboratory

Mission: ❖ Developing new technologies in the areas of micro and nano sensors technologies:
❖ Technological design, technological development up to the prototype level;
❖ New materials development (i.e. Nanocomposites);
❖ New assembly techniques for micro/nanosystems (based on mcm);
❖ Technological services: technological assistance and consultancy (technological flows design, control gates,
❖ Technological compatibilities) and defect analysis on technological flow.
All of these technological skills are used in applications for improved ambiental conditions for human beings (including health applications) and for traditional industries high-tech up-grading.

Main areas of expertise:
❖ Design and develop individual technological processes for micro/nano systems technology (as piezoelectric integrated microsensors, high speed photodetectors,white led micromatrix) and technological compatibilities;
❖ MCM technologies and other nonstandard assembly technologies for micro/nano systems technological design, mainly on applications in traditional industries;
❖ Nanocomposite materials synthesis and nanostructured sensing materials; ❖ FTIR and uv-vis spectroscopy services;
❖ RTP technological services.

Research team: The team is represented by a senior researcher I (PhD), a senior technological development engineer, two senior researchers III (with background in chemistry), 1 PhD students (with background chemistry) and an engineer specialized in electronic applications field. The team seniors have industrial experience and company RD activities in CMOS technologies (IC dice manufacturing and IC assembly techniques).

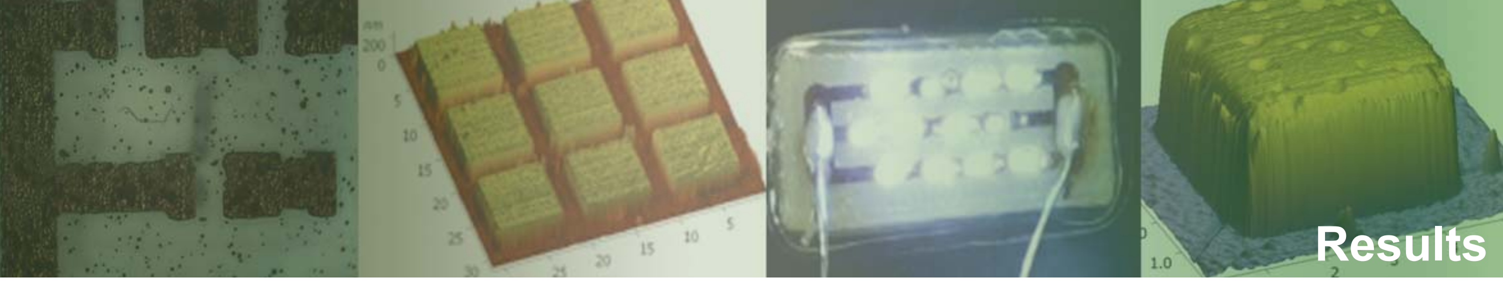
Specific instruments and equipment:
PROCESSING EQUIPMENTS: *RTP- RAPID THERMAL PROCESSING* system for silicon, compound semiconductors, photonics and MEMS processes (Annealsys, France)
Applications: ❖ Rapid thermal oxidation (rto)
❖ Rapid thermal nitridation (rtn); ❖ Crystallization and densification; ❖ Compound semiconductor annealing
Manufactured in 2010
HIGH TEMPERATURE FURNACE CARBOLITE
Fields of utilization: High temperature furnace can be used for sintering, annealing, desintegration, etc.
Applications in: ❖ Semiconductor field include annealing silicon, silicon carbide & nitride samples and solid state synthesis.
❖ Ceramics field include disintegration, long term high temperature tests and firing & sintering of ceramic samples.
Manufactured in 2010
CHARACTERISATION EQUIPMENTS - *SPECTROMETRIC CHARACTERISATION: FTIR SPECTROMETER TENSOR 27, BRUKER OPTICKS*
Applications: The FTIR spectrometry can be used to study the chemical process and the chemical structure of the compounds for: liquid, solid – film, powder, waxes, gels, pastes, etc.
Manufactured in 2007
UV-VIS SPECTROMETER AVASPEC-2048 TEC (thermo-electric cooled fiber optic spectrometer) AVANTES
Applications: Spectroscopic measurements are being used in many different applications, ideal for absorbance, transmittance, reflection, fluorescence and irradiance.
Manufactured in 2007

PACKAGING EQUIPMENTS: *DICING MACHINE* for silicium plates (3m225 - Russia) with 2,3 and 4 inches, performing assignment of silicon, si, glass substrates in chips, with diamonded dishes with thickness of 25 and 40 µm, until of maximum depth of 600 µm;
SOLDING THERMOSONIC MACHINE WITH GOLD FIBRE (ASM-USA): it execute operations for soldering of gold fiber of φ= 25 - 35 µm on chips at temperature of 150 - 250°C, at a frequency of 50-60 khz;

Our team (from left to right): Maria Cimpoca, Veronica Schiopu, Alina Matei, Ileana Cernica, Andrei Ghiu, Florian Pistritu

Laboratory head: Dr. Ilena Cernica, (ileana.cernica@imt.ro)

Ileana Cernica, ileana.cernica@imt.ro, she received msc. on electronics and telecommunication and phd in microelectronics both from University "Politehnica" of Bucharest. She worked as senior integration engineer in CMOS ic's technologies, CMOS RDactivities and as AQ responsible in the sole romanian CMOS ic's industrial company for 10 years. Now she is senior scientific researcher, currently coordinates national R&D projects and was responsible person in Eureka Umbrella project MINATUSE (up to2010) and Romanian-German Centre for micro and nanotechnology project. She is project evaluator national RD programs (CEEX, CNCSIS, PNCDI 2, and MNT-ERANET): associate professor at University "Politehnica" of Bucharest (faculty of electronics, telecommunication and information technology- OMEMS course in OPTOELECTRONICS Master Programme). Her scientific activity was published in more than 72 papers in international journals/conferences, 110 technical reports and is author or co author of 12 romanian patents (3 of them won silver, 2 gold medal at international inventions exhibition in Brussels and Geneva and 2 bronze medals international exhibition "ideas-inventions-novelties"IEna, Nurnberg) and 3 books.



PATENTS

◆*„Manufacturing method for yttrium aluminium garnet cerium doped used as phosphorous in emissive optoelectronics applications”*, BI Nr. 123429/30.04.2011, V. Schiopu, I. Cernica

AWARD: SALON INTERNATIONAL DES INVENTIONS, GENEVA 2012, GOLD METAL

„Manufacturing method for yttrium aluminium garnet cerium doped used as phosphorous in emissive optoelectronics applications”, BI Nr. 123429/30.04.2011, V. Schiopu, I. Cernica

Areas of micro/nanosensors of threshold for the detection in real time of aquatic medium contamination with chemical agents

NOVELTY

◆development a saw structure based on unstandard piezoelectrical substrate (ex: langasite, LiTaO3, LiNbO3) that allow different degrees for detection of sensibilities and so an extension of detectable contamination;

◆development some techniques of technological compatibility and preventing of accidental derive of threshold detection

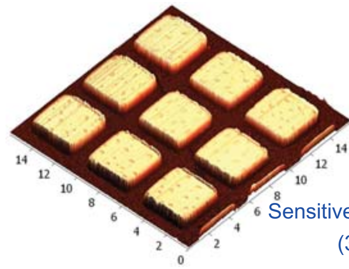
◆realization of a new sensor with detection columns area from zno on different substrates silica and piezoelectric materials.

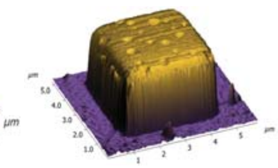
PNCDI 2 programme project.

Project manager: Ileana Cernica, ileana.cernica@imt.ro

Partners: ROM-QUARTZ S.A; SITEX 45 SRL; National Institute for Electrochemistry and Condensed Matter Timisoara; "GH. ASACHI" University Iasi; Politehnica University Bucharest (UPB-CCO, DCAE)

SAW microsensor with sensitive substance configured





Sensitive colonnade 4x4mmx340nm (3D image) and detail

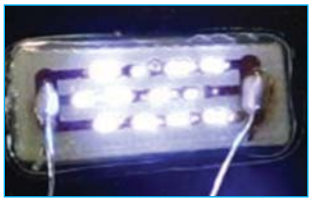
Development of new nanostructured phosphors technological processes and applications in emissive semiconductor micromatrix on flexible substrates

The main aim was to obtain nanostructured phosphors and integration of this in illuminating systems – manufacturing of monochromatic emissive semiconductor matrix devices on flexible substrate.

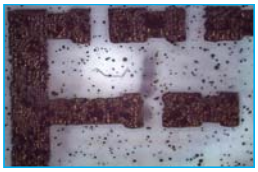
Nanostructured phosphors (obtained by sol-gel processes) deposited on light emitting structures of GaN (mounted on flexible substrate). This semiconductor device converts electricity into white light. The figure below presents: Flexible substrates and final device with white light emission.

Core Nantional Programme; **Coordinator: IMT Bucharest**;

Project manager: Veronica Schiopu (veronica.schiopu@imt.ro)

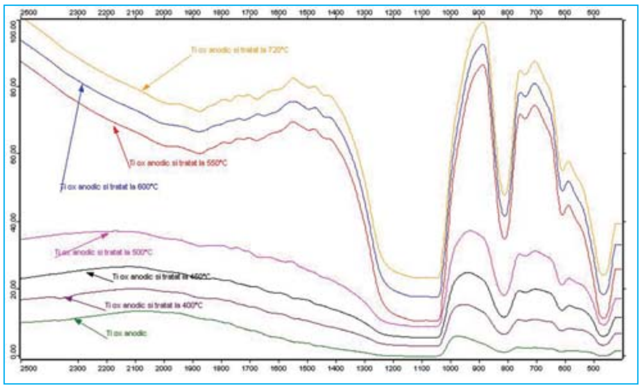


Micromatrix with white light emission on flexible substrate

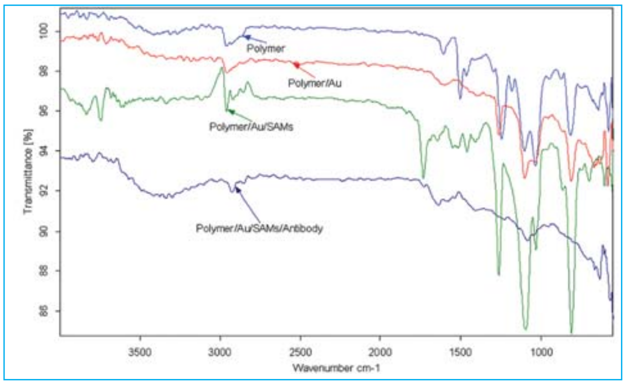


Flexible substrate

FTIR Resuts Examples



Study of the self-assembled monolayers (SAMs) of different process substrates (silicon and polymer) for E-coli detection



Titanium dioxide films, deposited on the silicon substrate study (Heat treatment step)

Micro and Nanofluidics Laboratory

- Mission and expertise
- Projects

The primary focus of our research is the design of microfluidic devices for applications in clinical diagnostics and regenerative medicine. These devices are fabricated using technology originally designed for the semiconductor industry and are capable of handling and manipulating small volumes of fluids and small numbers of cells. Our expertise is in numerical simulations, microfabrication and functionalization of microfluidic channels and achieving high-resolution cell separation through magnetophoresis or dielectrophoresis.

The research work is dedicated to the development of micro/nano technologies, especially glass silicon and polymeric micromachining, and their applications in micro and nanofluidics. With the enabling technologies, we fabricated devices and investigate fundamental fluidic effects in the micro scale such as convective/diffusive mixing, viscoelasticity, fluid/structural coupling, hydrodynamic focusing, dielectrophoresis and magnetophoresis. The knowledge from this fundamental research results in a number of microfluidic components such as microviscosimeters, micropumps, micromixers and microsensors.

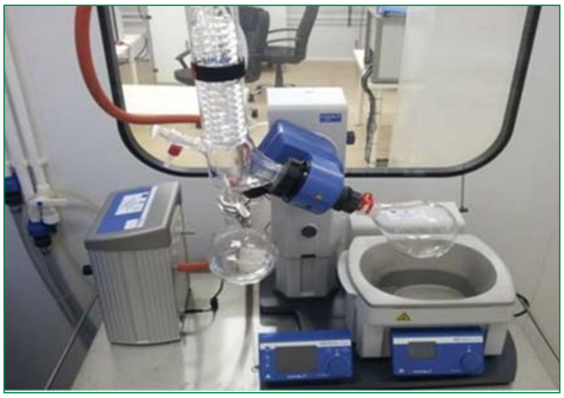
Future: A novel power generation device will be developed, utilizing a nanofluidic platform containing nanoenergetic materials, which are extremely mass-efficient in storing chemical energy. The stored chemical energy can be rapidly released, generating heat and pressure when an external stimulus is applied. These released energies need to be transformed to electricity and ultimately stored in energy storage devices, which can be used to power sensors, switches and fuses. The technology will transform the energy created by energetic materials into electrical energy using a nanofluidic system.

Mission and expertise: The Micro and Nanofluidics laboratory conducts research in two primary areas: the investigation of fluid flow and rheology at the microscale, and its application to optimize lab-on-a-chip devices based biosensors. Our interests include developing micron resolution particle image velocimetry (micro-PIV), micro-mixing devices and protocols, particle manipulation using dielectrophoresis (DEP) and magnetophoresis (MAP), and analysis of boundary conditions at the microscale.
Computational Fluid Dynamics (CFD) modeling of Newtonian and non-Newtonian flow, e.g. single- and multiphase flows, mixing, turbulence, heat transfer, user defined function implementation for additional flow parameters setting, magnetohydrodynamics, etc.
Design of microfluidic devices for applications in clinical diagnostics and regenerative medicine.

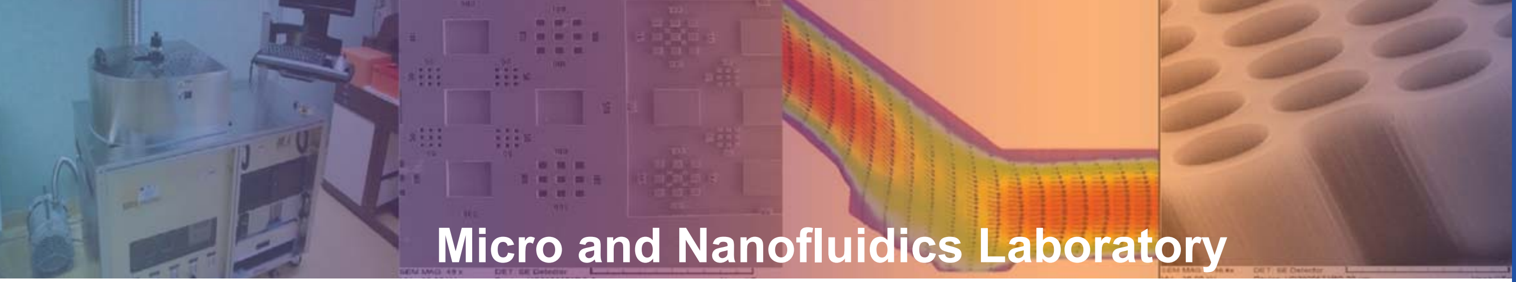
Investigation of fluid flow and rheology at the microscale, and its application to optimize lab-on-a-chip devices.
Experimental nano- and microtechnology: cleanroom processes (e.g. glass silicon and polymer micromachining, plasma based processes), design, simulation, fabrication and characterization of MEMS and biosensors.
Development of micron-resolution particle image velocimetry (μ-PIV), micro-mixing devices and protocols, particle manipulation using dielectrophoresis and magnetophoresis and analysis of boundary conditions at the microscale.
Bioengineering: Cellular uptake of gold-coated maghemite superparamagnetic nanoparticles; studies of cells apoptosis induced by magnetic hyperthermia; tumor cells investigation using UV fluorescence, microscopy (SEM, SNOM) and spectroscopy (FTIR, Raman, Impedance).
Microchannel Flow Physics: Hydrodynamic focusing of liposomes (e.g. a three-inlet and one outlet design has been studied from both experimental and numerical viewpoints.
Molecular transport in microfluidic devices: Magnetophoretic system for detection of magnetic marked biomolecules; active magnetophoretic systems for cell separation through magnetic fields; filters for separation of microparticles with different morphological, electrical and magnetic properties; nanoparticles separation microfluidic devices.
Visualization and flow characterization: our experimental methods used for microscopic flow investigations are based on (i) contrast substances for the path lines distributions (ii) μ-PIV measurements for local hydrodynamic behavior of a steady fluid flow and quantitative measurements of the velocity profiles and vortex identification.

Projects: Project co-founded by the European Fund for Regional Development (POS-CCE 209 - Microfluidic factory for assisted self-assembly of nanosystems, "MICRONANOFAB") until July 2013

- PNII – Partnership „Microfluidic biochip for the rheological characterization of non-Newtonian fluids with applications in medical diagnosis and treatment" (MELANOCIHIP), 2008-2011.
- PNII – Partnership „Micro-electro-mechanical system with applications in peripheral nerves microsurgery reconstruction" (RECONECT), 2008-2011.
- PNII – Partnership „Oxide semiconductor nanodevices for applications in nanoelectronics and nanomedicine" (NANOSICOND – NANOMED), 2008-2011.
- PNII – IDEAS „Development of a conceptual model of a lab-on-a-chip for continuous separation of particles by means of magnetophoresis and dielectrophoresis", 2008-2011.



Rotary evaporator with integrated heating bath and vertical glassware
Applications: Solvent removal; Distillation; Liposomes preparation; Vacuum controlled reactions



Micro and Nanofluidics Laboratory

Research team: **Dr. Ciprian Iliescu**, project manager, he set up the microfabrication lab within the Institute of BioNanoengineering from Singapore. He has experience in Micromachining and microfluidic systems.
Dr. Marioara Avram (marioara.avram@imt.ro): project manager, Senior Researcher, PhD in Magnetoelectronic microsensors. Her scientific interest: magnetic micro and nanofluidics, lab-on-a-chip electromagnetic systems, bioengineering, magnetic immunoassay, spintronic devices. Initiator, principal investigator and manager for several research projects.
Dr. Catalin Valentin Marculescu: He holds a PhD (2009) in Fluid Mechanics and Rheology from University "Politehnica" of Bucharest & University Claude Bernard Lyon, Laboratory of Multimaterials and Interfaces, with 8 months spent at the latter institution. His current main tasks are related to phenomenological modelling and post-processing data using specialized software, corroborated with experimental studies related to fluid flow in microchannels.
Dr. Catalin Mihai Balan: He holds a PhD (2011) in microfluidics and rheology from the Faculty of Power Engineering, University "Politehnica" Bucharest, Fluid Mechanics Dept. He is working on experimental and numerical simulation of fluid flow in microchannels. He is responsible for characterizing microfluidic devices using μ-PIV techniques.
Andrei Marius Avram: With MSc Degree in physics from the University of Bucharest, Faculty of Physics, he is currently pursuing his PhD. He has 5 years of experience working in Clean Room environment, of which >9 months in Singapore at Nanyang Technological University. He is currently involved in plasma processing and silicon bulk micromachining and all the technological processes required for the fabrication of microdevices. In addition he contributes to the development of new lab equipments.

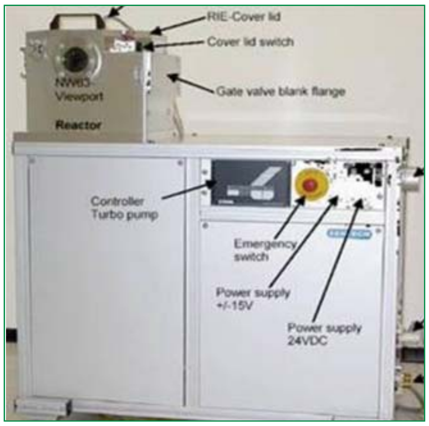
Catalin Marculescu, Marioara Avram, Catalin Balan, Andrei Avram

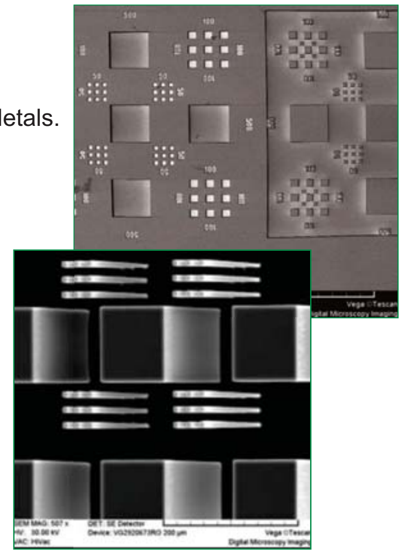
EQUIPMENTS

Plasma Etching Equipments

Reactive Ion Etching (RIE)

Manufacturer: SENTECH
Etching & Surface modification processes:
Oxides, Nitrides, Photoresists, Polymers, Metals.

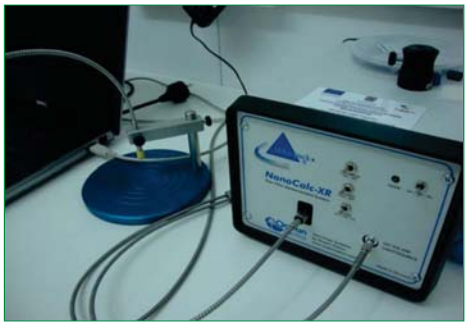




Deep Reactive Ion Etching

Manufacturer: Oxford Plasma Technology
Acquisition date: February 2011
Etching processes:
✓ Deep Si etching;
✓ Bosch process.

NanoCalc-XR - Refractometer for layer thickness measurements



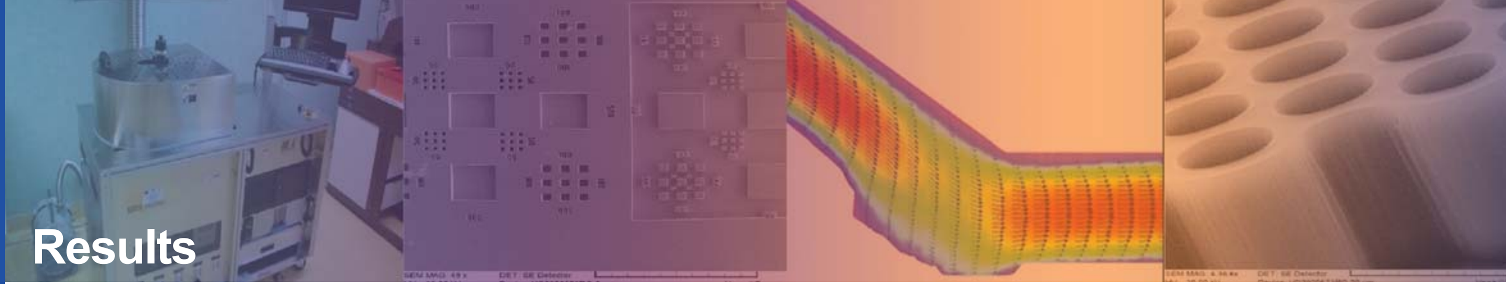
Manufacturer: Mikropack
Acquisition date: November 2010
Thickness measuring: Si oxide; Si nitride; Photoresist mask; Many others.

Anodic Bonding system

Manufacturer: Suss MicroTech
Acquisition date: February 2011
Bonding processes: Si to Si; Glass to Si.

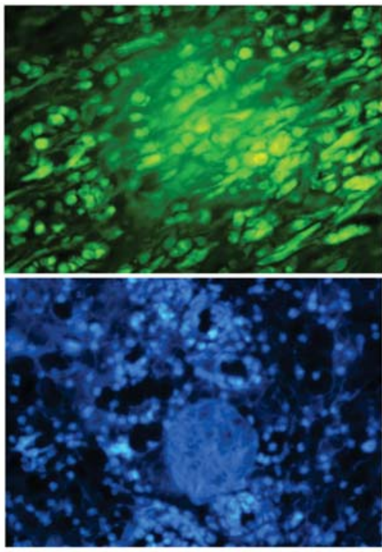
Micro-PIV system

Micro-PIV is an optical, non-intrusive technique measuring the movement of small tracer particles by means of a camera and pulsed laser light.

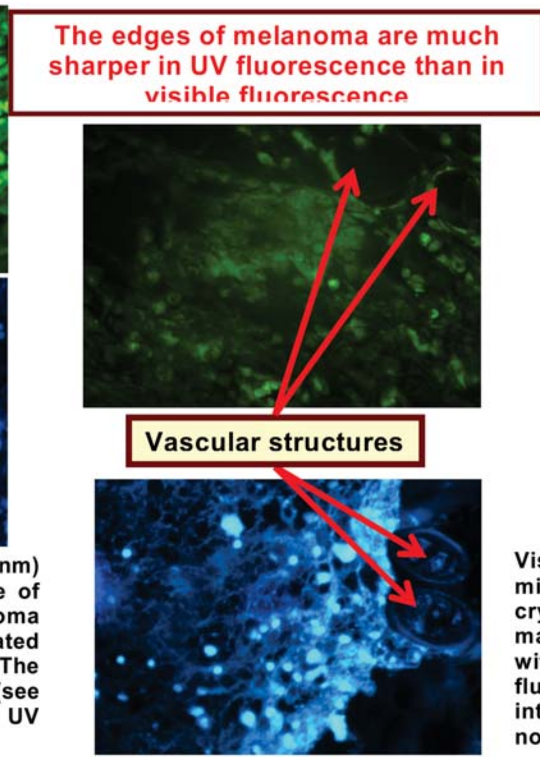


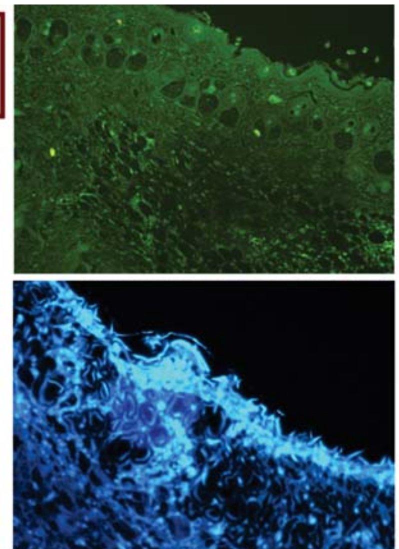
Results

Gold Nanoparticle Uptake by Tumour Cells of B16 Mouse Melanoma – molecular transport by endocytosis



Visible (550 nm) and UV (450 nm) fluorescence microscopic image of the cryosections of B16 melanoma injected with gold coated maghemite nanoparticles. The image is shifted from green (see previous image) to blue in UV

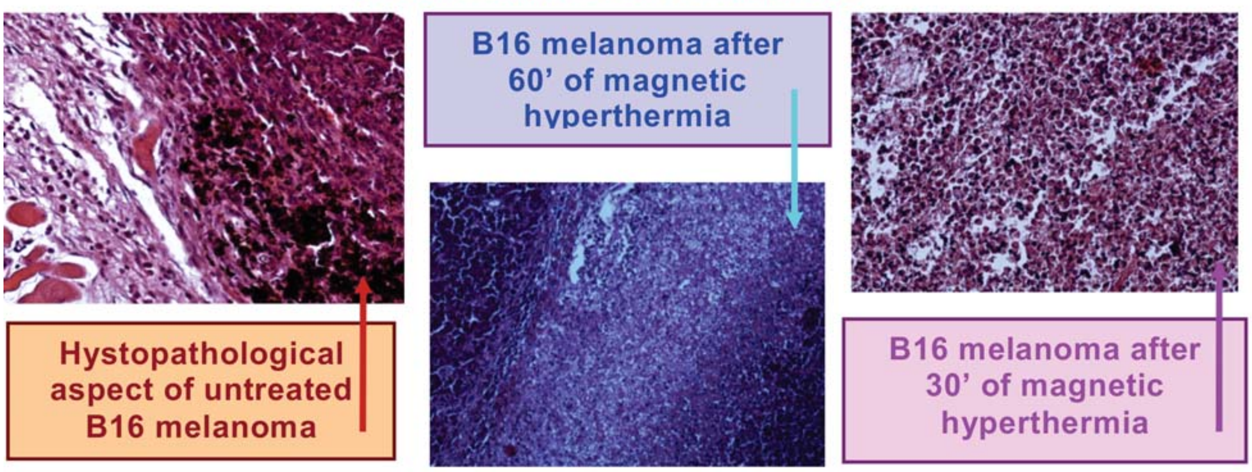


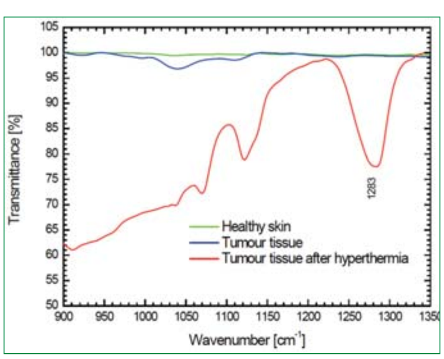


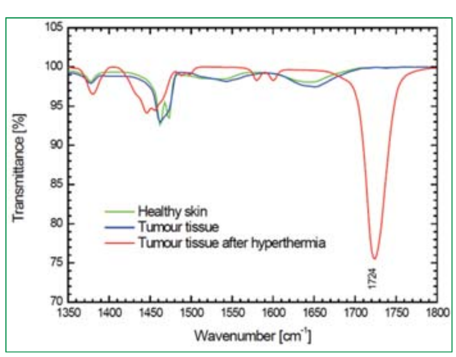
Visible and UV fluorescence microscopic image of the cryosections of B16 melanoma margins after uptake of AuSPION, with well defined border and high fluorescence in epidermis and intracellular in plasma lemma, but not in cell nucleus (x 60).

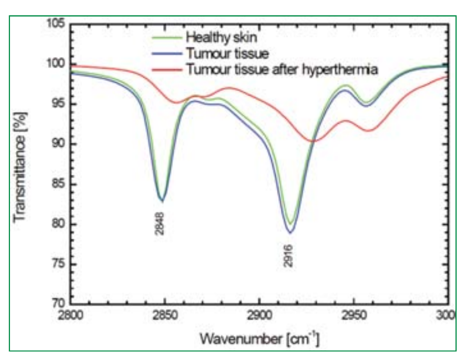
Study of melanoma cells apoptosis induced by magnetic hyperthermia

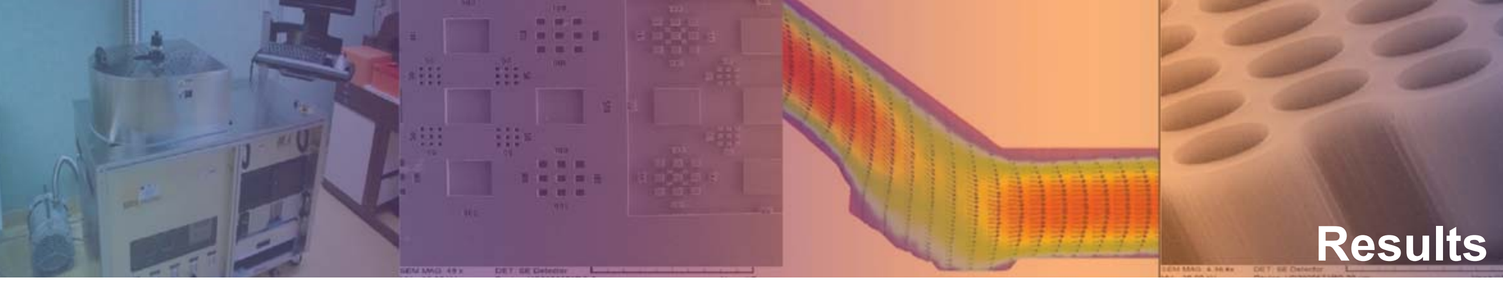
Histopathological aspect of B16 melanoma (Haematoxylin-Eosin stain, x60).



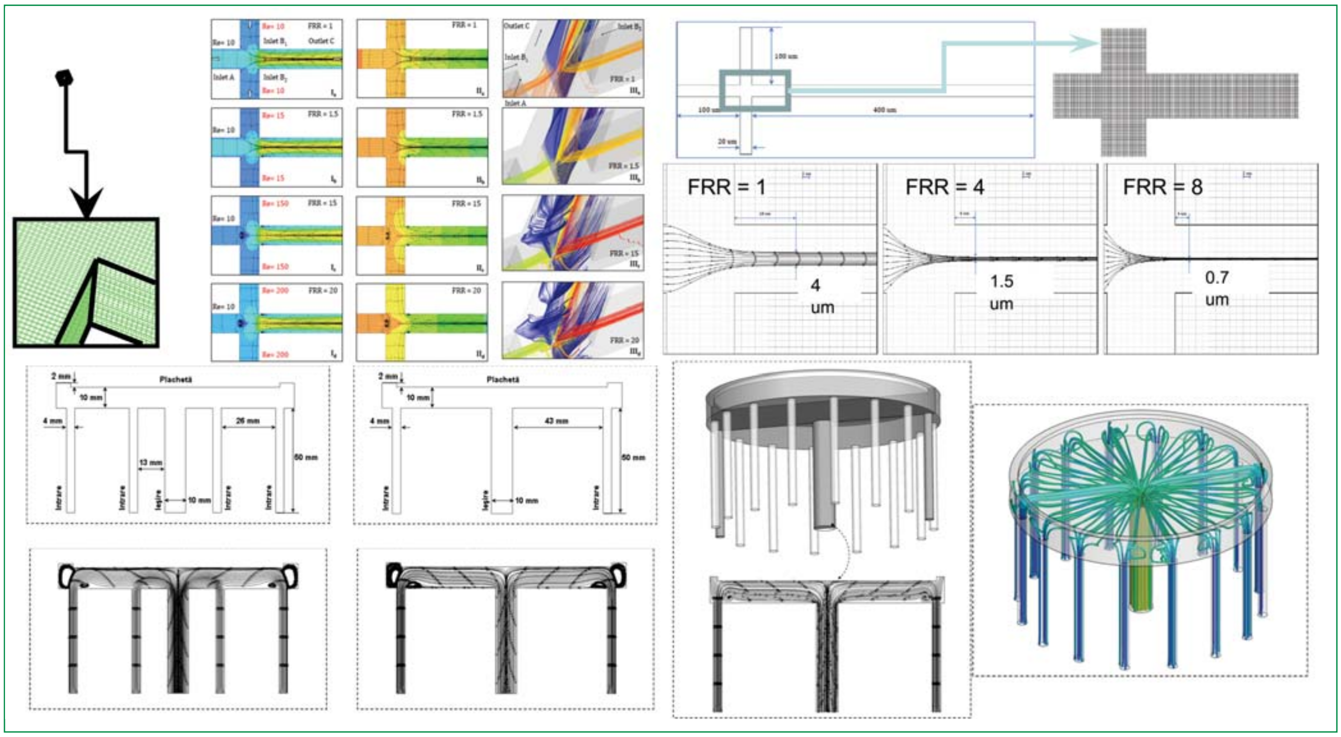






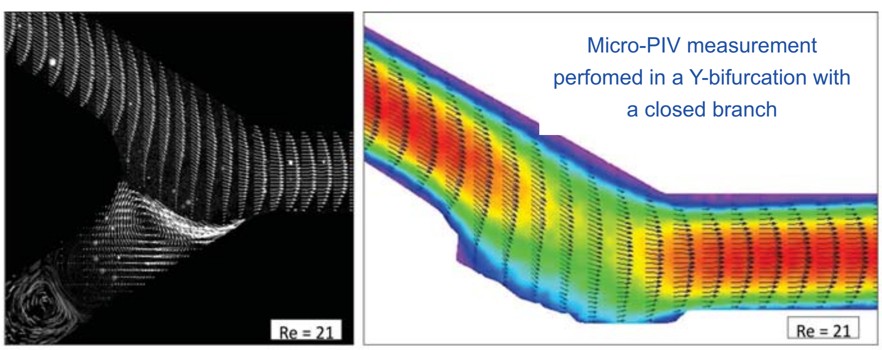


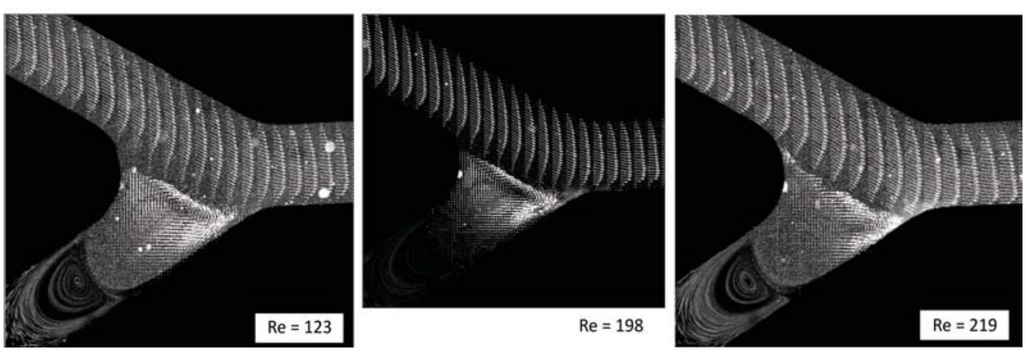
Study of melanoma cells apoptosis induced by magnetic hyperthermia



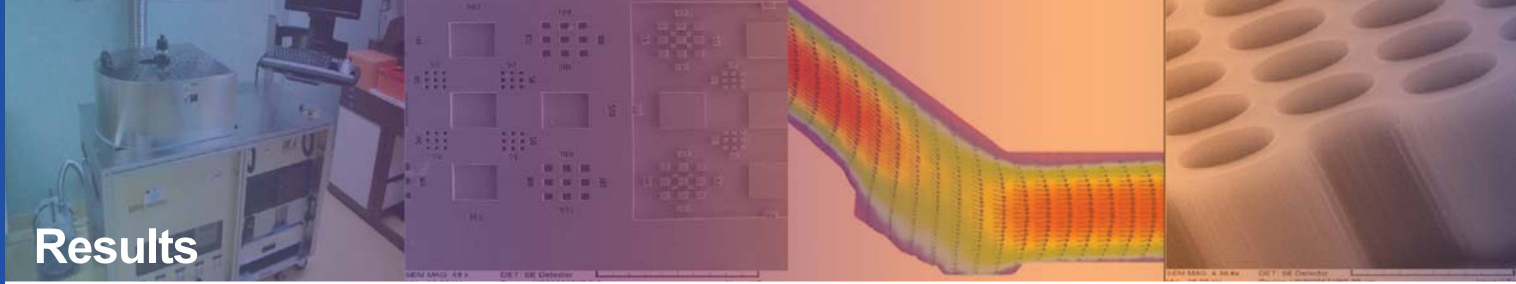
a) Velocity and pressure distributions correlated with streamtraces distributions for different flow rate ratios. b) HF reacting chamber optimization – geometry description; streamtraces and trajectories distributions of the flow.

Experimental and numerical microfluidic flow characterization





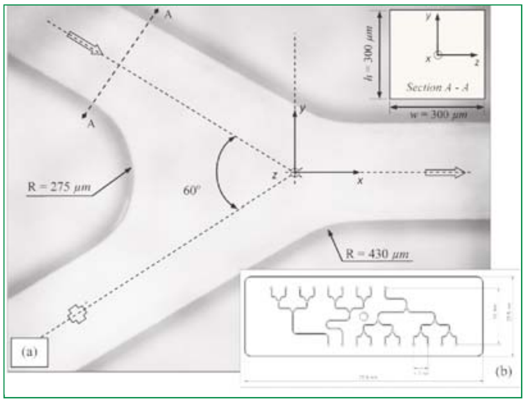
The micro-PIV measurement system is used in obtaining velocity profiles distributions in the main flows domains and in the vortex area. The system can be also used in identifying the vortex centre, stagnation points, and the separation line between the main flow and the secondary one. A well-known method consists in direct comparison of local flow field characteristics with numerical prediction. The flow geometries consist of the Y-bifurcations build under an angle of 60o, with two inlets and one outlet. The experimental methods used are based on (i) microscopic flow visualization – for a quantitative representation of the secondary flows and (ii) micro-PIV measurements – for quantitative measurements of the velocity profiles in a primary flow domain, and for vortex identification.

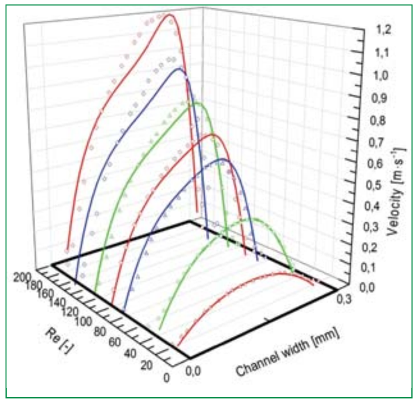


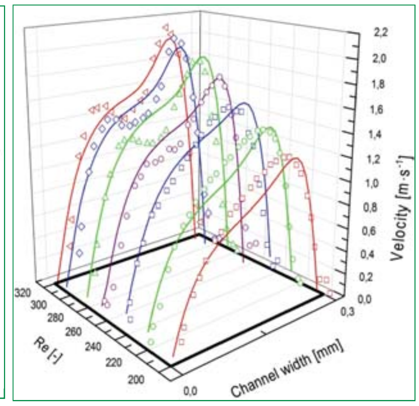
Results

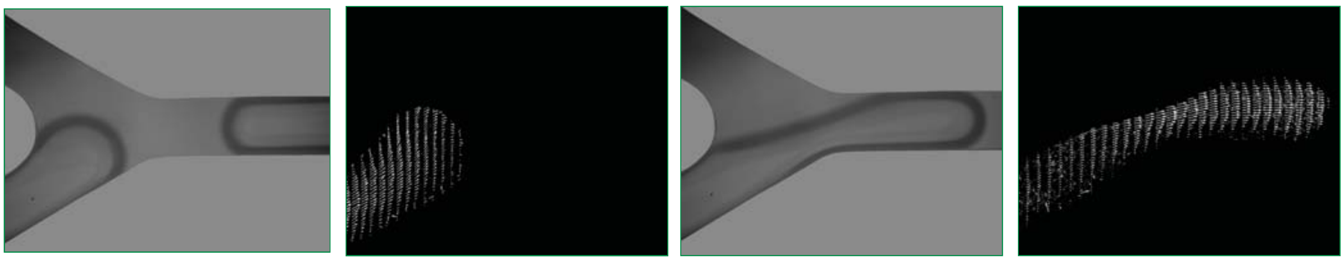
Study of melanoma cells apoptosis induced by magnetic hyperthermia

Experimental and numerical microfluidic flow characterization









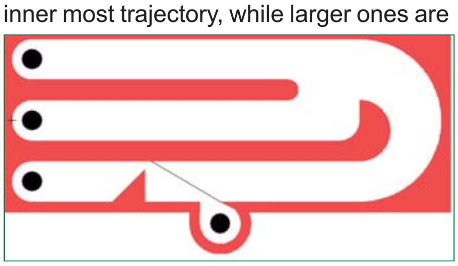
Direct vizualisation on the fluid flow and Micro-PIV measurement perfomed in the Y-bifurcation with two imiscible fluids (water and oil)

Integrated filter for the separation of microparticles with different morpohological, electrical and magnetic properties

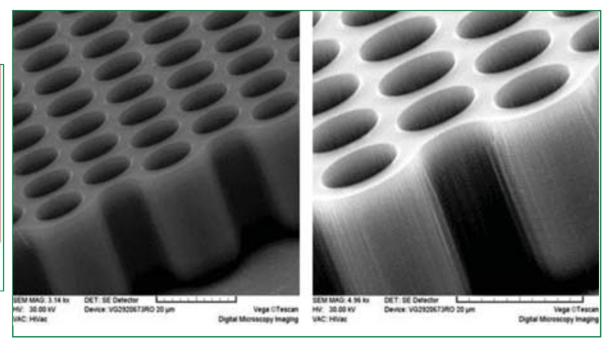
The first filter is placed at the narrowing of the channel. The separation is performed using equql-size pillars with varying spacing (to deflect larger particles towards the first outlet).

The second filtering is performed in the curved section of the filter. The smallest particles follow the inner most trajectory, while larger ones are deflected towards the outer trajectories.

The small size microparticles flow into the magnetophoretic filter, while the larger ones flow into the dielectrophoretic.

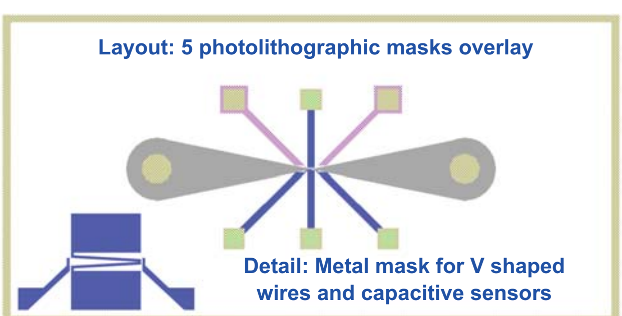


General filter layout and pillars



Active magnetophoretic system for cell separation by means of magnetic fields

The magnetophoretic system comprises two V-shaped conductive wires in parallel planes. One wire is at the bottom of the microchannel (the second one is on top). The wires are aligned to one another during the encapsulation process.



This wire assembly leads to maximum magnetic field gradient in the middle of the channel.

A capacitive sensor is placed at the input and output of the channel, for cell detection. When a cell passes through, the sensor sends an electrical signal.

The voltage through the two conductive wires is applied in such a way that the generated magnetic field is amplified.

A group of magnetic marked biocells will be drawn towards the middle of the channel and will move to the output driven by the magnetic field.

Scientific Events organized by IMT- Bucharest and Publishing Activities

International Semiconductor Conference CAS - IEEE event

The International Semiconductor Conference - former Annual Semiconductor Conference -CAS was the 34th edition in 2011. The aim of the conference is to provide a forum of debate on selected topics of scientific research and technological development. This is an occasion for refreshing a broad perspective of the participants through invited papers and tutorials.
The conference is an IEEE event, beeing sponsored by the IEEE Electron Devices Society. The conference is also sponsored by Ministry for Education and Research, the IEEE - Romania Section and the Electron Devices Chapter and also held under the aegis of the Romanian Academy as well as under aegis of the Electrochemical Society, Inc., including the European Local Section of the Electrochemical Society, Inc. All the contributed and invited papers presented at the conference were published in the CAS Proceedings, an ISI indexed proceedings, delivered to the participants at the beginning of the conference.

The main topics are: Nanoscience and nanoengineering; Microoptics and microphotonics; Micromachined devices and circuits for microwave and millimeter wave applications; Micro and nanotechnologies for transducers, interfaces and microsystems; Micro and nanotechnologies for biomedical and environmental applications; Novel materials and intelligent materials; Power devices and microelectronics (including CAD);

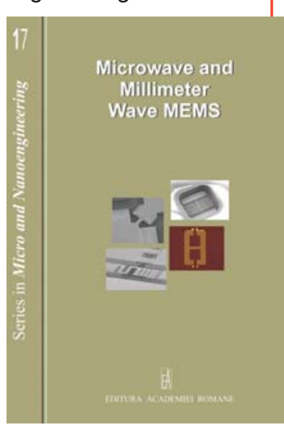
National Seminar for Nanoscience and Nanotechnology,

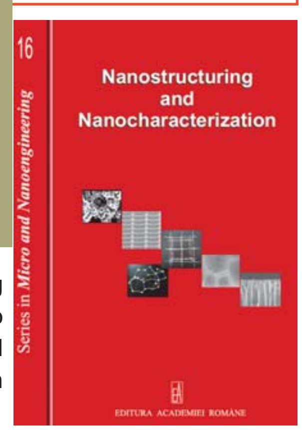
the 10th edition in 2011

IMT is co-organzer together with Romanin Academy (through the Centre for Nanotechnologies of IMT, working under the aegis of the Romanian Academy) of the National Seminar for Nanoscience and Nanotechnology (every year), in 2011, the 10th Edition. The best papers are published in a volume (in English), in a series of books “Micro- and nanoengineering”.

IMT has a crucial role in the publication, not only of the above series, but also of the ISI ranked ROMJIST (Romanian Journal for Information Science and Technology) edited by the Romanian Academy. ROMJIST is publishing a number of issues in micro- and nanotechnologies.

The volumes from the "Micro and Nanoengineering" series are edited by the Publishing House of the Romanian Academy and includes a selection of extended and updated papers presented at national scientific events or papers presented at workshops organized in the frame of international projects (FP6, FP7 and related projects). This volumes are addressed to scientist from universities, research institutes or companies working in the field.





NanoElRei Summit 2011: “Investments in R&D”

The local organizers: the National Institute for R&D in Microtechnologies (IMT-Bucharest) and Infineon Technologies Romania (IFRO), in partnership with the CCIB, University “Politehnica” of Bucharest and Technical University “Gh. Asachi” of Iasi.

The event highlighted the fact that Romania is now a full member to ENIAC-JU, i.e. public funding is provided to Romanian participants in successful projects. The purpose of the Summit was to underline the potential of Romania for nanoelectronics, as illustrated by both the international companies with subsidiaries in this country and the academic institutions (universities and research institutes).

Visits and Education activities at IMT-Bucharest

Officials, for general strategic cooperation:

- Dr. Aravind Padmanabhan *(right image)*, Director of Global Technology at Honeywell Automation & Control Solutions, with chief representatives from Honeywell Romania, September 23, 2011.
- Prof. Olivier Durand, INSA FOTON (France), September 16 , 2011.
- Officials delegation of Rigaku Corporation (Japan), Japan, Sept 16, 2011.
- Dr. Stefan Weiers, the European Commission, May 25, 2011.
- Dr. Romolo Marcelli, Responsible Delegate for CNR-IMM Roma, April 5, 2011
- Dr. Pyeong Rak CHOI, President of Korea Electronics Technology Institute (KETI), March 14, 2011.
- Dr. Mihail Roco *(left image)*, Senior Advisor for Nanotechnology at the National Science Foundation (NSF) and a key architect of the National Nanotechnology Initiative (NNI), January 20, 2011.

Larger delegations in FP7 scientific cooperation events:

- Thales Research and Technology (France), Commissariat à l'Energie Atomique (France), TopGaN Ltd. (Poland), Foundation for Research & Technology-Hellas (FORTH) (Greece), Institut d'Electronique Fondamentale Univ Paris Sud, Chalmers University (Sweden), Uppsala University (Sweden), November 21-22, 2011.
- XLIM –Limoges and University Limoges (France), July 11, 2011.
- Wroklaw Institute of Technology (Poland), Budapest University of Technology and Economics (Hungary), The Netherlands Organisation for Applied Scientific Research, Institute of Electron Technology (ITE) (Poland), National Center for Scientific Research Demokritos IMEL (Greece), INESC Investigação e Desenvolvimento (Portugal), Research Institute for Technical Physics and Materials Science (MFA) (Hungary), Materials Innovation Institute (The Netherlands), WESZTA-T Industrial and Trade Ltd. (Hungary), Volvo technology Co (Sweden), NXP Semiconductors Netherlands BV, June 16-17, 2011.

Master Courses held in IMT-Bucharest

M. Sc. Courses at the Faculty for Electronics, Communications and Information Technology, University "Politehnica" of Bucharest since 2009, (with access to experimental facilities).

▶ **Microsystems**
- → Intelligent sensors and microsystems;
- → Microphysical characterization of structures;

▶ **Micro- and Nanoelectronics**
- → Advanced Technological Processes

▶ **Electronic Technology for Medical Applications**

Micro- and Nanotechnologies for Medical Applications

Hands-on courses:

▶ **"Microsensors"**

Applications lab using MINAFAB Facility. For year IV students at Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest

▶ **Applications lab for RF-MEMS** - M. Sc. Course

Postdoc programs:

→ **Postdoc program** in the areas of **RF MEMS and MOEMS** financed by FP7 MIMOMEMS project (www.imt.ro/mimomems) (2009-2011) – 3 postdoc positions

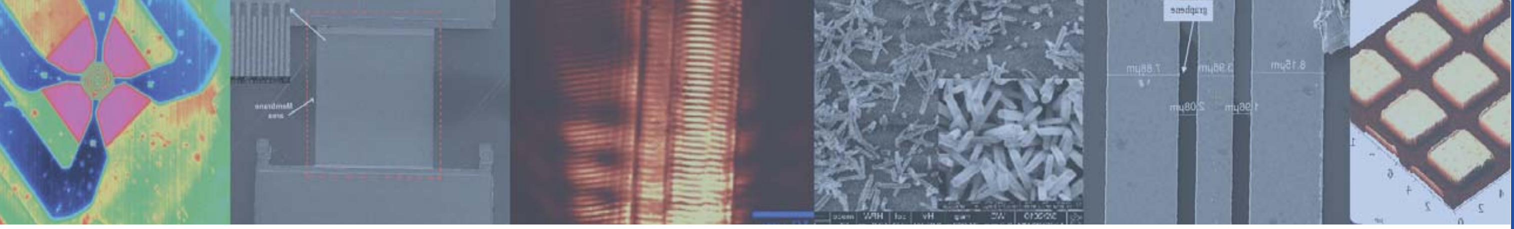
→ **POSDRU** Structural funds project: **"Human resources development through postdoctoral research in micro and nanotechnologies domain"** (April 2010 – March 2013) – financial support for 35 PhD researchers, in a postdoctoral program for the micro- and nanotechnologies domain.

Training by research for M.Sc. and PhD students:

→ INFN - LNF Frascati, Italia – microphysical caracterisation: SEM, XRD, Raman (2009, 2010, **2011**)

→ IESL- FORTH Heraklion, Grecia - microwave circuit simulation and SEM analysis (2009, **2011**)

→ Univ. of Pretoria – microwave circuit simulation and SEM analysis (2010, **2011**)



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2. **M. Miu, M. Danila, I. Kleps, A. Bragaru, M. Simion**, *"Nanostructure and Internal Strain Distribution in Porous Silicon"*, Journal of Nanoscience and Nanotechnology 11, 9136-9142, 2011;

3. **M. Simion**, L. Savu, **A. Radoi, M. Miu, A. Bragaru** *"Detection of Human Papilloma Viruses Using Nanostructurated Silicon Support in MicroarrayTechnology"*, Journal of Nanoscience and Nanotechnology 11, 9102-9109, 2011;

4. **I. Mihalache,** D. Dragoman, *"Graphene analogy to electromagnetic field propagation",* Journal of Optical Society of America B – Optical Physics 28(7), 1746-1751 (2011);

5. A. Stoica-Guzun, L. Jecu, A.Gheorghe, I. Raut, M. Stroescu, M. Ghiurea, **M. Danila,** I.Jipa, V. Fruth, "Biodegradation of Poly(vinyl alcohol) and Bacterial Cellulose Composites by Aspergillus niger", Journal of Polymers and the Environment 19(1), 69-79, 2011

6. M. Mihailescu, M.Scarlat, A.Gheorghiu, J.Costescu, **M.Kusko**, I.A.Paun, E.Scarlat, Automated imaging, identification, and counting of similar cells from digital hologram reconstructions, Applied Optics 50 (2011), pp.3589-3597.

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9. **A A. Muller, D Neculoiu, A Cismaru**, P Pons, R Plana, **D Dascalu, A Muller** "Novel micromachined lumped band pass filter for 5.2GHz WLAN applications "Int J Electron Commun (AEÜ) (2011), 65, 2011, pp 1050-1053

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11. **D. Dragoman and M.Dragoman** , Time flow in graphene and its implications on cutoff frequency of ballistic graphene devices, J. Appl. Phys. 110, 014302 (2011)

12. I.Stavrache, A-M. Lepadatu, V.S. Teodorescu, M.L.Ciurea, V.Iancu, **M. Dragoman**, G.Konstantinidis, and R. Buiculescu, Electrical behaviour of multiwalled carbon nanotube network embedded in amorphous silicon nitride, Nanoscale Research Letters 6, 88/1-6 (2011)

13. **EM. Pavelescu,** C. Gilfert, P. Weinmann, **M. Danila, A. Dinescu**, M. Jacob, M. Kamp, JP. Reithmaier, "1100 nm InGaAs/(Al)GaAs quantum dot lasers for high-power application", JOURNAL OF PHYSICS D-APPLIED PHYSICS Volume: 44 Issue: 14 Article Number: 145104 DOI: 10.1088/0022-3727/44/14/145104 Published: APR 13 2011

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17. **Radoi, A**., Litescu, S.-C., Eremia, S.A.V., **Miu, M., Danila, M., Dinescu, A.**, Radu, G.-L. Electrochemical investigation of a glassy carbon electrode modified with carbon nanotubes decorated with (poly)crystalline gold, Microchimica Acta, 175 (1-2), 97-104 (2011)

18. **Radoi A., Dragoman M**., Dragoman D., Memristor device based on carbon nanotubes decorated with gold nanoislands, Applied Physics Letters, 99 (9) 093102 (2011)

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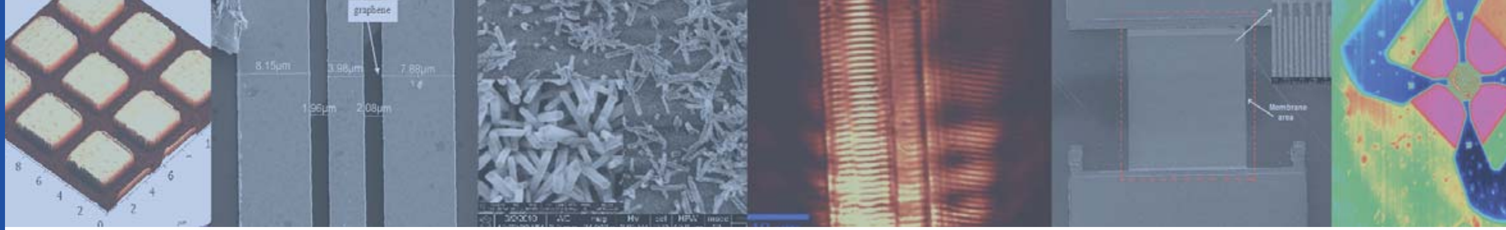

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20. Iliescu, C; **Avram, M**; Chen, B; Popescu, A; Dumitrescu, V; Poenar, D. P; Sterian, A, Vrtacnik, D; S. Amon, P. Sterian, Residual stress in thin films PECVD depositions: a review, JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Volume: 13 Issue: 2-4 Pages: 387-394 Published: 2011

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22. **Popescu, V**.; Popescu, G. L; Optical properties of lead sulfide films obtained by chemical bath deposition from static and ultrasonic baths; JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Volume: 13 Issue: 7-8 Pages: 926-932 Published: JUL 2011

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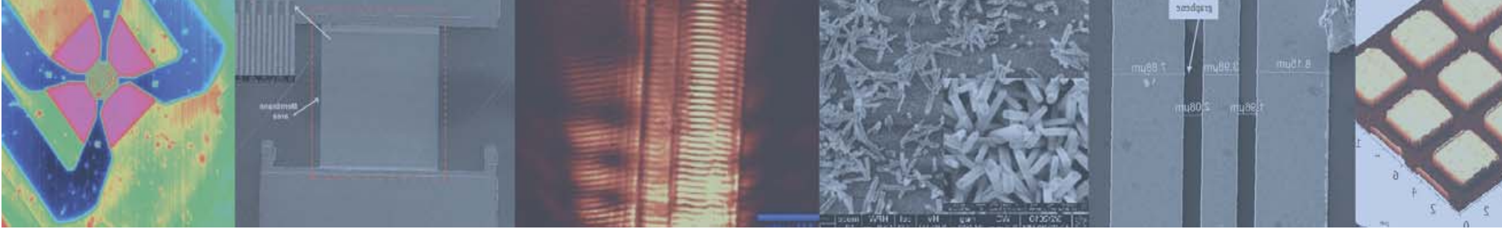

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4. **C. Moldovan, R. Iosub, M. Ion, C. Brasoveanu** "Ink Jet Printing Technology for Gas Sensors on Paper Substrate", Second International Conference on Multifunctional, Hybrid and Nanomaterials 6-10 march 2011,Strasbourg, France, poster

5. **A.C. Obreja, D. Cristea, R. Gavrila, V. Schiopu, A. Dinescu, M. Danila, F. Comanescu**, FunctionaliZed Graphene/Poly 3-Hexyl Thiophene based Nanocomposites, Proc. of IEEE International Semiconductor Conference CAS 2011 , Sinaia, Romania, 17-19 Oct. 2011, pp. 27-30.

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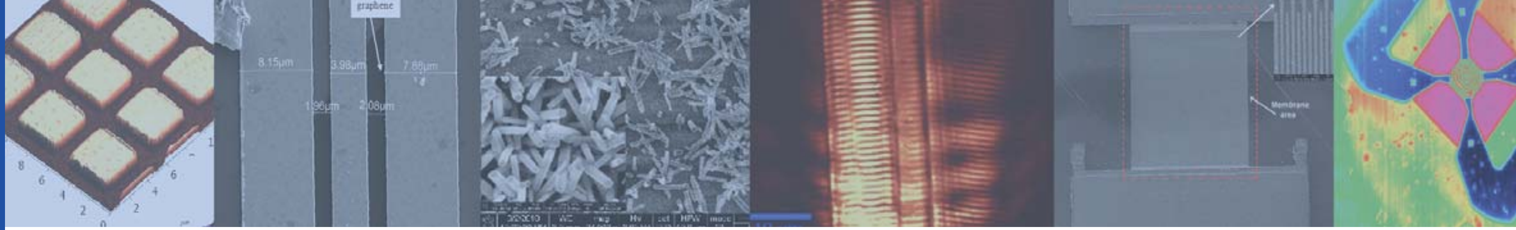

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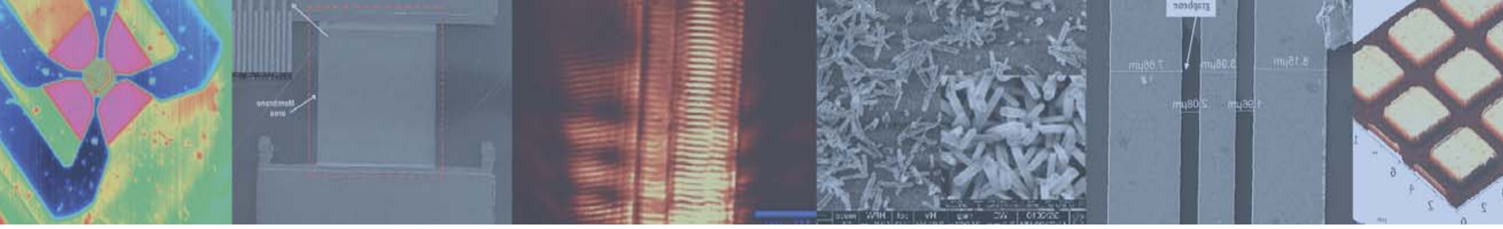

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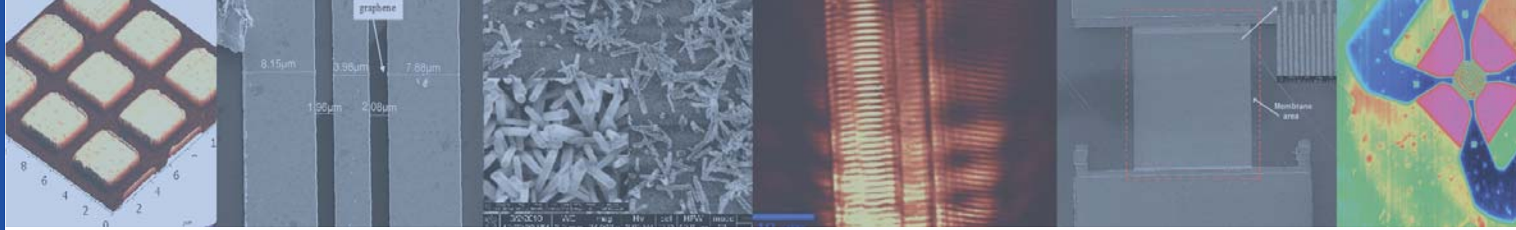

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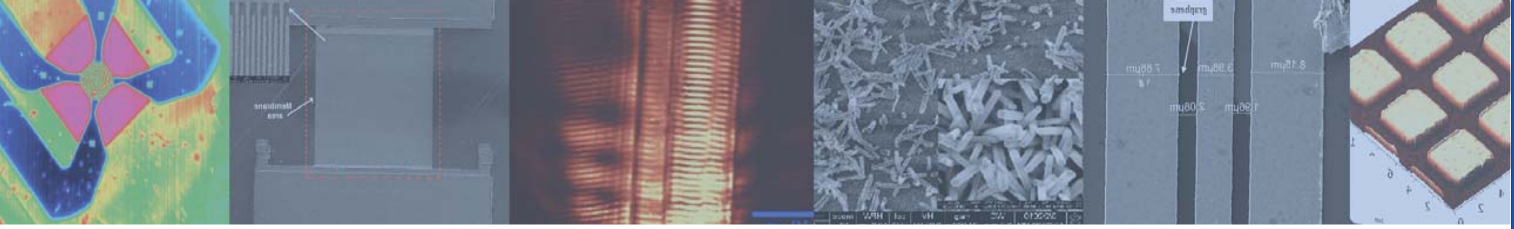

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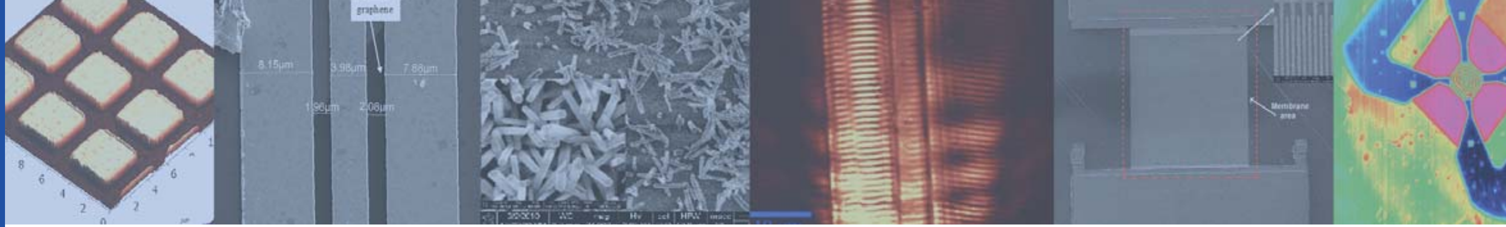

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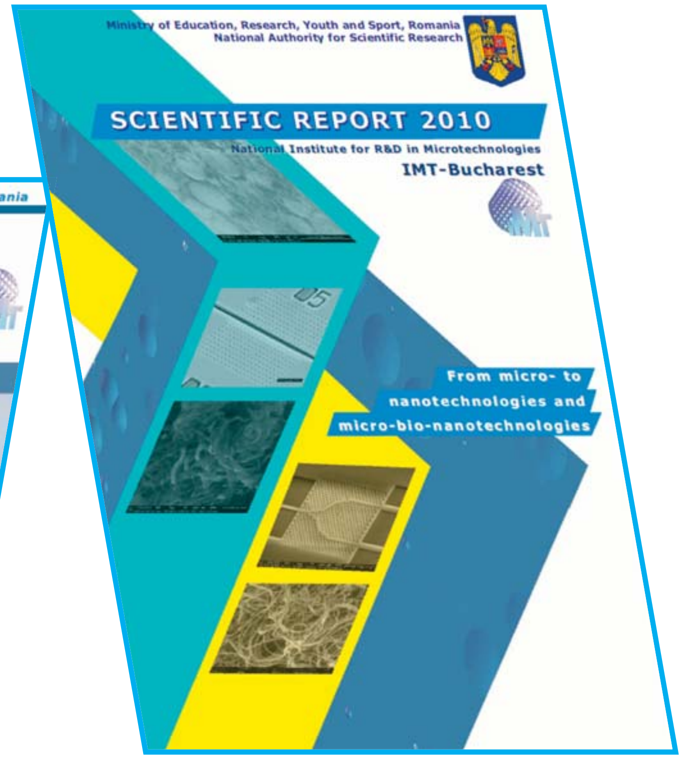

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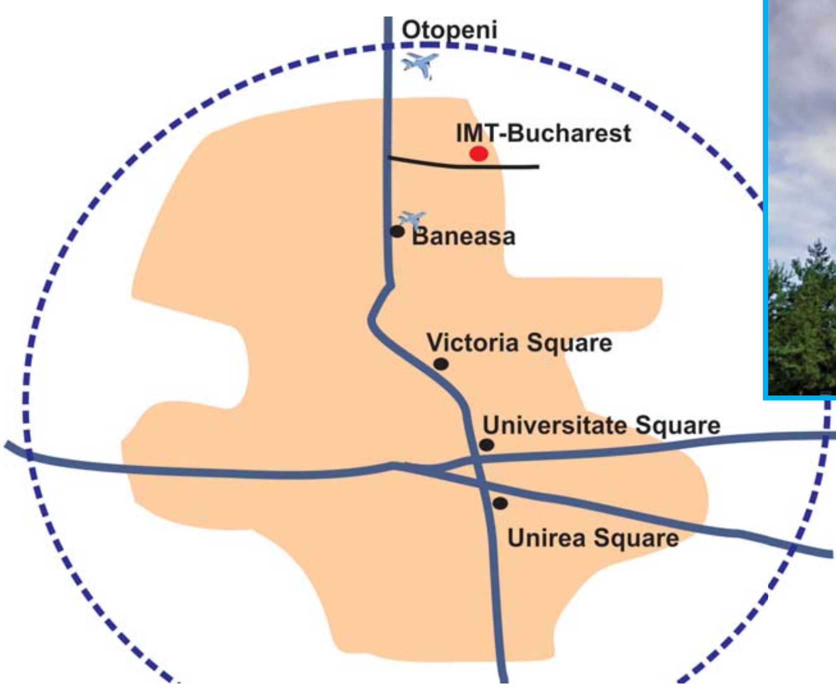

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